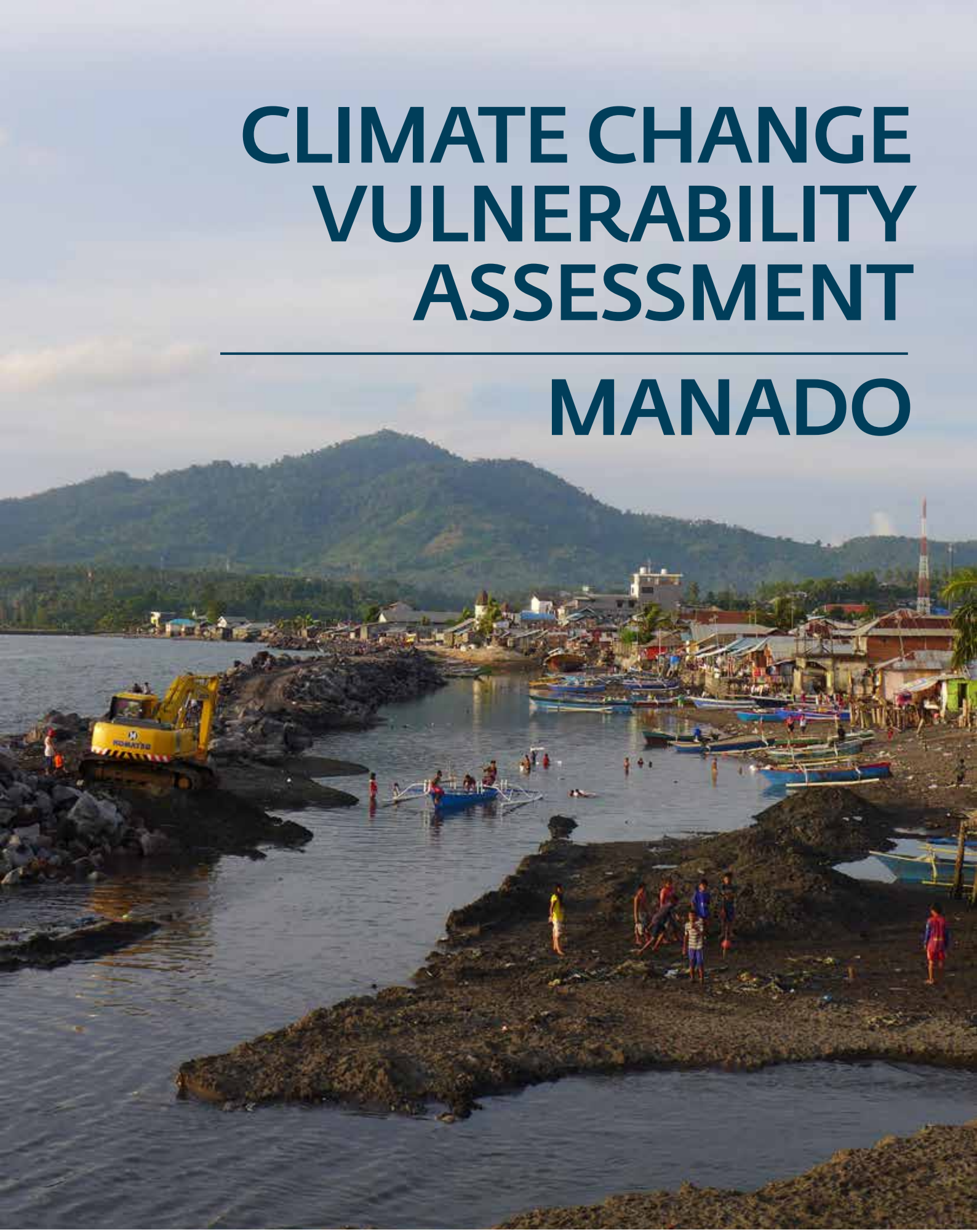
CLIMATE CHANGE VULNERABILITY ASSESSMENT

MANADO



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CLIMATE CHANGE RESILIENT DEVELOPMENT

CASCADIA CONSULTING GROUP

Kota Kita

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CITY OF MANADO

CLIMATE CHANGE VULNERABILITY ASSESSMENT

September 2014

The following Climate Change Vulnerability Assessment draws from site visits, workshops and inputs from interviews with local government and stakeholders conducted in 2013 and 2014. This report serves to develop an urban infrastructure inventory and linkages with other considerations that will support climate resilient planning efforts. The report also aims to demonstrate a rapid climate vulnerability assessment approach for infrastructure services.

The range of linkages includes thoughtful urban development and expansion along the coast that is sensitive to the surrounding marine ecosystems, as well as strategic expansion of the urban core that is sensitive to flooding and landslide issues.

The objective of this document is to assist the local government with identifying climate related vulnerabilities, possible impacts on key infrastructure and to enhance institutional capacities to effectively increase resilience throughout the City of Manado. Specifically, the Climate Change Vulnerability Assessment aims to: build an understanding about how the city is exposed to climate change hazards by identifying and documenting vulnerabilities to urban infrastructure, and identifying the government's capacity gaps and institutional needs; provide a set of planning recommendations to key government agencies that aligns future development with the city's goals while strengthening climate change resiliency; and design and implement a set of tools and training materials to address capacity building needs related to climate change awareness and response for urban infrastructure assets and future projects.

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Figure 1: Children are the future of Manado. Identifying infrastructure and areas vulnerable to climate change can help the government address these issues and increase capacity to respond to the adverse effects of climate change.

Executive Summary

THE CITY OF MANADO IS PERCHED IN A DELICATE BALANCE; ON ONE SIDE ITS FORTUNES ARE RAPIDLY BEING TRANSFORMED BY URBANIZATION AND ECONOMIC GROWTH, AND ON THE OTHER, IT IS THREATENED BY THE DAMAGING IMPACTS OF CLIMATE CHANGE.

Manado is a coastal city known for its natural beauty and diverse marine ecology, it has become both a national and international tourism destination and a thriving regional center. The city is growing quickly, building new infrastructure, expanding its waterfront and adding new housing to keep up with rising demand. Manado's City Vision, reflecting citizen aspirations, is intended to guide future development. The City Vision has three components: the Green City, a Commercial Center and a Regional Destination.

Planned development projects and other initiatives are already working towards achieving these goals. As this happens, impacts from climate change are having a disruptive impact on the people of Manado. Unpredictable and heavy rains are causing landslides that damage homes and property, flooding frequently disrupts business and traffic, and the noticeable effect on the city's bay is deteriorating the coral reefs that draw many visitors to the city each year. In one city, two distinct phenomena of climate change and urbanization, are influencing the future of the city and its people.

Manado's most recent climatic event in January 2014 is a powerful reminder of the damage that climate change can have on the city. On this occasion heavy rainfall submerged 75% of the city, causing damage homes, disrupted businesses and destroyed infrastructure such as roads, bridges and public services. The total damage was estimated at USD $45 million, or some 650 billion Rupiah. While this event was more serious than flooding the year before, of even greater concern is the recurring nature and frequency of flood events indicate that climate hazards are becoming increasingly common.

The confluence of these two forces is the subject of this Climate Change Vulnerability Assessment. The assessment was carried out in collaboration with the city government of Manado and made possible by the United States Agency for International Development Agency (USAID) and their Climate Change Resilient Development (CCRD) grant initiative.

The objective of this vulnerability assessment is to support the city government's efforts to reduce vulnerability, while taking advantage of the opportunities that come with urban growth and economic prosperity to achieve the city's vision.

To this end, this report aims to identify the city's most vulnerable communities and demonstrate how critical urban infrastructure systems are being impacted by climate change. Recognizing the need to better understand and plan for these impacts the vulnerability assessment helps to facilitate dialogue and consensus building around areas in need of further capacity building and institutional support. A set of conclusions and recommendations is offered to provide guidance for future city actions.

Vulnerability Assessment Findings

The vulnerability assessment demonstrates that exposure to climate change is having an impact on the City of Manado. Forces of unpredictable and heavy rains, sea-level rise and droughts all have harmful effects on the region, but different urban systems and different areas of the city are impacted in different ways. Areas that are particularly exposed to climate hazards range from coastal areas with sensitive ecosystems to steep hillsides prone to landslides. Climate change impacts can also be exacerbated if these areas lack roads and services, have lower levels of education and access to information, or rely heavily on economies that are climate-sensitive. These areas will respond differently to climate change impacts compared to areas that have better access to emergency assistance, higher investment in infrastructure and public services. Recognizing that vulnerabilities are not spread evenly throughout the city invites the government to plan and respond to needs accordingly.

People rely heavily on urban systems for daily life. These systems, such as citywide water delivery or drainage systems extend throughout the city, affecting many people at the same time. By identifying and focusing on deficiencies and opportunities to bolster these systems, making them more resilient to sudden shocks, can have far reaching impacts in increasing the resilience of the city. For example, ensuring that trash is effectively collected and treated can help reduce drainage problems and pollution to the city's rivers and consequently the marine wildlife of offshore islands.

Given the critical importance of urban systems on city management, if any deficiencies are not adequately addressed then climate hazards can exacerbate environmental, social and economic problems in the city.

Cities have the capacity to reduce vulnerability to climate change by adopting proactive policies that increase the adaptive capacity of communities and institutions, and reduce sensitivity to climate hazards. Both physical and non-physical interventions are needed and encouraging signs are evident of the City of Manado's willingness to promote these approaches. From local development grants to support small-scale improvements to mapping areas of risk and raising awareness, these are signs of a proactive city government.

Thematic Questions

This executive summary frames the findings of the vulnerability assessment in the form of thematic questions for the city leaders, citizens and policy makers of Manado to reflect on as they strive to reduce the city's vulnerability.

The following three questions highlight key issues and challenges facing city government and aim to facilitate the transition from assessment to strategy development and implementation. They provide direction to support understanding planning problems and identifying lines of enquiry that will lead to effective solutions.

1. What role can governments play in directing and promoting development in safe places that reduce vulnerability to climate change?

Cities like Manado are growing so rapidly that they present a challenge to governments to effectively plan

and direct growth, ensuring that development occurs in areas that are safe. With private developers and individual households building in areas that may be vulnerable, and by doing so creating risks for those around them, governments need to find ways to identify designated areas to promote development.

This is made more difficult by the lack of resources available to governments to invest in infrastructure, as well as jurisdictional issues of planning in the neighboring districts that surround the city.

2. How can cities reduce their vulnerability to the economic shocks that may come with climate change, when they rely so heavily upon a dominant economic sector?

Many cities rely heavily upon one economic sector. To become more resilient to climate change shocks, it would be beneficial to diversify. Developing new industries and sources of employment is not easy, and can be even more challenging to do when maintaining the city's natural beauty and setting are also priorities. With tourism being Manado's dominant economic sector, the government needs to balance its reliance upon the natural beauty and coral reefs with a need to grow and diversify its economic base.

3. How can emerging cities develop and reap the benefits of investment and growth that come with rapid urbanization without putting their environment and vulnerable populations at risk?

Manado is finding ways to ensure that its growth and development are socially inclusive of the poor, and also does not sacrifice the environmental principles of the city. In the context of rapid growth, it is important that the values of social equity, access to economic opportunities and sustainable balance with natural ecosystems be maintained, as they contribute greatly to urban resilience.

4. How can efforts to build resilience locally be supported by improvements to urban systems that reach throughout the city?

Climate change impacts affect people at different scales, but with limited resources, city governments are best positioned to affect change by strategically focusing their resources and capacity at the city scale. Such interventions can help reduce vulnerability and promote resilience at the individual, household and community levels.

Recommendations

Recommendations were compiled from a workshop held in Manado on June 17th 2014. The workshop was an inter-sectoral discussion between leaders of various government agencies concerned with climate change adaptation issues, as well as representatives of civil society organizations and Sam Ratulangi University.

The following general recommendations are directed towards the government of the City of Manado.

- Campaigns are needed to raise public awareness
- Better maintenance and management of systems are necessary
- Strategic infrastructure is needed
- Regulations are needed and existing laws should be enforced
- Improved coordination is required

Detailed recommendations that refer specifically to each of the infrastructure systems are summarized below. These are disucssed in more detail in Section 5.

Water supply and drainage systems

- Implement seawater desalination plants to support water supply
- Implement rainwater harvesting to support improved water access
- Improve overall connectivity of the drainage system
- Expand the primary drainage system
- Protect conservation areas of the watershed

Solid waste management system

- Create an inter-regional waste management strategy
- Raise community awareness of waste reduction and recycling
- Build temporary transfer points and expand the existing landfill

Road and traffic system

- Promote the use of public transportation and improve pedestrian and bicycle amenities
- Restrict the number of vehicles in the city center
- Strategically disperse commercial activity and job creation
- Build transit centers to encourage use of public transportation

Drainage systems and coastal development

- Coordinate efforts to preserve rivers and watersheds
- Create regulation for new development to install infiltration ponds
- Improve awareness and enforcement of government regulations

The City of Manado reminds us of the importance of balancing the relationship of urban development and the natural environment, particularly as the city faces mounting climate change impacts. Although urbanization is occurring rapidly it is possible to guide city development a way that achieves a more sustainable, safe and secure future. The public's awareness of the need for effective stewardship of the natural environment, and the government's leadership in promoting local neighborhood resilience-building initiatives serve as encouraging signs, but more proactive planning is necessary to ensure that balance is maintained.

Figure 2: Settlements along the Tondano River.

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Figure 3: Manado's economic potential is connected to the sea. Not only is the Bunaken National Park known as a national and internation tourist destination, but many livelihoods depend on the city's relationship with the coastline and the sea.

1 Introduction and Background

Climate change is affecting communities and regions throughout the world: sea-level rise affects island nations in the Pacific, more frequent and severe flooding disturbs low-lying river communities, and arid regions face more prolonged droughts. In urban areas, the effects of climate change can be difficult to discern because cities are complex, with a concentration of different people, activities, ecosystems and services. One climate change impact might cause a number of different effects. For instance, where prolonged dry seasons in an isolated rural area may affect one community's subsistence, the very same climate phenomenon experienced in a city might have a cascading effect that spreads to thousands of people, their jobs, public institutions and the urban economy. An urban climate change vulnerability assessment attempts to identify and make sense of the challenges that cities are facing in relation to climate change and urbanization.

Indonesia is the world's largest archipelago, consisting of about 17,500 islands, 3.1 million square kilometers of territorial waters, almost 2 million square kilometers of land area, and 81,000 kilometers of coastline. With an estimated population of 267 million inhabitants in 2013, it is the fourth most populous country in the world. Indonesia supports tremendous species diversity of both animal and plant life in its rain forests and rich coastal and marine areas. The landscape is also mountainous, volcanic and rich in natural resources with deposits of petroleum, natural gas and metal ores. The country's macro-economic development over the past 35 years has largely been based on its natural resources.

MANY CITIES IN INDONESIA TODAY ARE FACING TWO CHALLENGING REALITIES; THAT OF RAPID POPULATION GROWTH AND THE IMPACTS OF CLIMATE CHANGE.

Rates of population growth and urbanization are very high. Rapid urbanization offers the benefits of larger economies, increased human resources, and potentially more development opportunities. Rapid population growth, however, also strains public services and infrastructure, increases unsafe informal sector employment, causes pollution and overwhelmed ecosystems, and leads to immobilizing traffic. Effects of the informal economy, including lack of regulation of industries and lack of sanitation, in addition to high density of development and the presence of slums, all contribute to deteriorating urban ecosystems. Inadequate and poorly maintained drainage infrastructure, sewage and solid waste management systems lead to public health outbreaks and eutrophication of the sea water. Climate change impacts in rural communities mean that cities are attracting migrants, often without a clear plan to cope.

Manado is located at the northern tip of the island of Sulawesi. Climate change data projections for the larger region indicate Manado will be affected by unpredictable seasons and shifting weather patterns that will make the livelihoods of many farmers and fishermen increasingly unstable and vulnerable. Increased precipitation particularly during heavy rainfall events is projected. These devastating rains and floods may uproot families and cause them to seek safety and refuge in urban areas. These are just a few of the many reasons that migrants continue to seek a better future in urban areas. The city is often seen as a place that offers stability and opportunity.

Manado is experiencing many of the same challenges that cities across Indonesia face today: it is urbanizing quickly and is also threatened by climate change risks. Urbanization is relevant in a county in which over 120 million people live in cities, over half the country's total population. Interestingly, much of this growth is happening in secondary cities, like Manado. In fact, around 100 million people are either living in, or moving to cities of under one million people. While rural areas and livelihoods are highly vulnerable to climate change, cities are far from immune and are also faced with major challenges because they concentrate large numbers of people where the impacts are experienced. Cities are also often located in geographies (along coastlines or near water bodies) that are exposed to sea-level rise, flooding and droughts.

In January 2014 Manado suffered from a particularly intense period of heavy rainfall, causing flooding and landslides in the city. The flooding submerged around 75% of the city, impacts were particularly felt in dense neighborhoods along riverbanks and on hillsides, where landslides caused significant damage to homes. The flooding affected around 87,000 people, or some 25,000 households, and led to temporary displacement of families, and loss of property. In total the city suffered some $45 million worth of damage to infrastructure, including roads, river dykes and bridges.

The Mayor of Manado is aware of the importance of preparing his city for such growth and is taking measures to transform the city into a regional urban center. The city government is expanding infrastructure, developing public services and shaping the landscape for urban projects. By engaging in the vulnerability assessment they are also building an understanding of how these urban growth dynamics interact with climage change trends and impacts.

Within this context, the vulnerability assessment aims to shed light on the confluence of growth dynamics with that of climate change impacts. The assessment is comprised of a Climate Change Vulner-

CLIMATE RESILIENT DEVELOPMENT APPROACH

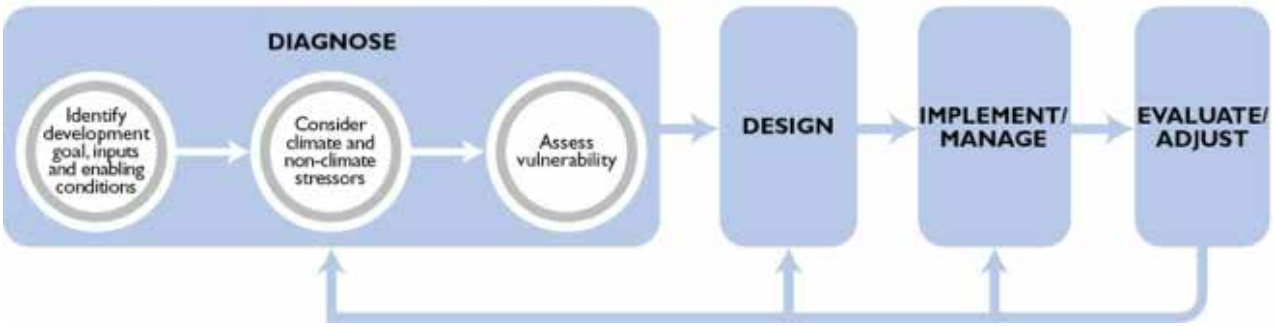

Figure 4: Climate Resilient Development Approach diagram
Source: USAID 2013 Climate Resilient Development: A Guide to Understanding and Addressing Climate Change

ability Assessment and an Infrastructure Vulnerability Assessment. Together, these perspectives present a thorough evaluation of climate change threats and impacts and begin to indicate more sustainable solutions, and the potential of institutions and communities to strengthen their adaptive capacity.

Within the Climate Resilient Development (CRD) framework, the Vulnerability Assessment serves as an integral part of the Diagnose stage. This is the typical starting point for a strategy, because it is directed toward understanding how to achieve development outcomes while taking into account the impacts of climate change. The Diagnose stage helps stakeholders identify what is both important for development and vulnerable to climate stress.

Findings from the vulnerability assessment should feed into the subsequent stages of Design, Implement/Manage and Evaluate/Adjust. In the Design stage, adaptation options and an adaptation approach is designed. The adaptation approach is then implemented and managed, and in the final step, the actions are monitored, evaluated, and adjusted, to improve their effectiveness in increasing climate resilience.

Issues and challenges documented in this vulnerability assessment will be critical in identifying indicators to guide monitoring and evaluation as the city continues to pursue climate resilient development.

This Vulnerability Assessment was supported by the United States Agency for International Development (USAID) through a grant from the Climate Change Resilient Development (CCRD). It was made possible through collaboration with International Resources Group (IRG) and Cascadia Consulting, with the full support and collaboration of the city government of Manado.

1.1 Objectives of the Vulnerability Assessment

The Climate Change Vulnerability Assessment (CCVA) is composed of three complimentary sections of analysis: a general Vulnerability Assessment where the components of Exposure, Sensitivity and Adaptive Capacity are individually analyzed in the Manado context; an Infrastructure Vulnerability Assessment; and finally a set of recommendations on how to foster and increase local institutional adaptive capacity. The recommendations are intended to enhance disaster preparedness plans and improve efficiency on institutional response for the benefit of vulnerable and poor communities for the City of Manado.

The intended audience of this CCVA is primarily local government officials, policy makers and key members of organizations and institutions working to improve urban systems and living conditions of poor and vulnerable communities in the City of Manado. This assessment will also inform community leaders, NGOs and CBOs, and others interested in increasing their awareness or taking action to mitigate potential climate change hazards in the city.

This Vulnerability Assessment is intended to serve as a planning tool as well as an advocacy document to guide decision making about effective responses to issues related to climate change impacts. While the assessment is created in collaboration with the city government of Manado, all stakeholders can use the assessment to understand the nature of these issues and consider possible responses.

The recommendations from this CCVA can be used to:

- Identify priority urban systems, places and populations that are being impacted by climate change and inform ways that their adaptive capacity can be supported for greater climate resilience.
- Design appropriate social, environmental or governance related policies and programs that target specific issues, systems and weaknesses, and help the city build resilience to climate change impacts.

- Inform planning decisions at the city and neighborhood levels, and help key public officials make strategic decisions about the city's direction in partnership with communities, civil society, and provincial and central government.

1.2 Methodology

The research team gathered information from available government data and maps, as well as through numerous observation field trips, community meetings, focus group discussions and interviews with civil society organizations, community members and government officials. Data was analyzed and structured by the research team to align with the components of the Vulnerability Assessment. Criteria used to assess each component was developed to create citywide vulnerability maps that take into account identified urban trends and characteristics. The results of the analysis were then discussed internally among team members and presented to government officials and civil society members for verification and feedback. As such, the CCVA compiles and synthesizes a great deal of information from the metropolitan, city, as well as neighborhood scales.

1.3 Structure of the Report

The Vulnerability Assessment is structured as follows: the report begins with an overview of the City of Manado, trends that influence its growth, the Mayor's vision for city's future, and recenlty completed or planned development projects. Section 3 examines climate change issues and vulnerability, analyzing how exposure, sensitivity and adaptive capacity may vary throughout the city and how these factors determine the geography of vulnerability. Section 4 explores how climate change puts the city's infrastructure systems at risk. Finally a summary and set of recommendations in Section 5 provides guidance for further steps as the city moves forward in building resiliance.

While multiple sources of data are referenced in the report, the primary source is the *Manado Dalam Angka, 2012-2013* information handbook.

1.4 Limitations of the Study

Official information and data from city level government agencies was the main source of secondary data for this assessment. Among the challenges faced during the data analysis phase was that some information was incongruous, outdated or not to the spatial level of analysis needed. Time to access data, meet additional stakeholders and explore deeper into identified issues are recognized as limitations for this Vulnerability Assessment.

In addition, the Vulnerability Assessment is grounded in the understanding of two political, socioeconomic and environmental phenomena: urban growth and climate change. Considering both are extremely complex and dynamic fields, and that the interaction of the two create a variety of possible scenarios and outcomes, Kota Kita confirms that the situation analyzed in this Vulnerability Assessment is, to the best of our ability, a fair assessment of the current situation in the City of Manado and aspires to be referenced as a baseline for future climate-related analysis.

As Manado continues to develop its city vision and climate models improve over time, the set of recommendations and conclusions from this Vulnerability Assessment will diminish in relevance for city planning. Climate change analysis should ideally be a reiterative process led by the city government in order to ensure adaptive actions are based on updated and timely information.

Unless otherwise noted, the geographic scope of this assessment is the municipal boundary of the City of Manado. Exceptions were given to cases where the ecosystems or impacts of urban growth extend beyond the city to the larger metropolitan area.

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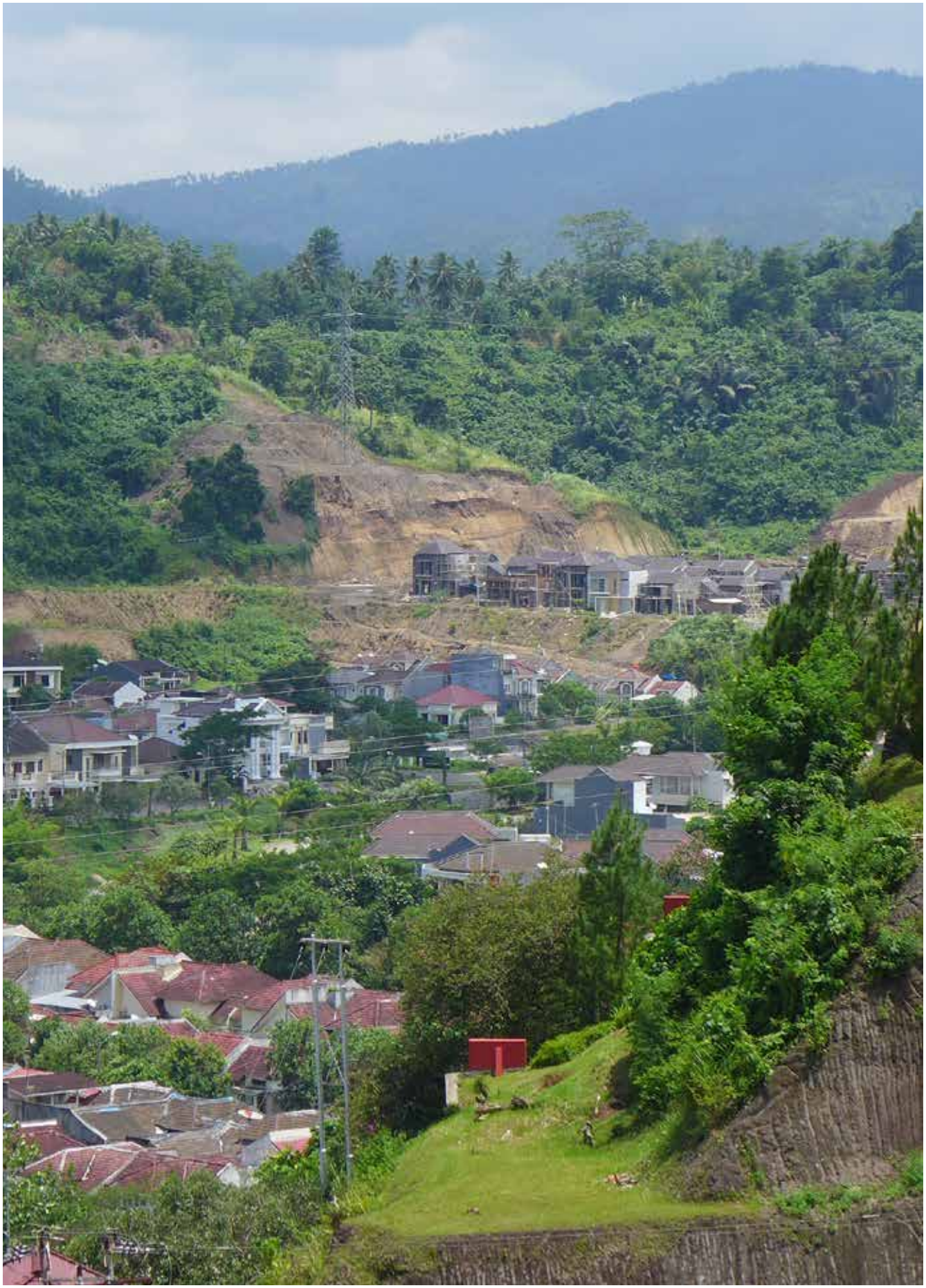


Figure 5: Manado is growing; new housing and commercial developments in the periphery are re-shaping the landscape. The deforestation and leveling of hillsides to make way for this development affects drainage systems and causes increased risk of flooding in he city center.

2 City of Manado Overview

Manado has a population of just under 500,000 inhabitants. Though Manado is not a large city, it plays an important role in the region due to its growing economy and position as the provincial capital of North Sulawesi. Given that it has an international airport, seaports, hosts national and international conferences and hotel infrastructure of a city twice its size, it has characteristics of a much larger city. There are a number of ambitious projects that the city is undertaking that reflect its regional importance, including: the extension of the airport runway, a new regional bus terminal, a new port for cruise liners, a ring road, and coastal reclamation projects to promote commercial and real estate development projects.

2.1 City Profile

Geography

Manado is the capital city of North Sulawesi province, at the northern tip of the island of Sulawesi. To the north, the region borders the Philippines, Sulawesi

REGIONAL MAP OF SULAWESI

Figure 6: City of Manado location on Sulawesi Island.

MAP OF THE PROVINCE OF NORTH SULAWESI

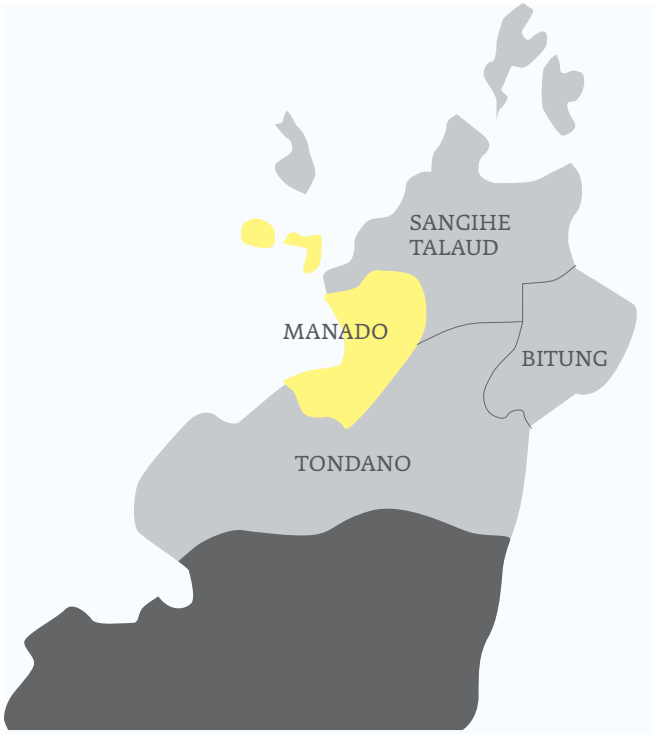


Figure 7: City of Manado location in North Sulawesi and surrounding cities.

MANADO FACTS

415,114
POPULATION

6.4%
%HH IN POVERTY

LAND

Total Land Area	15,726 ha
# of Districts	9
# of Neighborhoods	87
% Residential	24.2 %
Population Density	26 people / ha
% Open Space	71.7 %
Open Space per 1,000 persons	11.3 ha

ECONOMY

Economic Sectors (% of GDP in 2011)

Agriculture	1.7%
Manufacturing	5.5%
Utilities	0.6%
Construction	15.5%
Trade, Hotel, Restaurant	27.8%
Transportation and Communication	16.9%
Finance & Business Services	9.0%
Other Services	23.0%

NORTH SULAWESI REGIONAL ROAD NETWORK

As the capital city of the province, Manado is well-connected to regional roadway infrastructure. The city also has an international airport and cruise port.

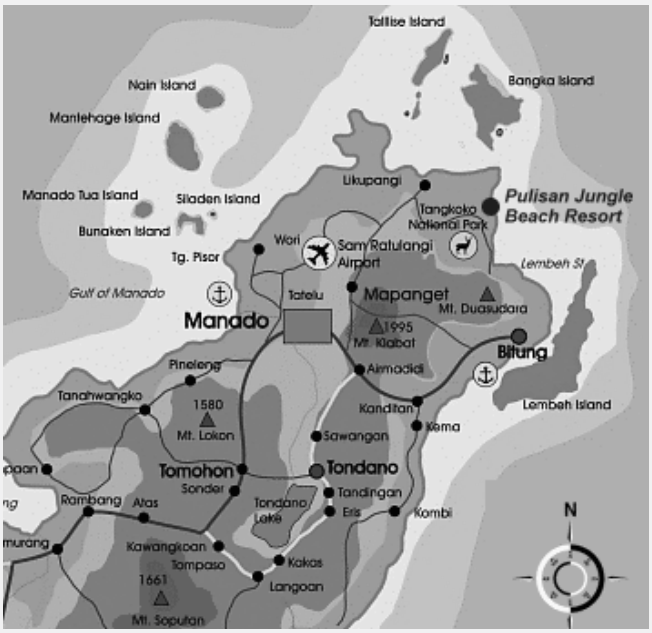
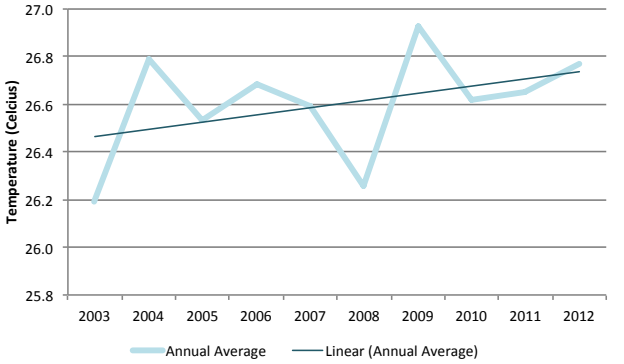


Figure 8: Manado city profile figures and regional road network map
Source: Manado In Figures, 2013

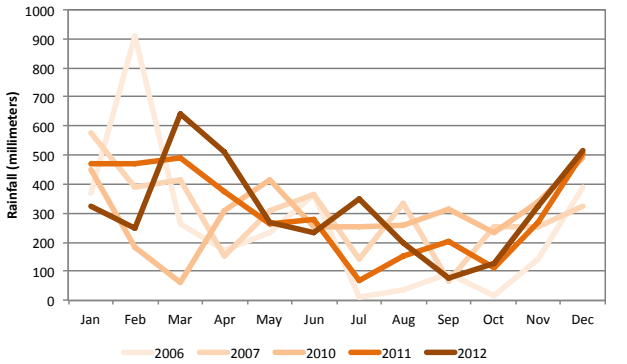
Sea and the Pacific Ocean. Manado is located at the Bay of Manado, and is surrounded by mountainous regions to the east and south. This mountainous terrain includes many volcanoes, some of which are active. Rich volcanic ash makes the land in North Sulawesi very fertile. The highland and lowlands produce rice, corn, coconut, clove, nutmeg, vanilla and a variety of vegetables. The North Sulawesi landscape has many lakes and rivers, most of which are utilized for irrigation of rice fields. The Tonado River is also used to generate electrical power for the Manado and Minahasa region.

MANADO TEMPERATURE AND RAINFALL TRENDS

AVERAGE TEMPERATURE IN MANADO FROM 2003 - 2012



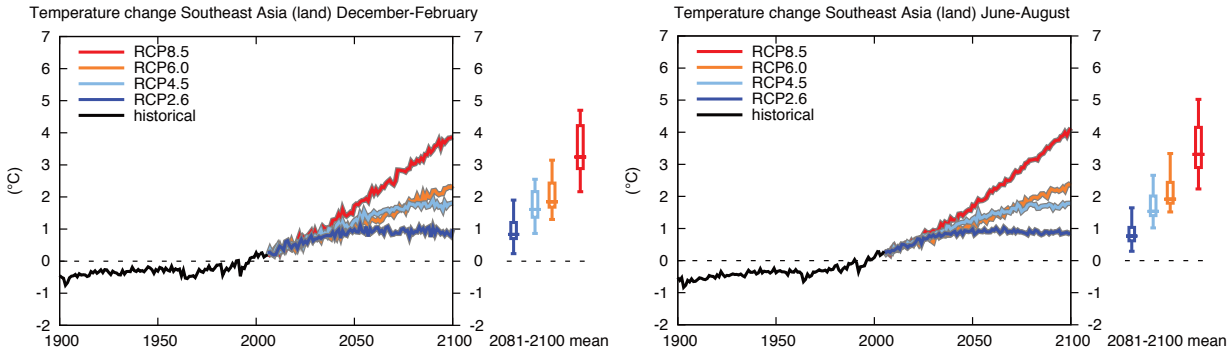
MANADO RAINFALL FROM 2006 - 2012



note: data for 2008 and 2009 not available

Figure 9: Manado climate data
Source: Manado In Figures, 2002-2013

Southeast Asia Temperature Change (through 2100)



Southeast Asia Precipitation Change (through 2100)

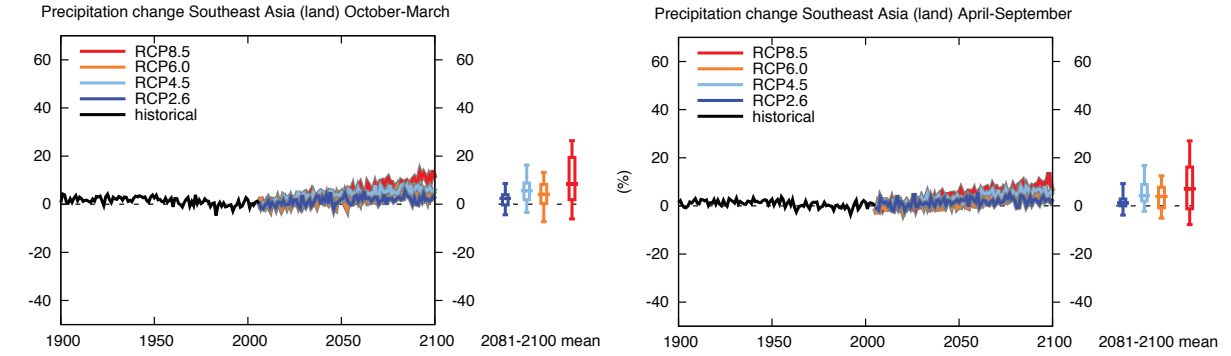


Figure 10: Southeast Asia climate change projections (through 2100)
Source: IPCC, 2013. Annex I: Atlas of Global and Regional Climate Change Projections

Climate

North Sulawesi has an equatorial climate with two seasons, rainy and dry. Average temperatures in Manado remain mostly constant throughout the year, with average high temperatures around 30 degrees Celsius and average low temperatures around 20 degrees Celsius. Average temperatures from 2003 to 2012, indicate a warming trend of about 0.3 degrees over the seven year period. The rainy season has historically spanned from November through April. Manado rainfall data from 2006 through 2012 show that the rainy season has lengthened and total annual rainfall has increased in recent years.

Regional and National Climate Change Projections

While no climate change models are available specifically for Manado or North Sulawesi, regional and national models indicate broad climate trends that can be expected to impact Manado.

According to projections published in the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5), temperature and precipitation in Southeast Asia are expected to rise. Mean temperature is projected to increase by between 1 to 4 degrees Celcius and annual rainfall is projected to increase by 3 to 13% by the year 2100. These ranges reflect the different Representative Concentration Pathways (RCPs) chosen to represent a broad range of climate outcomes. Each RCP is a scenario based on a combination of economies, technologies, demographic, policy and institutional futures.

Across Indonesia, changes in the timing of seasons are projected, with the seasonality of precipitation (wet and dry seasons) shifting. Some parts of the country may become up to 30% wetter during the

rainy season, while others could be up to 15% drier. Increases in rainfall are mostly expected during heavy rainfall events, rather than distributed evenly across the wet season. It is projected that a longer dry season and a more intense rainy season will result in prolonged drought and more intense flooding.

Demographic and Social Profile

The population of Manado is estimated at 415,000. The average rate of population growth for the city is 2.5 percent, with the areas along the coastline and the peri-urban areas to the south and northeast of the city growing the fastest. This puts additional pressure on inadequate infrastructure and services in those areas. The impacts of climate change may force rural populations to the city to seek housing and employment. Newcomers are likley to settle in peri-urban areas.

The Bunaken islands have also experienced high population growth. The livelihoods of residents in many of these high growth areas are more likely to be vulnerable to climate change impacts as they tend to be dependent on agriculture and fisheries industries.

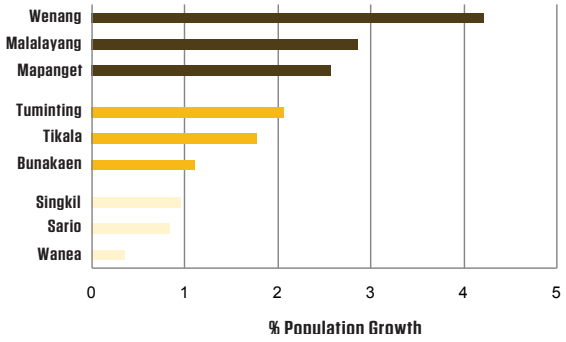
The city's coastline has been re-shaped by land reclamation where new commercial development has further concentrated economic activity in the city center. Expansion of the city is occuring along corridors leading to Bitung, Tomohon and the airport, however, adequate planning and infrastructure are not yet able to provide services.

Manado's urban poor and refugees

Manado is a stable city that attracts migrants from nearby islands and localities where internal conflicts and ethnic strife have made daily life difficult. It is seen as a receptor city for those wishing to flee and seek refuge. These migrants often settle in peripheral

POPULATION GROWTH 2010 - 2011

Areas in the periphery of the city are growing rapidly, putting additional pressure on inadequate infrastructure and services. The livelihoods of residents of peri-urban areas are more likely to be vulnerable as they tend to be dependent on agriculture and fishery industries.



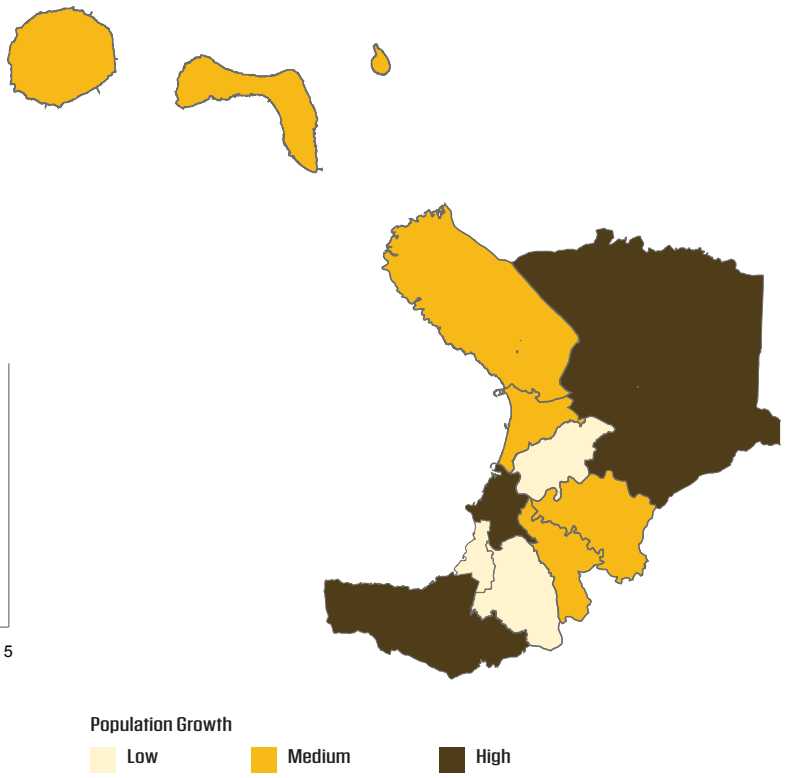
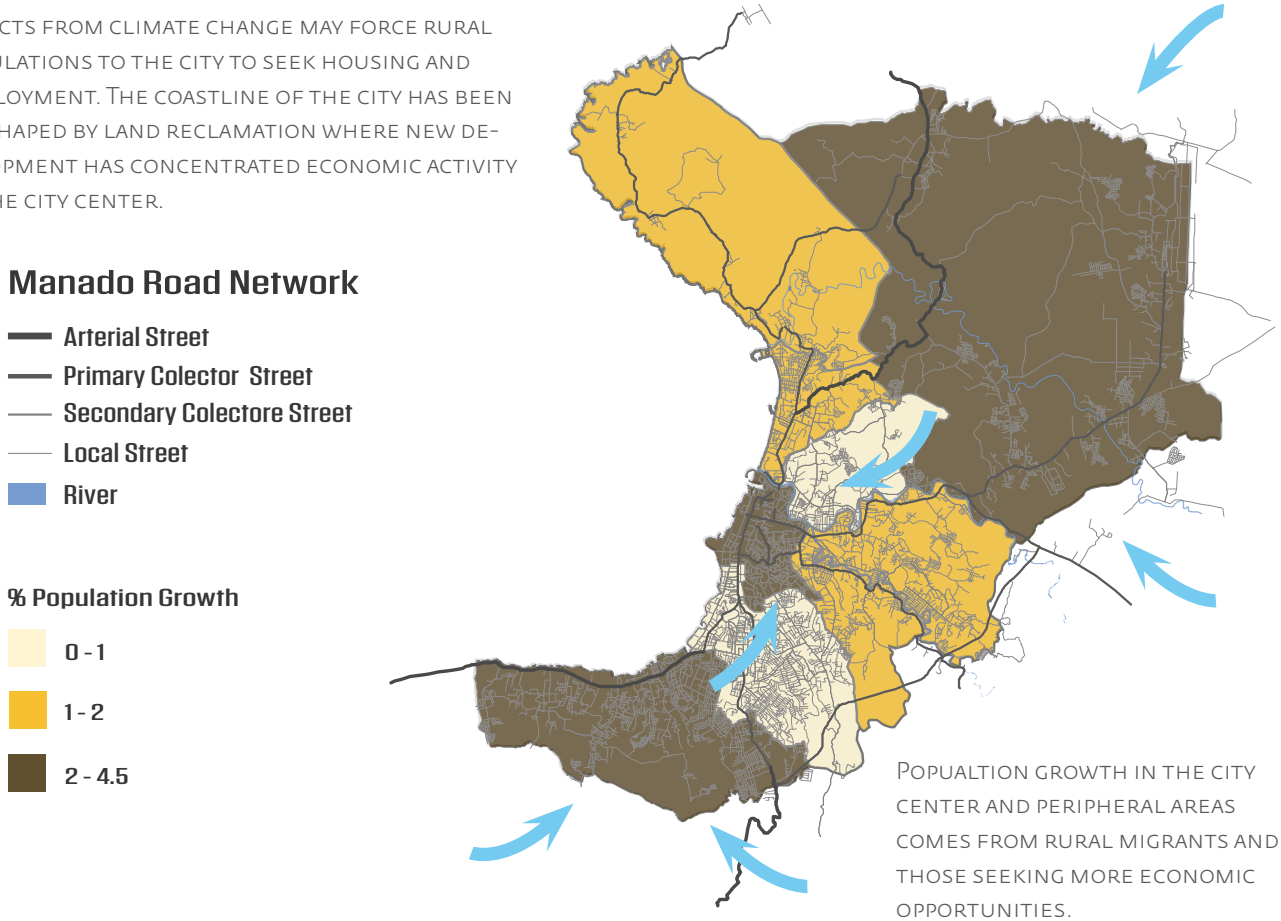


Figure 11: City of Manado, Population Growth 2010 - 2011
Source: Manado in Figures 2012

URBAN EXPANSION

Impacts from climate change may force rural populations to the city to seek housing and employment. The coastline of the city has been re-shaped by land reclamation where new development has concentrated economic activity in the city center.



Popualtion growth in the city center and peripheral areas comes from rural migrants and those seeking more economic opportunities.

Figure 12: Manado population growth in city center and peripheral areas
Source: Manado In Figures, 2012

PROJECTED POPULATION GROWTH 2010 - 2060

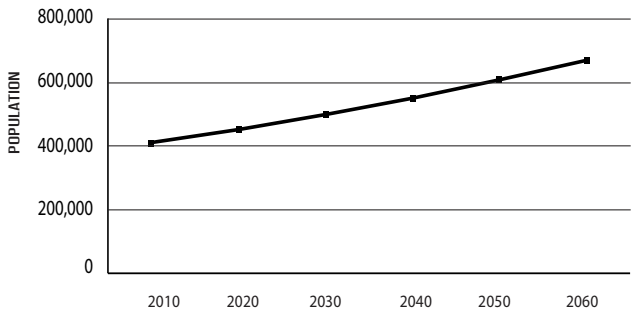


Figure 13: Manado projected population growth 2010 - 2060
Source: Statistical Yearbook of Indonesia 2013

areas (to the North, East and South of the city center). They primarily rely on agriculture for their livelihood. A small number of poor households are concentrated along the coast, and are predominantly fishermen

Projected Population Growth

From 2010 through 2060, Manado's population is projected to grow by 260,000 new residents, to 670,000. This corresponds to an increase of 63%, and an average annual growth rate of 1% per year over the 50 year period.

ECONOMIC SECTORS

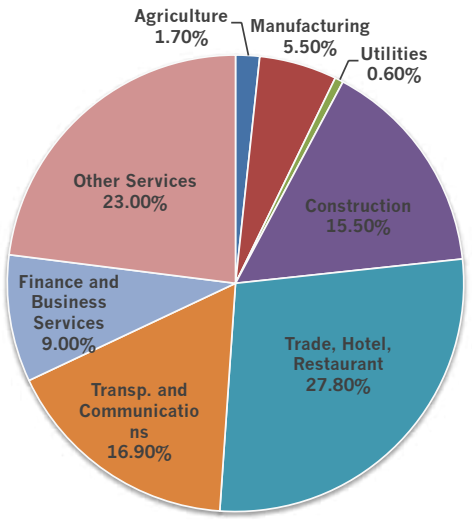
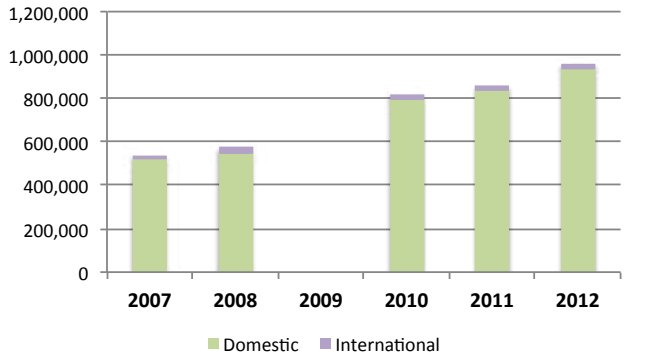


Figure 14: Manado economic sectors
Source: Manado In Figures, 2011

GROWTH IN TOURISM

Sam Ratulangi Airport Arrivals (2007-2012)



note: data for 2009 not available

Passenger Arrivals at Manado Port (2007-2012)

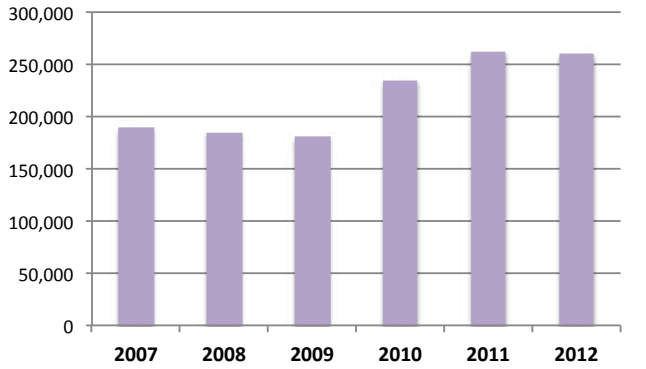


Figure 15: Manado tourism growth data
Source: Manado In Figures, 2012

Urban Economy

The economy of Manado is heavily reliant on tourism with the Trade, Hotel and Restaurant sector comprising 28% of the city's economy. Finance and Business Services and Other Services together make up 32%. Transportation and Communications and Construction are also significant industries. Agriculture, Manufacturing and Utilities industries make up a relatively small proportion of overall economic activities.

Tourism and conferencing are significant sources of revenue for the city. Growth in passenger arrivals at both the Sam Ratulangi Airport and Manado Port are evidence of the city's continued reliance on tourism industries. Between 2007 to 2012, airport arrivals have increased over 80%, with domestic passengers accounting for most of the growth. Over the same period, passenger arrivals at Manado Port have increased by nearly 40%.

Governance System and Decision Making Process

In managing the growth and development of the city, Manado's government departments and agencies are supported by a five-year budget plan listed in the Regional Medium-Term Development Plan, Rencana Pembangunan Jangka Menengah Daerah (RPJMD), which is derived from the Regional Long-Term Development Plan or Rencana Pembangunan Jangka Panjang (RPJP). RPJMD sets out a comprehensive development vision of the city for each five year period, through the allocation of funds to different departments on an annual basis, resulting in a document known as the Rencana Kerja Anggaran / budget plan (RKA). City council approves the RKA for each department and compiles them into a legal document called Anggaran Pendapatan dan Belanja Daerah (APBD), which serves as the basis for implementation of the programs and activities of each department.

LOCAL GOVERNMENT DECISION MAKING PROCESS

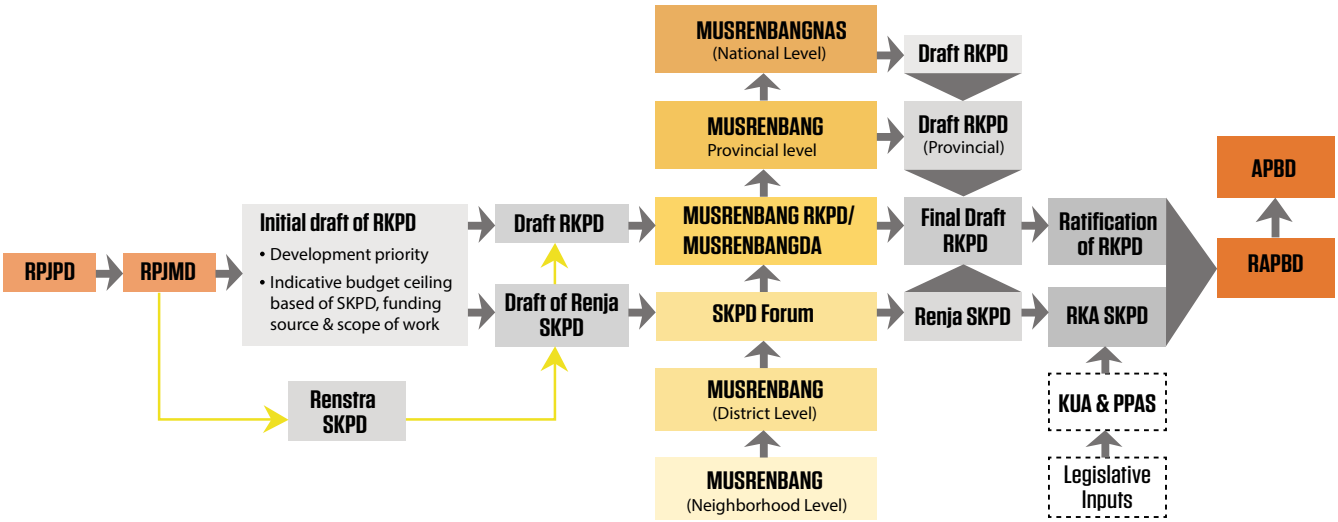


Figure 16: Manado local government decision making process

The process can be simplified as follows - RPJMD is used as the basis for each department and agency to make the annual work plan. The annual work plan for each department is then given a specified allocation of the budget, which is reflected in the RKA. Once the budget is ratified by city council into the APBD, each department is responsible for implementation of the work plan.

Some of the key agencies in Manado's city government are: the Department of Public Works, which arranges the annual work plan for infrastructure projects such as roads, bridges, and water treatment installation; DTRK, which is responsible for city spatial planning, arranges annual work plan on the arrangement of city spatial planning, monitoring and evaluation of development plan; BAPPEDA, which arranges annual work plan on regional planning; and the municipal water companny (PDAM), which arranges the annual work plan on water supply management.

In order to foster the development of the city, Manado cannot only depend on funds and resources that are available locally. Some projects also get funding from the national government, particularly those which have the potential to create large scale impacts.

Additionally, there are district and neighborhood governments, which play important roles as extensions of city government at the local level. The role of district and neighborhood governments are to provide service for communities and as community liasons to city government.

Institutional Capacity

In Manado, the local government and civil society have created a number of promising governance initiatives that demonstrate potential to shape the city's future. There are several community-level activities that stand to positively impact communities and build resilience. A few notable examples are described below.

Local planning and budgeting (Mapalus)

The government is implementing a program to empower communities to select and implement projects that protect the environment and reduce vulnerability (Mapalus) with BPL block grant funding (BPL). This allows sub-neighborhood units (lingkunan) to be proactive about local development and gives them resources to build.

Local information system

A local government initiative is innovating the information sharing system, largely internal, so that different government agencies have more information at their disposal. We don't know much about this other than that there have been efforts to improve the quality of information and make it available.

Disaster early warning system

Each neighborhood has an early warning system where the Kepala Lingkungan (Head of Neighborhood) gives warning to their community in the case of a natural disaster, such as landslide or flooding. Kepala Lingkungan receives information from the city government by phone via the National Disaster Management Agency (Padan Nasional Penanggulangan Bencana BNPB). Kepala Lingkungan can help notify residents and evacuate an area efficiently in the event of heavy rains that may cause a landslide.

Citizen's Riverfront City initiative

A civil society-led initiative called the Riverfront City, which has been promoted by the citizen's board, is working towards reactivating the river's edge. The initiative promotes reorienting houses that back onto rivers to face them. This has prompted a revalorization of the river, which has in turn led to efforts to clean it, install footpaths and adequate drainage. This shows the power of civil society to mobilize community and government support.

Several city awards

The City of Manado has won 6 Adipura Awards. These are awards for city governments across the country for general cleanliness. Although waste management is still one of the Mayor's top three issues of concern, the award demonstrates that the city government has already had some success in dealing with waste in the past. The awaards demonstrate a successful track record and good capacity to implement programs.

2.2 City Vision and Development Framework

THE VISION FOR THE CITY OF MANADO IS TO PROMOTE A 'HAPPY CITY' AND BECOME A LEADING 'ECO-TOURISM' DESTINATION FOR INDONESIA.

Manado's is known for both its lively, outgoing and fun nature and for its stunning location and natural beauty. It is leveraging these characteristics to put forward a model for a sustainable city: a thriving center to do business and study, a center of trade and commerce, and a destination for tourism and confer-

ences. This city vision, put forward by the Mayor, embraces citizen aspirations and initiatives and was agreed upon in consultation with residents. Intended to guide future development of the city, there are three components of the city vision:

The Green City

Manado is located on the coast of the Celebes Sea between verdant hills and the ocean, and overlooking the islands that make up Bunaken national park. As a small city reliant on tourism and its natural assets the city vision promotes a sustainable and responsible relationship with nature. By developing better waste collection and treatment systems, better care for urban rivers, and continued environmental stewardship, both at the citywide and neighborhood level, Manado will continue to enjoy the advantages of its natural assets.

A Commercial Center

The city offers a wide range of services to both residents and visitors, making it a growing center of trade and commercial activity. Manado is already a national center for hosting conferences and conventions, and is serviced by a port, international airport and markets. The city vision is to continue to develop the commerce and service sectors by providing improved infrastructure and promoting the city as a place to do business.

A Regional Destination

The city vision promotes Manado as a strategically located city at the national and regional level, with improved airport and road facilities, connections to the port city of Bitung, and a ring road. The interconnected city will accommodate growing demand for trade and regional visitors. In additional it its tourism potential, the city boasts a renowned university and commercial areas. The city will seek to build on these assets to become a city of regional importance.

2.3 Urban Trends of Manado

As a first step of the analysis we examined several trends that characterize the City of Manado's growth. The following urban trends are evidence of the city's rapid urbanization and are strong drivers of change in Manado. Even before considering climate change issues, these trends are having a significant effect on the city and its population, and they present a growing concern for the future of the city's sustainability.

Trend 1: Coastal Reclamation and Commercial Development

Commercial development along the coast with intensive land reclamation efforts is concentrated in the city center. Expansion of commerce and tourism industries in the urban core has displaced traditional fishing communities. This brings heavy traffic congestion to an area already plagued by flooding.

COASTAL RECLAMATION

Large stretches of the coastline have been developed using reclaimed land, which has displaced traditional fishing communities and negatively impacts the marine ecosystem.

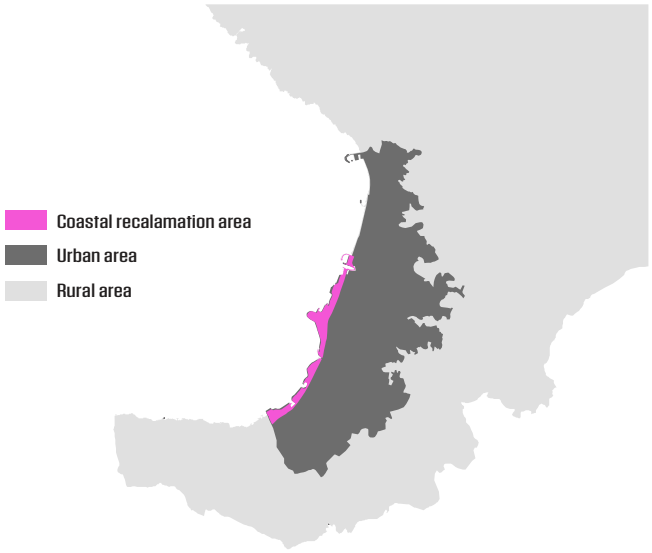


Figure 17: Manado coastal reclamation area

Trend 2: Development Along Steep Topography

Continued urbanization and the topography of the city means more development in steep areas, which are prone to landslides. This development often requires land excavation, prompting erosion and run-off, sedimentation, and flooding downstream. Both wealthy and poor communities have built housing settlements on steep topography.

Trend 3: Urban Expansion

Expansion is extending beyond the city limits, but the consequences of this development continues to impact the city. The lack of coordinated planning means no authority ensuring construction does not adversely impact the water supply, watershed area, flooding risk, or overwhelm services. Inadequate planning for new infrastructure and expanded services will lead to haphazard growth. These concerns highlight a need for coordination between districts.

STEEP TOPOGRAPHY

Retaining walls to prevent landslides

Settlement areas on steep topography

CLIMATE CHANGE BRINGS UNPREDICTABLE AND HEAVY RAINS THAT CAN CAUSE DEVASTATING LANDSLIDES AND DAMAGE HOMES. POOR AND WEALTHY COMMUNITIES ALIKE, INHABIT THESE VULNERABLE AREAS WHERE STEEP SLOPES CAN OFTEN GIVE WAY UNDER HEAVY RAIN.

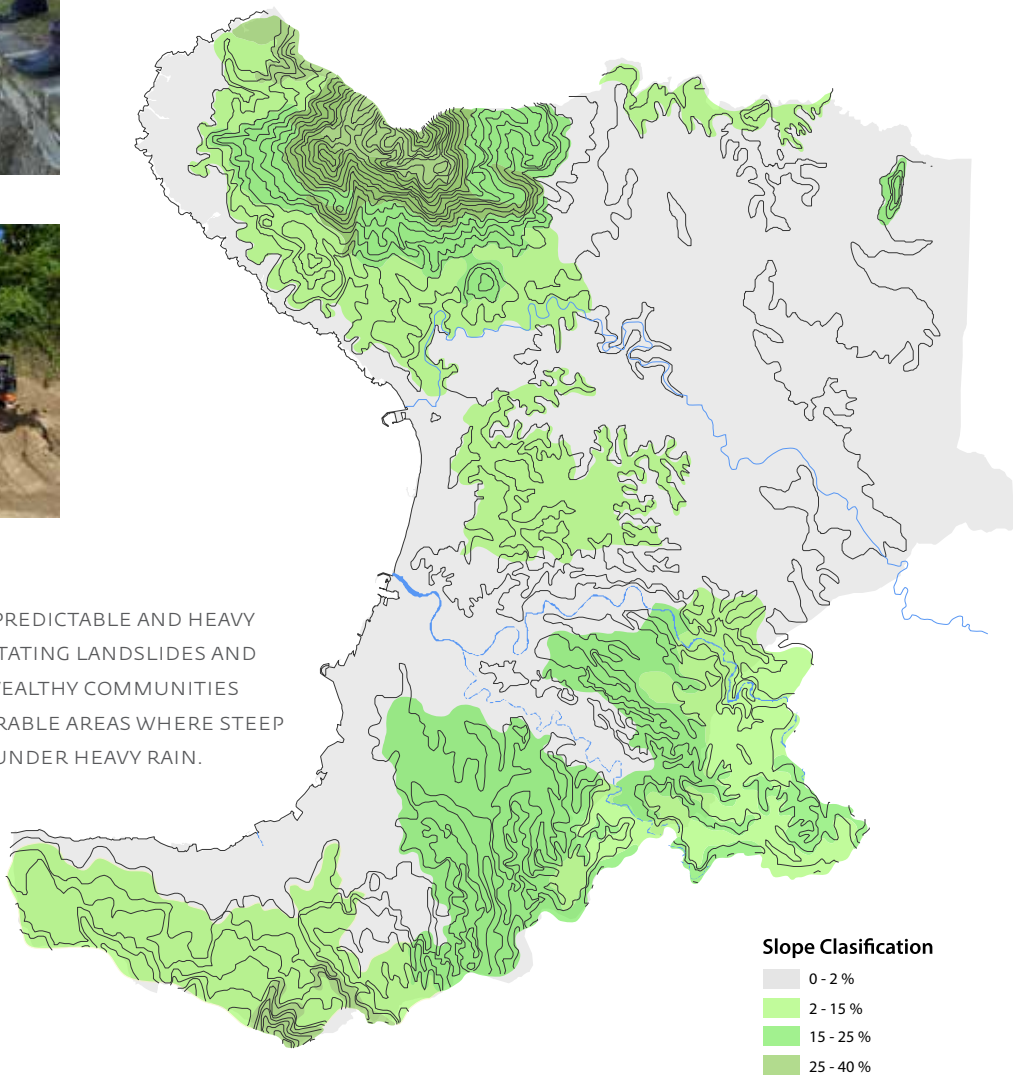


Figure 18: Manado areas of steep topography

2.4 Development Pipeline

The City of Manado has already made some strides in achieving the goals of their city vision as evidenced by number of projects in the pipeline. The table lists pipeline projects the city vision component which the project advances.

The majority of these pipeline projects are physical interventions that will alter the geography and physical organization of the city. The projects have been mapped below to illustrate how they will begin to weave together different parts of the city. Projects that advance the Commercial Center Vision are concentrated around the city center, commercial corridors and along the coastline. Projects that advance the Green City Vision traverse the city, primarily along the city's riverways. Finally, projects that advance the Regional Destination Vision encircle the urbanized areas, connecting the city's roadway and transportation infrastructure to destinations beyond.

CITY VISION PROJECTS

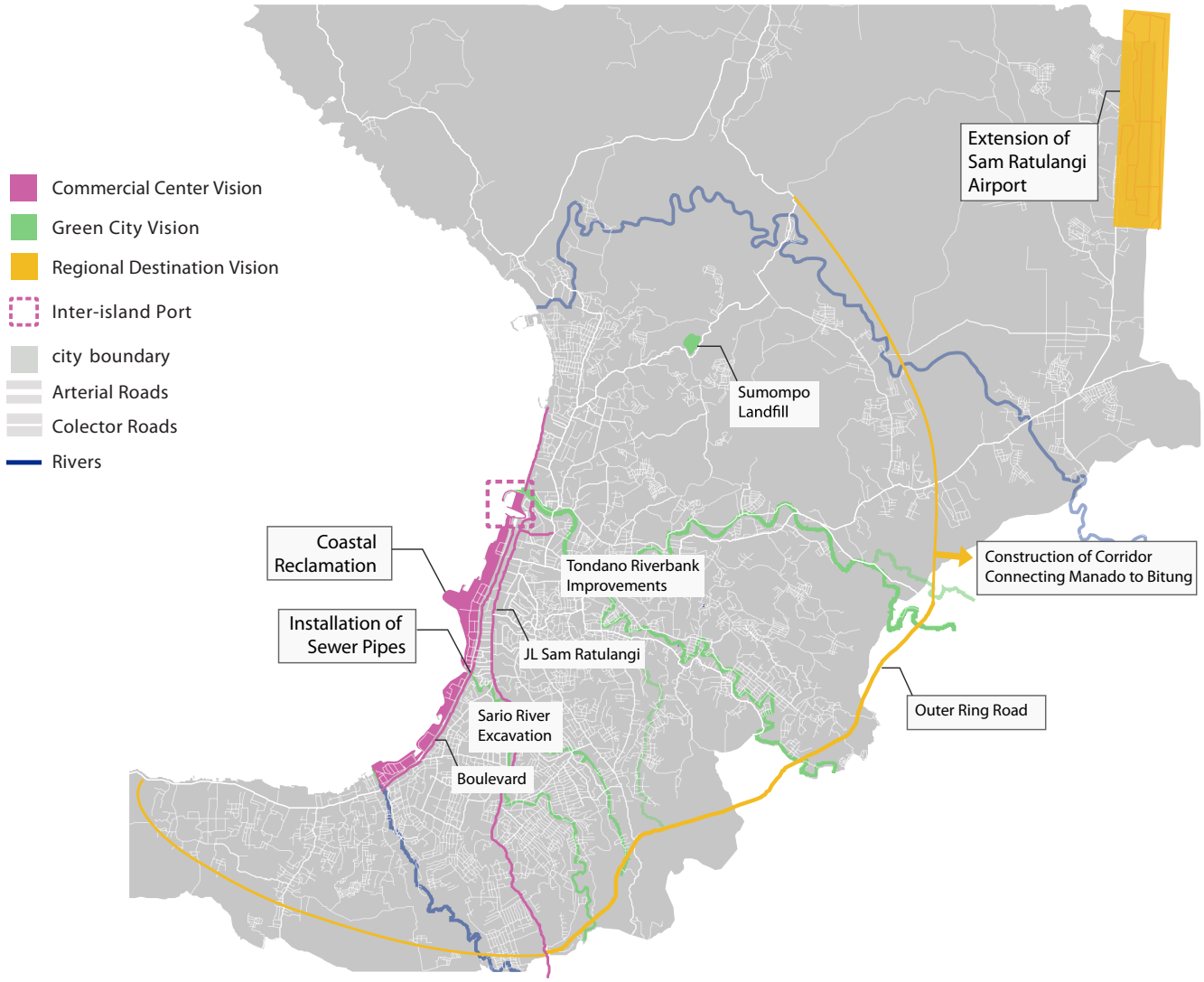


Figure 19: Manado City Vision projects

PIPELINE PROJECTS

PROJECT	DESCRIPTION	STATUS/YEAR
GREEN CITY		
Solid waste treatment improvement	Mechanical Biological Treatment in Sumompo Landfill, Tuminting, Manado • Recycle and reuse of trash • Produce refuse drive fuel (rdf) and compost	2013 : Preliminary studies 2014 : Start project
Tonado Riverbank improvement	• Normalization of Tonado River with widening of riverbed • Flood control early warning system and hazard map • Waterfront city along Tonado river, 7.2 km from estuary	
Sario River excavation	• Normalization of Sario River with widening of riverbed	
Installation of sewer pipes in commercial district	• Pipes for citywide sewage system from commercial district at Jl. Tendean and Jl. Sam Ratulangi corridor	2012-2013
Disaster risk reduction	• Providing resources (personnel and equipment) for emergency response	2011, 2012, 2013
COMMERCIAL CENTER		
Boulevard landfill project	• Boulevard 1: south area • Boulevard 2 : north area towards Tuminting	1993: Boulevard 1 completed 2014: Start Boulevard 2
Jl. Sam Ratulangi revitalization	• Heritage and ecological conservation • Provide public infrastructure	2014: Start Aspol (angkot, shuttle, parking, toll)
Inter-island passenger port	• Seaport development in Kecamatan Wenang • Port area in city center and southern area	2011 - 2015: Seaport 2014 - 2020: City Center Port
Coastal reclamation	• Phase 1 : 67ha for business area • Phase 2 : Building and Environmental Management Plan	2006: Phase 1 2013: Phase 2 (delayed)
Drainage along Boulevard	• Culvert installation along boulevard for drainage	2012
Sukarno bridge	• Connect commercial district at reclamation land (megamas) in southern Manado to the northern area - length : 622 m	2003: Completion delayed due to land acquisition issues
REGIONAL DESTINATION		
Corridor connecting Manado-Bitung toll	• 39km toll road • Supporting infrastructure for the Special Economic Zone Bitung • Reduce congestion and transportation cost	2013 : Preliminary studies 2014 : Under construction
Manado Ring Road	• Bypass road Phase 1 (Winangun-Maumbi) • Bypass road Phase 2 (Maumbi-Buha)	2005: Phase 1 completed Phase 2 Completion delayed due to land acquisition issues
	• Manado bypass road Phase 3 (Malalayang-Winangun)	2014: Tender preparation
	• Monginsidi Street	Under construction
	• Soekarno Bridge	Completion delayed due to land acquisition issues
Extension of the Airport	• To become international airport	2014-2016
Regional bus station Liwas	• Relocation regional bus station from Pal Dua to Liwas	2013-2014
Trans-Sulawesi road	• Trans-Sulawesi road, Gorontalo-Manado section have been improved since 2011	2014

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Figure 20: The city government and private sector have focused planning efforts to reshape the coastline and provide improved mobility and opportunities for commercial development. This coastal reclamation has significant impacts on the surrounding fragile ecosystem and also complicates drainage.

3 Climate Change Vulnerability Assessment Issues and Methodology

3.1 Climate Change Issues

The coastal city of Manado in North Sulawesi is sensitive to a series of climate change hazards. Water management and flooding are key concerns of the municipal government. Local officials are becoming increasingly aware of the array of current and projected climate change impacts. Assessments like this can increase awareness and support the preparation of adequate institutions, evacuation maps and city development plans.

Regional climate change data from the IPCC indicate that Manado is likely to experience unpredictable seasons and shifting weather patterns that will make the livelihoods of many farmers and fishermen increasingly unstable and vulnerable. Temperatures are anticipated to increase by 0.14 to 0.20 degrees Celcius per decade, and rainfall intensity is expected to increase while the rainy season becomes more erratic and unpredictable.

Climate vs Non-Climate Stressors

Climate stressors are those which directly result from climate change related weather impacts. These climate stressors interact with the many non-climate stressors that are present in urbanized areas.

The Vulnerability Assessment focuses on how urbanization and non-climate stressors exacerbate climate stressors with the assumption that the effects of climate stressors are made more intense.

Climate Stressors

- Sea-temperature rise, which will affect the coral reef, tourism and fishering industries
- Unpredictable heavy rains and landslides, which will affect roads/ circulation and agriculture, causing sedimentation of rivers and flooding
- Sea-level rise, which will affect coastal communities
- Droughts

Non-Climate Stressors

- Continued urbanization
- Continued coastal reclamation
- Residential development along rivers and periphery
- Unregulated settlements on hillsides and green areas
- Lack of adequate public services
- Eutrophication (trash and sewage waste that threaten coral reefs)
- Growth activities and land development of surrounding districts (deforestation, housing development, Pemakaran)

3.2 Methodology and Definitions

Vulnerability has been defined in a variety of ways; some definitions focus on places and systems, while others focus on people, livelihoods, sectors, and particular ecosystems. According to the IPCC, from a climate change perspective, vulnerability is "the degree to which a system is susceptiable to, or unable to cope with, adverse effects of climate change, including climate variability and extremes." In order to understand vulnerability, it is essential to recognize its three main components: **Exposure, Sensitivity and Adaptive Capacity.**

Vulnerability is determined by integrating the results of exposure, sensitivity and adaptive capacity assessments. **Vulnerability** to climate change is a function of an input's **Expoure** and **Sensitivity** to climate change and its **Adaptive Capacity**, the ability to adapt to their adverse effects. Assessing vulnerability is achieved through the use of the following formula:

Vulnerability = [Exposure x Sensitivity] - Adaptive Capacity

Exposure shows future climate change trends and potential related hazards based on climate change models and in some cases, recorded meteorological patterns, while sensitivity displays what urban systems, which communities and what areas will be more severly impacted by a particular hazard. Based on projected and perceived climate impacts, the two most relevant impact scenarios for the city of Manado are: sea level rise (including storm surges, tidal floods and salinization of coastal aquifers) and flooding (including torrential and flash floods). Adaptive Capacity refers to individual or collective actions taken by households, communitities, organizations or insitutions to minimize potential impacts from climate change hazards. Examples of some indicators for each component that could be used to assess vulnerability are shown in the table below.

1. Exposure

The degree of climate stress upon a particular unit of analysis (i.e. neighborhood, sector) and may be characterized by the long-term change in climate conditions, or changes in climatic variability, cinlduing the magnitude and frequency of extreme events in the urban context. Depending on location, the degree of climate stress may have a different impact.

2. Sensitivity

The degree to which different systems and sectors of the population are affected by climate related hazard.

3. Adaptive Capacity

The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Exposure	Sensitivity	Adaptive Capacity
Whether an area is exposed to: • Flooding • Droughts • Sea-level rise • Increase in temperature • Rivers or canals that flood • Coastal Storms	Whether an area is: • Dependent on livelihoods or industries that are adversely affected by climate change • Characterized by high levels of poverty	Whether an area possesses: • High levels of public services • Community organizations • Good levels of public spending • Access to health services • Access to information • Access to financial services

3.3 Current Exposure to Climate Hazards in Manado

The recent floods in Manado that occurred in January 2014 and February 2013 are part of a trend that indicate that heavy rainfall and flooding are recurring climate phenomena. These climate events cause damage and widespread harm in the city. Communities located along riverbanks and canals in dense urban areas are most exposed to flooding risk, although other areas with poor drainage are also affected.

Accounts from city officials indicate that the most likely climate change hazards the city will face in the future are: heavy rainfall during a shortened rainy season, flooding, droughts, sea-level rise, increase in temperature, and coastal storms with high winds. How these climate hazards affect different areas of the city depends on the geography of the city and exposure.

Intense rainfall during a shortened rainy season

Areas that are exposed to intense rainfall are those along hillsides, riverbanks, urban areas that are prone to inundation, and also agricultural areas. Those along hillsides risk landslides and damage to their property, while those along rivers may experience flooding and contamination of wells and septic tanks. Intense rainfall can also damage agricultural crops.

Flooding

Large areas of Manado are exposed to flooding due to its low-lying topography, as well as the five rivers that run through the city, and their multiple tributaries. Flooding can disrupt mobility, contaminate wells, and damage structures and property

Increased temperature and droughts

The areas most exposed to temperature rise and droughts are those where communities primarily depend upon agriculture for their livelihoods. Droughts can threaten harvests and cause damage to local crops. They can also cause migration of rural workers to the city, endanger the local food supply, and decrease the availability of water. The districts of Mapanget and Pal Dua, which are largely rural, as well as others, are most exposed to droughts and increased temperatures.

Sea-level rise

The areas most exposed to rising sea-levels are low-lying areas along the coastline and the island communities like Bunaken Kepulauan. Sea-level rise can inundate homes, decrease the availability of ground water, and inhibit mobility. It can also cause destruction to coastal ecosystems leading to economic losses to fishing communities.

Coastal storms and high winds

High winds and coastal storms damage houses, infrastructure and property along the coastline. When coastal communities are impacted, both physically and economically, it can lead to displacement and migration as they seek alternative sources of income. Those communities that inhabit the more unprotected coastal areas, for example in Bunaken Kepulauan, Bunaken and Tumiting, are most exposed.

While the above climate hazards have the potential to impact some areas of the city more than others, certain populations and urban systems are more exposed than others. The location of urban poor communities on hillsides and along rivers for example means that they are much more exposed to the effects of flooding and landslides. Below is a list of those urban systems and people most exposed to climate hazards in the city. The degree to which they are affected will be further explored.

- **Exposed urban systems:** drainage system, roads, water distribution, coastal defenses, key infrastructure (such as the toll road and airport that cannot function if flooded)
- **Exposed urban populations:** urban poor communities living on hillsides, along the coastline, communities in newly settled areas, businesses and industries in low-lying coastal areas, businesses reliant upon exposed infrastructure.

The following section on climate change sensitivity turns to understanding the ways in which such systems will be affected by these climate hazards and explore what are the factors that make them vulnerable.

Evaluating and Mapping Exposure

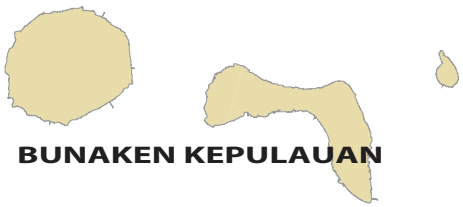
Exposure to climate hazards is experienced differently in each district. Districts coastal frontage will be exposed to sea-level rise while inland districts will not. Similarly, districts that have rivers and canals running through them will have more exposure to flood risks, while those that do not have less exposure. The scoring of the exposure indicators reflects these physical features of each district.

Depending upon their location and geographic features, the districts will accrue 1 point for each hazard to which it is exposed. Therefore districts exposed to all six hazards of drought, landslides, flooding, sea-

EXPOSURE

Climate Related Hazards
1. Drought
2. Landslides
3. Flooding
4. Sea-level Rise
5. Exposure to Rivers/Canals
6. Exposure to Coast

Exposure Rating: Low Medium High Very High



Kecamatan	Exposure					
	1	2	3	4	5	6
Malalayang	✓			✓		✓
Sario	✓	✓		✓		✓
Wanea	✓	✓	✓		✓	
Wenang	✓	✓	✓	✓	✓	✓
Tikala	✓	✓	✓	✓	✓	
Pal Dua	✓	✓	✓	✓	✓	
Mapanget		✓				
Singkil	✓	✓	✓	✓	✓	
Tuminting	✓	✓	✓	✓	✓	✓
Bunaken			✓	✓	✓	✓
Bunaken Kepulauan				✓		✓

Figure 21: Manado climate change exposure mapping

level rise and exposure to rivers/canals and the coast, can score up to 6 points. This score will be combined with that of each district's sensitivity assessment, discussed in the following section.

3.4 Current Sensitivity in Manado

This section examines the different impacts climate hazards have on Manado's urban systems, and describes the contributing factors that make certain systems more susceptible, or sensitive, than others to climate hazards. Sensitivity is defined as the degree to which a system is affected by the biophysical impact of climate change. It considers the socio-economic context, as well as other non-climate stressors that may affect vulnerability, such as urbanization trends, the economy, and the city's development plans.

The exposure analysis identified the most relevant climate hazards that impact Manado are increased rainfall/ flooding, sea-level rise, coastal storms, and heat and drought. These hazards will cause impacts in different parts of the city in different ways, thus an understanding of the range of consequences is essential to designing strategies to reduce vulnerability.

Sensitivity and Urbanization Trends

The three urban trends that are currently shaping the development of the city also pose threats to the city's capacity to withstand climate hazards. The following are examples of how the three urban trends are increasing the vulnerability of the people of Manado and their sensitivity to climate hazards.

Trend 1: Coastal Reclamation and Commercial Development

Commercial development along the coast has hindered coastal communities' access to the sea, and in many cases displaced households. Drainage water from upstream areas will pool in areas of low elevation and without mechanisms to pump water out, it will be trapped between the new coastal developments and old coastal communities. This will cause prolonged water stagnantion and exacerbate health risks in vulnerable coastal communities. Development along the coastline can also alter the marine coastal ecosystem, impacting fragile coral reefs and the ability of fishermen to fish in nearby shallow waters.

Trend 2: Development Along Steep Topography

Residents living in steep hillside areas are often physically isolated with limited roadway access, as well as inadequate public services, such as trash collection and piped water. This means that during emergencies they face greater difficulty accessing evacuation routes and services. Additionally, given the challenges of building on steep topography, homes and building structures are likely to be less robust compared to those built in flat areas. Poor families are particularly vulnerable as they are less likely to have the resources to construct deep foundations and use more resilient building materials.

Trend 3: Urban Expansion

The rapid growth of Manado's periphery means that the city is expanding. In the coming years, more and more people will be coming to the city to access jobs and employment centers. Inadequate roads and poor public transportation options hinder access to employment opportunities. A growing population in the periphery also increases demand for services, which requires public investments and infrastructure.

Priorities include extending the water supply and sanitation networks to new residential areas, and the construction of new schools and health centers to serve new populations. Delayed rainy seasons, droughts and unpredictable weather patterns will cause hardship for farmers. Economic hardship may force them to sell their land and move to the city to seek other employment opportunities.

Sensitivity and Economic Systems

Economic activities such as fishing and agriculture are particularly sensitive to climate change. When fishing and agriculture are disrupted, the livelihoods of fishermen, farmers and their families are negatively impacted. Consumer food prices could also be affected, and as a result threaten food security, especially for the poorest populations.

A large part of Manado's economy is based on the hotel and restaurant sector (27.8%). Many of these businesses are located along the coastline where they are at risk from flooding and sea-level rise. Other hotels and services may be located atop hillsides are potentially at risk from landslides.

Sensitivity and Urban Systems

Manado's growth and development are due in part to its urban systems, such as roads, water network and drainage system. They provide a functioning infrastructure for the city that supports its many economies, services and inhabitants, but climate hazards put many of these urban systems at risk if they are dated, lack maintenance and repair, or require investments to expand service and capacity. When the systems are overwhelmed they can fail. For example, heavy rainfall and flooding can cause the drainage system to overflow and back up.

Some parts of the city are still not connected to drainage networks and can remain flooded for days after rainfall stops. Such issues are systemic because they extend over large areas and are interconnected.

Sensitivity and Manado's Development Vision

Climate predictions foresee an increase in the intensity of rainfall and see sea-level rise. The city has already suffered from historical flooding events, damage from landslides and coastal flooding. While there is understanding of the seriousness of climate change on the city's future, there is a mismatch between some components of the City Vision promoted by city leaders, and the realities of Manado's vulnerability to climate hazards.

City leadership has put forward three vital elements of the city's development vision: Manado as a Green City, a Commercial Center and a Regional Destination. It is important to understand that achieving each of these visions presents additional challenges when vulnerability to climate hazards is considered. Some considerations to be made are described below.

1. A Green City

Located on the coast where coastal storms and sea-level rise will occur, Manado is sensitive to damage to its natural ecosystems. Protecting the Bunaken National Park, which draws visitors from throughout the region, is a high priority. Also the functioning of the city's infrastructure, utilities and provision housing (especially on steep hillsides) require effective environmental management.

2. A Commercial Center

Manado's geography makes it sensitive to disruptions in access. Flooding and landslides can cut off roads, the port and airport, which would significantly impact its capacity to function as a commercial center and destination, since many goods and visitors come from outside the city. Manado is also a center for trade, with many goods and services flowing through the city. Disruptions to roads threatens its viability as a trading center.

3. A Regional Destination

Manado's connection to ports, the ring road and airport are vital to its success as a regional destination. Since roads are vulnerable to landslides and flooding, it will be critically important for the port and airport to have reliable maintenance of road connections.

Disruptions to the regional transportation network will hinder the city's efforts to achieve its vision of becoming a regional destination

Manado's current planning vision should be better aligned with the reality of development trends. Failure to match a demand for services and infrastructure and supply, could expose the city to increasing levels of vulnerability in the future. Those that will suffer most are people that inhabit hillsides, the coastline, riverbanks, those that are not adequately serviced, and the urban poor.

Evaluating and Mapping Sensitivity

The three urban trends discussed in Section 2.3 also contribute to increased vulnerability to climage hazards because they are happening so quickly and at such a large scale. Land reclamation along the coastline, for example, requires thousands of tons of rock and earth excavated from the surrounding areas. This is not only changing the coastline and coastal ecosystems, but also the watershed catchment areas and agricultural production of communities outside the city. Therefore, these trends will have far reaching impacts on the city's ecosystems, where people live and access resources, and the extent of services they will require in the future. It must also be noted that much of the current rapid urbanization of the city is not controlled by the Manado City government, but rather by private developers and informal settlers, and also may occur in developments outside the city limits. This presents a challenge for government officials to regulate the development and for policymakers to respond to them.

Sensitivity is related to both the presence of climate hazards as well as the socio-economic context of the system that is being affected. As such the chosen indicators reflect both of these considerations. For each district the analysis evaluated: poverty rates, access to utilities and services, and whether the physical environment is particularly susceptible to damage, such as the presence of steep slopes and sensitive ecosystems.

The six indicators used to evaluate and map sensitivity in Manado were based on available citywide data collected from the city government:

1. Poverty Rate

Povery data was accessed from the BPS Manado in Figures 2012 (Manado Dalam Angka 2012). The average percentage of poor households across the nine districts in Manado was 7.6%. Districts that had percentage of poor households above this average were given a score of 1, while those that were below the average scored 0.

2. Access to Electricity

Figures on the number of households with access to electricity by district was compiled from *Manado in Figures 2012*. The average percentage of households without electricity across the nine districts was 8.4 %. Districts with a higher percentage of households without access to electricity were given a score of 1 and those with a lower percentage were given a score of 0.

3. Development on Steep Topography

Land use and topotgraphic map data was accessed from the city's planning and GIS department. Districts that showed development on land areas that have slopes greater that 25% to over 40 percent were given a score of 1. Districts that did not have development on steep topography were given a score of 0.

4. Sensitive Ecosystems

Mapped ecosystem data that show areas with mangroves, wetlands, forests and coral reefs was accessed through the city's planning and GIS department. Districts that contained these sensitive ecosystems were given a score of 1 and those that did not were given a score of 0.

The scoring of each indicator was summed to create an aggregate sensitivity indicator as shown in the following map.

5. Economic Activities Dependent on Climate Sensitive Industries

Data on local economic activities was compiled from Manado in Figures 2012. Certain districts have greater economic dependence for employment and household income on industries that are sensitive to climate change. These would include fisheries and agriculture, which may be adversely affected by temperature change, flooding, drought and high winds. Districts with climate sensitive fisheries and argicultural lands were given a score of 2, those with one or the other were given a score of 1, and those that have neither were give a score of 0.

3.5 Current Adaptive Capacity in Manado

Adaptive Capacity refers to the ability of a system to adjust to climate change in a way that moderates potential damage, takes advantage of opportunities, or copes with the consequences of climate hazards. The qualities that contribute to a system's adaptive capacity combine both physical and social/institutional elements that support its ability to adapt to climate

SENSITIVITY

Climate Related Sensitivities

1. Poverty
2. No Access to Electricity
3. Steep Topography
4. Sensitive Ecosystems
5. Climate Sensitive Industries

Sensitivity Rating: Low Medium High Very High

Kecamatan	Sensitivity				
	1	2	3	4	5
Malalayang				✓	✓
Sario				✓	✓
Wanea		✓	✓		✓
Wenang				✓	✓
Tikala	✓		✓		✓
Pal Dua	✓		✓		✓
Mapanget	✓	✓	✓	✓	✓
Singkil	✓	✓			
Tuminting	✓			✓	
Bunaken	✓	✓	✓	✓	✓
Bunaken Kepulauan		✓		✓✓	✓

Figure 22: Manado climate change sensitivity mapping

change. Thus, in the context of an urban area such as Manado, it can refer to the extent of infrastructure and public services, accessibility of information, technological capacity of institutions and communities, levels of wealth, the amount of 'social capital' of a given community, and the capacity of public institutions.

This section provides an analysis that quantifies and maps current adaptive capacity levels in the city to evaluate where potential opportunities exist and where challenges may lie. Adaptive capacity can be classified at three different scales:

Autonomous Adaptive Capacity

- Autonomous adaptive capacity refers to actions taken at an individual or household level to protect livelihoods and assets from potential climate related hazards. Autonomous adaptation is usually small-scale and effective for low intensity disasters. Adaptation is triggered by ecological changes in natural systems and by market or welfare changes in human systems.

Collective Adaptive Capacity

- Collective adaptive capacity refers to the capacity of actions taken by groups. These are generally community initiatives aimed at reducing exposure or minimizing sensitivity, the efforts and benefits of which are sought after by a wider group than just individual households. Collective adaptation is geographically larger than autonomous adaptation and usually requires more resources and coordination.

Institutional Adaptive Capacity

- Institutional adaptive capacity refers to the capacity of organizational systems. These might be programs, policies, regulations, human resources and technological expertise of government at the local, regional or national levels, and of civil society groups. The scale of institutional adaptation generally covers a large area and aims for systemic, long-lasting solutions.

Mapping Adaptive Capacity

Adaptive Capacity refers to the ability of a system to adjust to climate change in a way that moderates potential damage, takes advantage of opportunities, or helps cope with the consequences of climate hazards. The qualities that contribute to a system's adaptive capacity combine both physical, social and institutional elements that support its ability to adapt to climate change. In the context of an urban area such as Manado, it can refer to the extent of infrastructure and public services, accessibility of information, technological capacity of institutions and communities, levels of wealth, the amount of 'social capital' of a given community, and the capacity of public institutions.

While no standard indicators used to quantify adaptive capacity exist, it is important that quantitative data can be used to map its distribution spatially. Three indicators were employed for this assessment. They estimate the capacity of local communities to access health care, education and local resources for community development.

1. Access to Health Services

Health centers data from *Manado in Figures 2013* show the ratio of each district's population to hospitals and community health centers, as well as the ratio of children (age 1 to 5) to childrens' health centers. The districts with combined ratios of population to health centers higher than the citywide average were given a score of 1 and those with lower than average were given a score of 0.

2. Access to Education

Data on the ratio of teachers to students was accessed from the *Manado in Figures 2013*. The ratios for Kindergarten, Elementary School, Junior High School, Senior High School and Vocational Senior High School were considered. The districts with combined teacher to student ratios higher than the average across all nine districts was given a score of 1. Districts with teacher to student ratios lower than the average were given a score of 0.

3. Neighborhood Initiative Grant

An estimated US$6,500 development grant is provided to each lingkungan, the smallest neighborhood unit of a city, in order to address small infrastructure improvements. This policy helps local residents determine their needs and provides resources to help implement programs to address them. Each of the city's lingkungans receive the same amount, irrespective of population size. Therefore, by calculating the amount spent per person, per district, an estimate can be made for how much grant money was received per capita for addressing local infrastructure needs.

The average grant received per capita across the city of Manado was approximately 17,100 rupiah. Districts where the per capita grant money received was greater than the average was given a score of 2 and those that were below the average was given a score of 1.

3.6 Vulnerable People, Places and Systems

The vulnerability assessment indicates the areas, people, and urban systems that are most vulnerable to climate change hazards in Manado. Because vulnerability is defined by the interaction of the exposure, sensitivity and adaptive capacity variables, which vary from one place to another, vulnerability is not distributed evenly. By examining the spatial distribu-

ADAPTIVE CAPACITY

1. Access to Health Services
2. Access to Education
3. Neighborhood Initiative Grant

Adaptive Capacity Rating: Low Medium High Very High

Kecamatan	Adaptive Capacity		
	1	2	3
Malalayang	✓	✓	✓
Sario			✓✓
Wanea	✓		✓
Wenang		✓	✓✓
Tikala			✓
Pal Dua	✓	✓	✓✓
Mapanget	✓	✓	✓✓
Singkil		✓	✓
Tuminting			✓
Bunaken			✓✓
Bunaken Kepulauan	✓	✓	✓✓

Figure 23: Manado climate change adaptive capacity mapping

tion of vulnerability, the city government may use a variety of actions and strategies, giving emphasis to some areas over others.

The following section puts forward methodologies and offers analyses that map the spatial distribution of vulnerability at the city scale. Priority areas are identified here as 'hot spots' of vulnerability and identified using the vulnerability equation. The interaction of the variables is instructive: if adaptive capacity is high then vulnerability levels will be lower; similarly, if exposure is high but sensitivity is low, then vulnerability may be lower.

It is worth noting that vulnerability is constantly changing and this spatial analysis only offers a snapshot of the current situation. As the city and local areas develop, variables will change, and with it the levels of vulnerability will also shift. Newly developed neighborhoods may initially be very exposed to hazards because they are isolated and lack infrastructure, but as they become more connected to the city and receive better services their adaptive capacity increases and sensitivity decreases, reducing vulnerability, though this may take several years. Attempts to monitor vulnerability must be continually updated and actions should be adapted accordingly.

The following section describes the most vulnerable people and urban systems in the city, and concludes by offering a set of findings intended to support reducing climate change vulnerability in Manado.

City-Scale Vulnerability Analysis

The city-level vulnerability maps indicate the districts that are most vulnerable to climate change impacts, based upton the criteria and analysis described above.

Vulnerability is concentrated in districts that lie in the periphery of city. This is largely because adaptive capacity is low in these areas with lower levels of public services and low institutional capacity. These areas also have growing populations and thus have greater public service and infrastructure needs compared to previously urbanized areas closer to the city center.

The analysis suggests that some ways to address vulnerability might include revisiting city budgeting priorities to address the large populations and service demand in the periphery, as well as finding ways to build capacity and provide more support to kecamatan-level government.

In relation to Manado's three urban trends this study found the following:

Coastal Reclamation and Commercial Development

While coastal communities are exposed to sea-level rise and coastal storms, vulnerability along the coast varies by district. This may be attributed to the fact that some areas are relatively well served by public services and have higher levels of institutional support than other areas in the periphery. It may, however, conceal pockets of poverty and under-served communities at sub-district levels. Overall coastal communities have benefitted from better connectivity within the city, to markets, and to services. However, continued coastal development threatens the displacement of poor communities by commercial development. This creates social consequences, such as providing adequate compensation and housing alternatives, that must be address.

Development Along Steep Topography

The districts that have steep topography are amongst the most vulnerable to climate hazards. Topography has a significant impact upon exposure and also sensitivity. Steep hillside communities are often isolated and have lower levels of access, not only to services, but also mobility. As competition to live close to the city center increases hilly districts like Tikala, Wanea and Wenang, will become more vulnerable.

Urban Expansion

The growth of the city has brought new residents and new housing developments in the periphery. It is important to recognize that there are different populations living on the periphery: middle income inhabit-

ants living in new housing developments, farmers, and migrant newcomers. During times of heavy rain, such areas may become flooded because they have yet to be connected to a drainage networks. Residents in these areas may lack basic emergency services or easy access to evacuation routes and health services. As the city continues to urbanize, more farmers will sell their land. This process of land conversion is already increasing sedimentation of rivers and provoking flooding downstream.

Vulnerable People

While it has been found that climate hazards are not distributed evenly across the city, it is also true that different groups of people are more susceptible, or vulnerable, to climate hazards than others. For example, the elderly and the young are more likely to suffer from extreme weather conditions, and are less likely to be able to evacuate an area during a disaster without assistance. Identifying which groups are more vulnerable than others can inform what measures will support them in the face of future climate hazards.

The assessment found that urban poor communities across the city are exposed to multiple layers of physical and social vulnerabilities. Climate change impacts serve to expose and aggravate these vulnerabilities. Seniors, children, families dependent on fishing and agriculture, and women-headed households are particularly vulnerable to climate change impacts.

Vulnerable Urban Systems

Urban systems are networks of infrastructure, utilies and services that cover large areas of the city and provide necessary services for many citizens. These systems can be vulnerable to climate hazards, and if damaged or services interrupted, can cause more widespread problems. The next chapter will expand upon the findings related to the vulnerability of urban infrastructure systems. Short descriptions of the city's most vulnerable systems based upon their exposure and sensitivity are presented below.

1. Water Supply

Perhaps the most critical urban system for the city is the water supply network. This network is threatened by increasing demand for water resulting from the growing population of the city. The urban water system relies heavily on water from the River Tondano and neighboring districts, but urbanization and a lack of water resource management puts these at risk. The system also requires regulat maintenance and expansion to meet increasing needs.

2. Roads and Traffic

The road network is a vital system to the city but given the city's topography it is particularly exposed to landslides and flooding, which would obstruct vehicular movement. The highly centralized spatial distribution of activities and services means that the city is vulnerable to disruptions in the road network with few options for alternate pathways. The completion of the ring road should be a significant improvement, but alternative transportation options are needed to reduce vulnerability.

3. Drainage Systems and Coastal Development

Effective drainage of rainwater is hindered by new development along the coast that blocks outlets to the sea. This is causing increased incidences of flooding in low-lying areas. The combination of intense rainfall, sea-level rise and inadequate drainage threaten low-lying areas in the city center. Some new developments in the periphery have not yet been connected to the drainage network. An adequate and well-maintained drainage network is important for the city's health and public safety.

4. Solid Waste Management

The city's solid waste management system has not kept up with demand and as a result, trash has accumulated in rivers, the sea and on the hillsides. This is evidence of inadequate service. Properly collecting and disposing of trash is critical for public health and

overall city functioning. Climate hazards expose the failings of current systems because rain, flooding and increased temperatures can turn inadequate trash management into a widespread public health issues.

Mapping Citywide Vulnerability

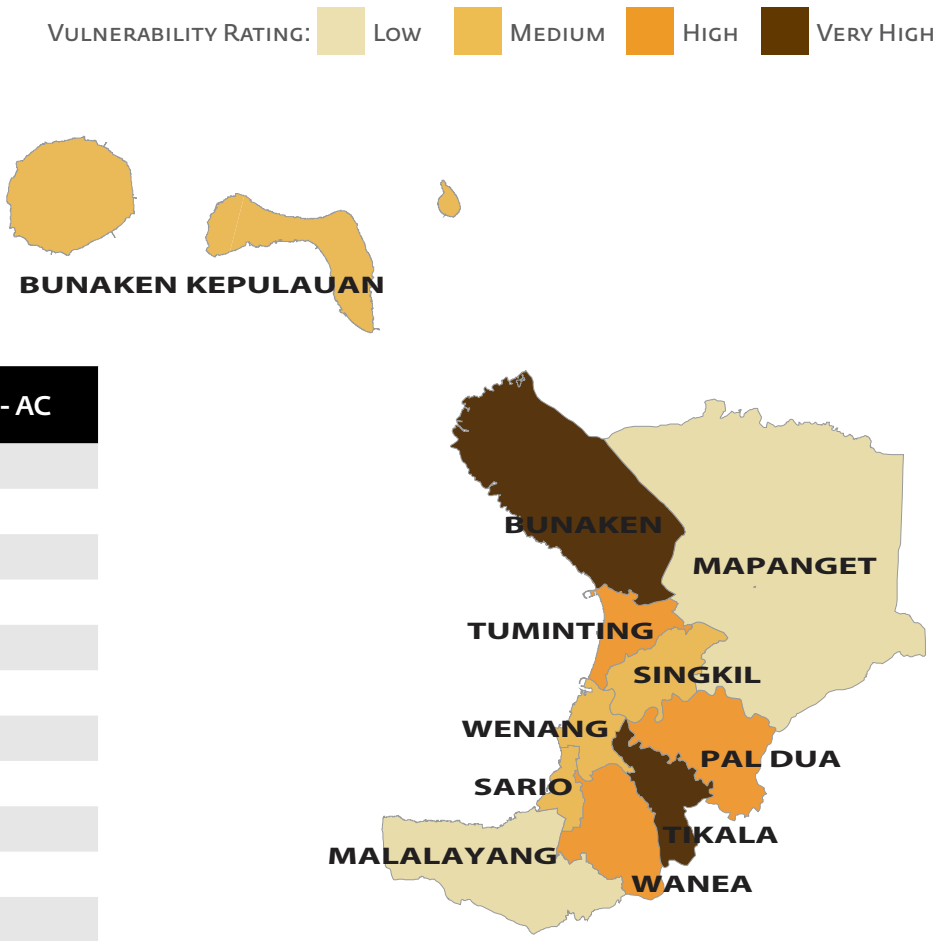
The consolidated map merges information on exposure, sensitivity and adaptive capacity from three separate maps based on the vulnerability formula. The resulting map indicates the varying levels of vulnerability and how they are distributed throughout the city.

Vulnerability is very high in the Bunaken district and also other districts in the city periphery such as Tikala and Wanea. These areas are experiencing growth but, being on the edge of the city, don't yet have adequate public service levels. Communities in these areas largely rely on fishing and agriculture-based activities for their livelihood, which are highly vulnerable to climate change impacts. These areas are also characterized by steep topography and coastlines, and so they are more exposed to rainfall and sea-level rise.

Districts that are in the city center, such as Sario and Wenang, have lower vulnerability due to greater

VULNERABILITY MAP BY KECAMATAN

Vulnerability = [Exposure x Sensitivity] - Adaptive Capacity



Kecamatan	[E x S] - AC
Malalayang	3
Sario	6
Wanea	10
Wenang	9
Tikala	14
Pal Dua	11
Mapanget	1
Singkil	8
Tuminting	11
Bunaken	18
Bunaken Kepulauan	8

Figure 24: Manado climate change vulnerability mapping

access to infrastructure and public services, which increases their adaptive capacity, and relatively low exposure. Other districts in the periphery, such as Mapanget and Malayang, have lower than expected vulnerability because they have lower populations, are not as exposed to flooding or landslides, and are relatively well serviced for the size of their populations.

3.7 Vulnerability Study Findings

1. The government can reduce vulnerability by improving adaptive capacity and reducing sensitivity.

There is little that the citizens or government can do to control exposure to climate change hazards, therefore the only way to reduce vulnerability is to find ways to increase adaptive capacity and reduce sensitivity. There are a variety of measures that city government can adopt, for example improving public services and increasing the institutional capacity of local government to respond to climate hazards. Government can also reduce sensitivity by improving spatial planning and focusing efforts to reduce poverty.

It is important to remember that the government's response should focus on both physical and non-physical actions. Non-physical actions are important because they increase adaptive capacity, such as programs that build social cohesion and awareness. Such programs increase the capacity for collective action, which is the first line of response to climate impacts. Increased institutional capacity can also support neighborhood and district level governments to adapt by providing information and facilitating collaboration with local people.

2. Vulnerability is constantly changing with the rapid urbanization of the city

Priority areas considered most vulnerable to climate change can change from one moment to another. They evolve and shift depending upon what kind of urban growth the city is experiencing at a given time. At the moment, the three trends that influence the city's vulnerability to climate change, identify the communities in hillside areas and along riverbanks as priorities. City government should continue to monitor vulnerability levels as they will change over time with shifting priority areas. For example, a poor slum area may not always be vulnerable if it can successfully increase its adaptive capacity by improving awareness and access to services. Policies and actions should also be flexible to adapt to the differing locations, groups and systems that are considered vulnerable at any point in time.

3. Vulnerability can be reduced by both environmental conservation and better urban planning and management

The city's unique natural setting is a key amenity, one that draws tourist visitors and commercial opportunities, and gives Manado its distinct identity. Protecting its natural environment is important for the city's long-term development strategy. Doing so will require the alignment of environmental conservation efforts (to protect the reef, coastline and watershed) as well as improved urban planning and management (to improve public services, reduce urban poverty and plan adequate infrastructure). Government's response should work together with civil society organizations and citizens with both environmental conservation and better urban services in mind.

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Figure 25: The Soekarno Bridge is Manado's newest additionl to the skyline. It symbolizes the city's rising aspirations and rapid growth.

4 Infrastructure Vulnerability Assessment

The combination of impacts from both climate hazards and urbanization patterns on a city has the potential to negatively impact not only people and communities, but entire urban systems too. Urban systems are citywide infrastructure or services that support the basic functioning of an urban area, examples are the road and transportation network, water supply, trash collection, and coastal protection. These urban systems operate as supply networks that bring necessary services to residents throughout the city.

Urban systems are vulnerable to climate hazards, which can also exacerbate problems caused by inadequate or defective urban systems – vulnerability is thus closely interrelated. As an example, if heavy rainfall causes a landslide and cuts off a road, the road blockage may obstruct the passage of vehicles and could negatively impact the local economy. Another example would be if a district's water mains are damaged and leak during a period of extended drought, the population's capacity to access water would be greatly threatened and could put the public health of communities at risk.

The infrastructure vulnerability assessment was conducted in consultation with the city government, who identified strategically important urban systems. The assessment also considered the importance of the urban systems together with their vulnerability to evaluate which would pose a greater risk to the population if they were damaged during a climate hazard event, or if climate change were to negatively impact the functioning of one of the city's important systems.

This section describes the critical issues that affect four urban systems, the people and areas that would be most negatively affected if the system were to fail, and the impact that climate hazards have on them. The four systems are: City water supply, Roads and traffic, Urban drainage systems, and Solid waste management.

4.1 Water Supply

The water supply system is one of the most important urban systems in the city because it supplies clean water to households and if compromised, there would be significant public health consequences. The water supply system goes beyond the pipes that bring water to standpipes and taps within houses, it also encompasses the watershed that collects and filters water, and the water treatment plants that draw water from rivers and readies it for distribution. At the moment, 60% of the city's water supply comes from the Tondano River.

CRITICAL ISSUES

Protecting water catchment areas	Catchment areas must be protected to ensure that enough water is collected. Urbanization can reduce catchment areas due to land conversion.
Ensuring treatment capacity	To keep up with demand water treatment facilities must have adequate capacity. Growing population increases need for water treatment.
Ensuring supply keeps up with demand	Increasing supply means increasing intake of water, this can be complicated by pollution, low rainfall and low treatment capacity.
Ensuring equal access to water for the poor.	Supplying the poor is a challenge as many are unable to pay for water delivery infrastructure or live in areas that are a challenge to supply.

CRITICALLY AFFECTED PEOPLE AND AREAS

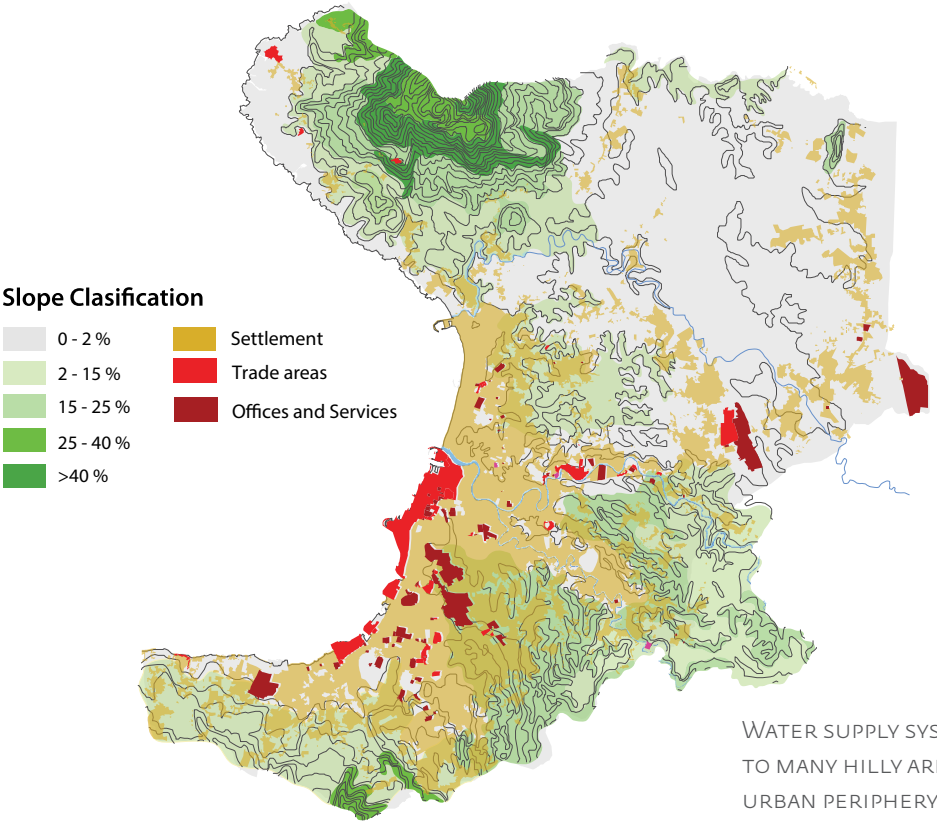


Figure 26: Manado water supply systems mapping

Water treatement (IPA)

Hillside settlement areas

WATER SUPPLY SYSTEMS HAVE YET TO BE EXTENDED TO MANY HILLY AREAS AND OUTER LYING AREAS OF THE URBAN PERIPHERY. LACK OF WATER CAN CAUSE PUBLIC HEALTH ISSUES DURING PERIODS OF DROUGHT.

TONDANO WATERSHED

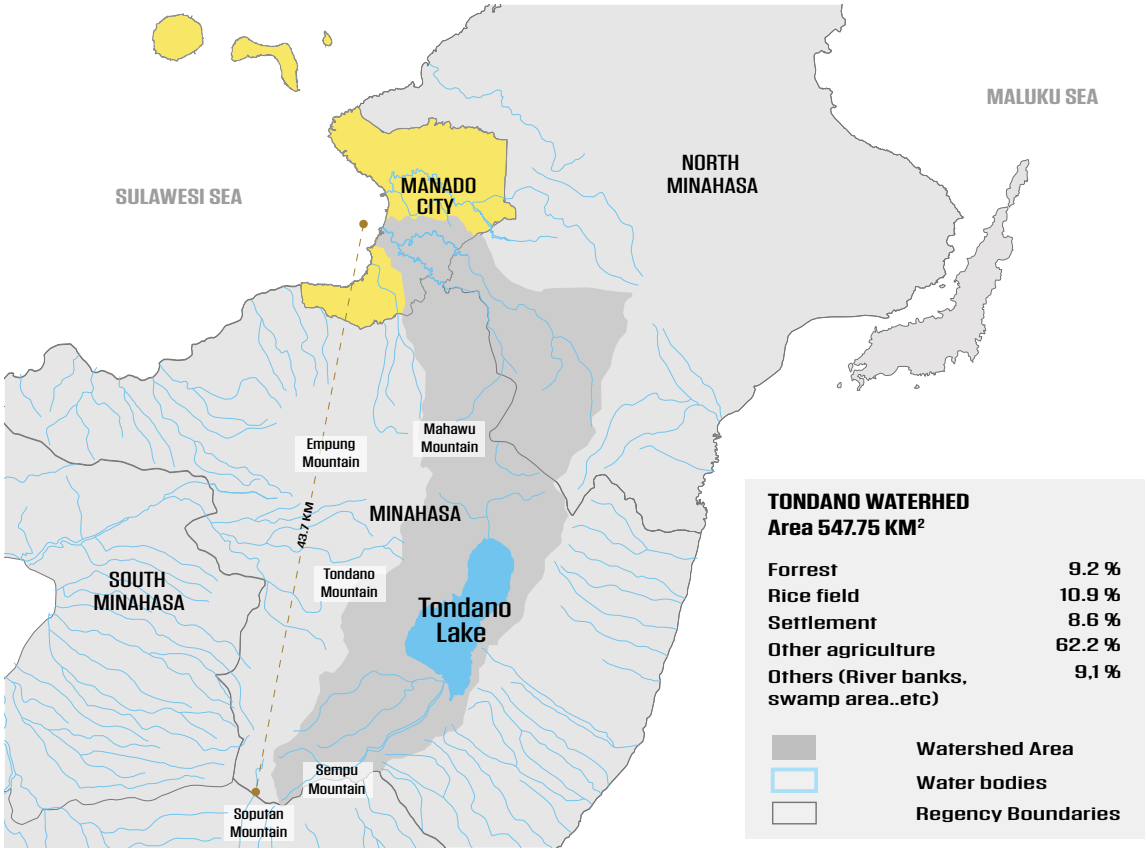


Figure 27: Manado Tondano watershed map. There are five rivers that run through the City of Manado. Lack of adequate management and degradation of the watershed, together with expanding urban development in the catchment area, can cause floods during periods of unpredictable and heavy rain.

People Critically Affected

- Poor communities living in hilly areas often don't have adequate service since pushing water uphill requires pumps, which many of the poor who live there cannot afford.
- The population of the city would be affected by polluted water, or low service levels, if anything should affect raw water collection.

Areas Critically Affected

- Hillside communities.
- Communities in outlying areas where pipes connecting to the water supply network have not been constructed yet.

Impact of Climate Stressors

- Droughts will exacerbate the need for water, so water supply systems should function effectively and cover the entire city. If service is disrupted during extended periods of drought, the population would be vulnerable to public health issues.
- Unpredictable rainfall and flooding could affect the supply of water to rivers that in turn would affect the city's water supply. Ensuring the water catchment areas are protected can help bring more stability to the flow of water.

4.2 Roads and Traffic

The road network is an essential urban system that provides access and supports the passage of people and goods throughout the city. If the road network is compromised, communities could be denied access to emergency safety vehicles and evacuation routes. Congested roadways slow access and passage of goods, which would negatively impact the local economy. Roads should be safe and in good condition to ensure can circulate efficiently.

Manado's road network radiates in spokes from the commercial area in the city center and most roads entering the city lead directly to the center. A critical problem is that during flood events, poor drainage along roads causes the roadways to narrow, which means traffic flows slower. This causes congestion and impacts businesses and other functions of the city. Given that so many businesses are located in the city center, and many people from outside the city come to Manado to seek services and trade, congestion in and around the city center is a disruption to daily life.

A ring road is currently being constructed and aims to alleviate some of the strain placed on the road network. There is an initiative of the Mayor to improve public transportation and encourage parking outside commercial areas. The planning department is also exploring the possibility of dispersing activities, and therefore traffic, to surrounding areas of the city.

CRITICAL ISSUES

Too many cars	There are so many cars on the streets that traffic is common. There is not yet an alternative public transport system.
Flooding causes congestion	Heavy rainfall causes flooding in the city center due to poor drainage. This creates congestion and traffic and can bring the city to a standstill.
Land use concentrates activity in the city center	Most commercial activities are concentrated in the city center, which is prone to flooding. The central area is vulnerable to flooding and traffic, which impacts the economic activity and mobility of the city.

CRITICALLY AFFECTED PEOPLE AND AREAS

HEAVY RAINS AND FLOODING CONTRIBUTE TO CONGESTION IN THE CITY CENTER. BETTER PLANNING OF URBAN GROWTH IS NEEDED TO DISPERSE ACTIVITY TO AREAS THAT ARE NOT VULNERABLE TO FLOODING AND LANDSLIDES.

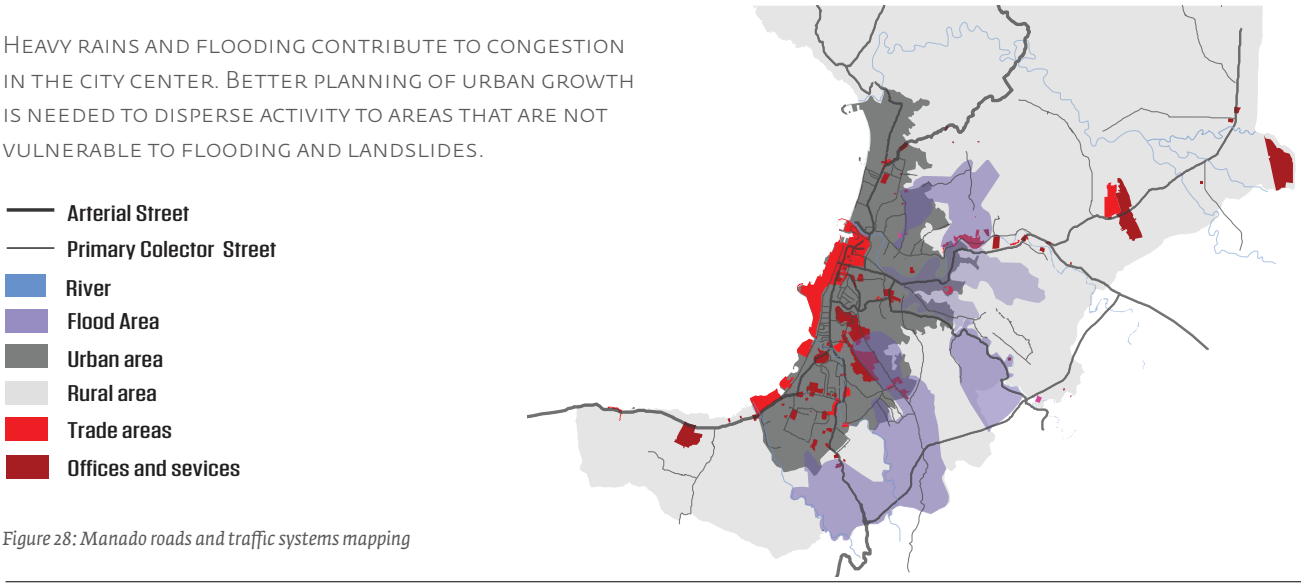
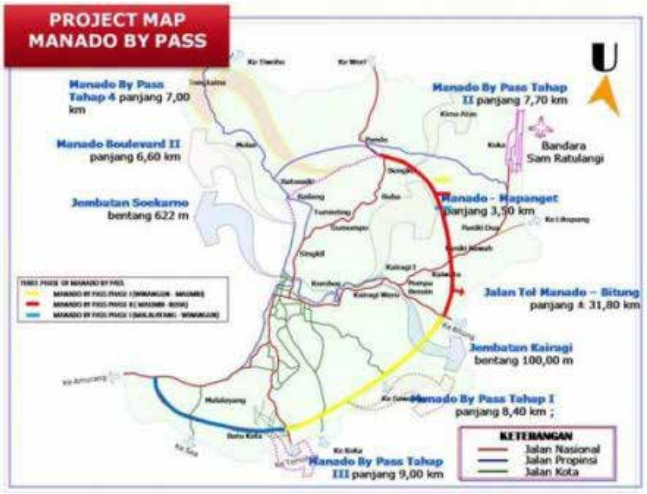


Figure 28: Manado roads and traffic systems mapping

NEW RING ROAD CONSTRUCTION AND POPULATION DENSITY

With the population projected to grow by approximately 260,000 inhabitants over the next 50 years, there will be extra pressure on current roads and infrastructure. Adequate roadway infrastructure is critical to directing future development away from vulnerable and sensitive areas.



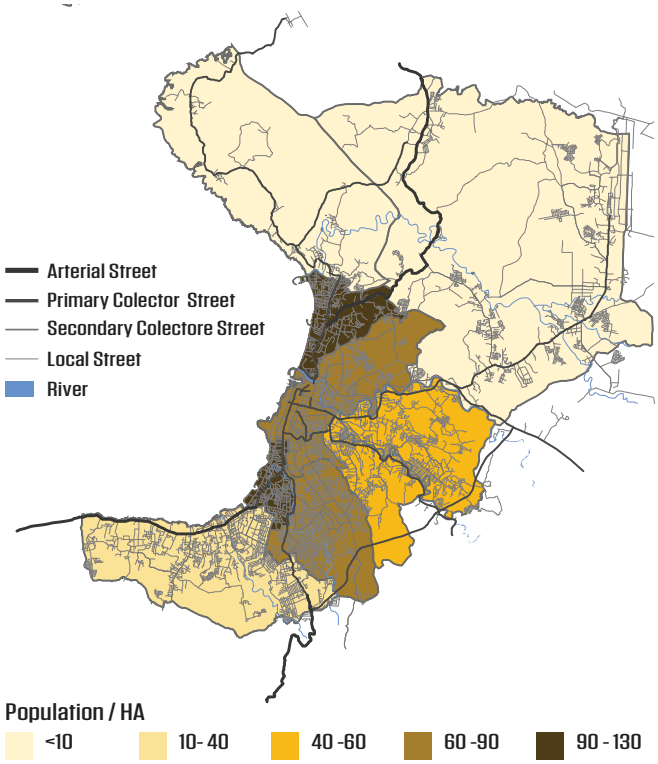


Figure 29: Manado road network and population density

The proportion of damaged and poor quality roadways (by length) in Manado increased between 2011 and 2012. Damaged roads can make areas of the city more vulnerable to climate change due to difficulty of access for health, social support and evacuation in the event of climate impacts.

CONDITION OF ROADWAYS

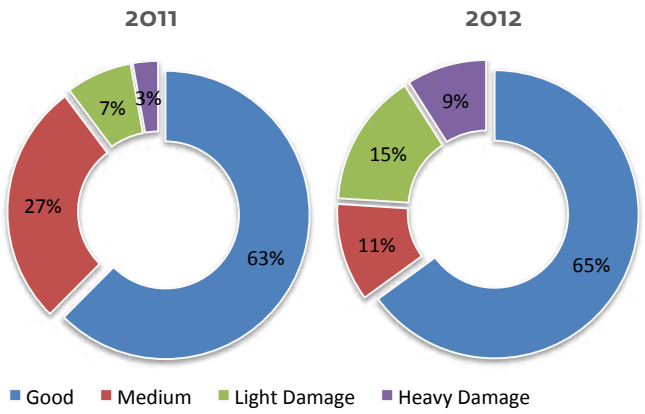


Figure 30: Manado condition of roadways 2011 and 2012
Source: Manado In Figures, 2013

People Critically Affected

- Motorists and commuters are most affected by traffic.
- The poor who live far from jobs, perhaps in outer lying areas, spend the most time in traffic on small vans.
- Businesses are affected by the poor level of circulation that can hinder productivity and activity.

Areas Critically Affected

- The city center where most traffic congestion occurs.
- Low lying areas that are most often flooded, exacerbating areas where road congestion occurs.

Impact of Climate Stressors:

- Heavy rain can cause flooding in low-lying areas, such as the city center, and create traffic that negatively impacts the local economy.
- A road system that functions well can help victims of flooding to evacuate vulnerable areas.

4.3 Drainage Systems and Coastal Development

The city's drainage system carries away surface water from rainfall and ensures it is removed quickly from the city, thereby preventing flooding, which causes damage to property and puts human lives at risk. The drainage system is an important urban system in Manado given the city's steep hillsides and frequent rainfall, but its capacity to function effectively is reduced by climate change and urbanization trends.

One factor is the construction of housing developments on the city's periphery and in steep hillside areas. Often these areas are deforested to make way for housing, which provokes soil erosion and silting of rivers. Without trees and vegetation to absorb water from the unpredictable and heavy rainfall that comes with climate change, rivers flood faster. Additionally, new developments may not be connected to drainage system infrastructure and storm water could flow directly into rivers, overburdening them.

Rivers play an important role in channeling water away from the city, but sedimentation is raising the

CRITICAL ISSUES

Urbanization of the periphery is accelerating sedimentation	As the city expands outwards more sediment becomes eroded and this accelerates the sedimentation of drains and rivers.
Flooding affects the urban poor the worst	Flooding of rivers affects the communities along the riverbanks, many of whom are the poorest. Damages from flooding compound poverty issues in these areas.
Displacement of coastal communities neglects fishing communities	Coastal flooding and coastal development threaten the livelihoods and communities of fishermen who are often displaced. Without adequate re-settlement their lives are negatively affected.

CRITICALLY AFFECTED PEOPLE AND AREAS

POOR DRAINAGE AND URBAN DESIGN CONTRIBUTE TO FLOODING PROBLEMS IN LOW-LYING AREAS OF THE CITY WHICH MAY STAY FLOODED FOR LONG PERIODS DUE TO LACK OF PROPER DRAINAGE TO THE SEA.

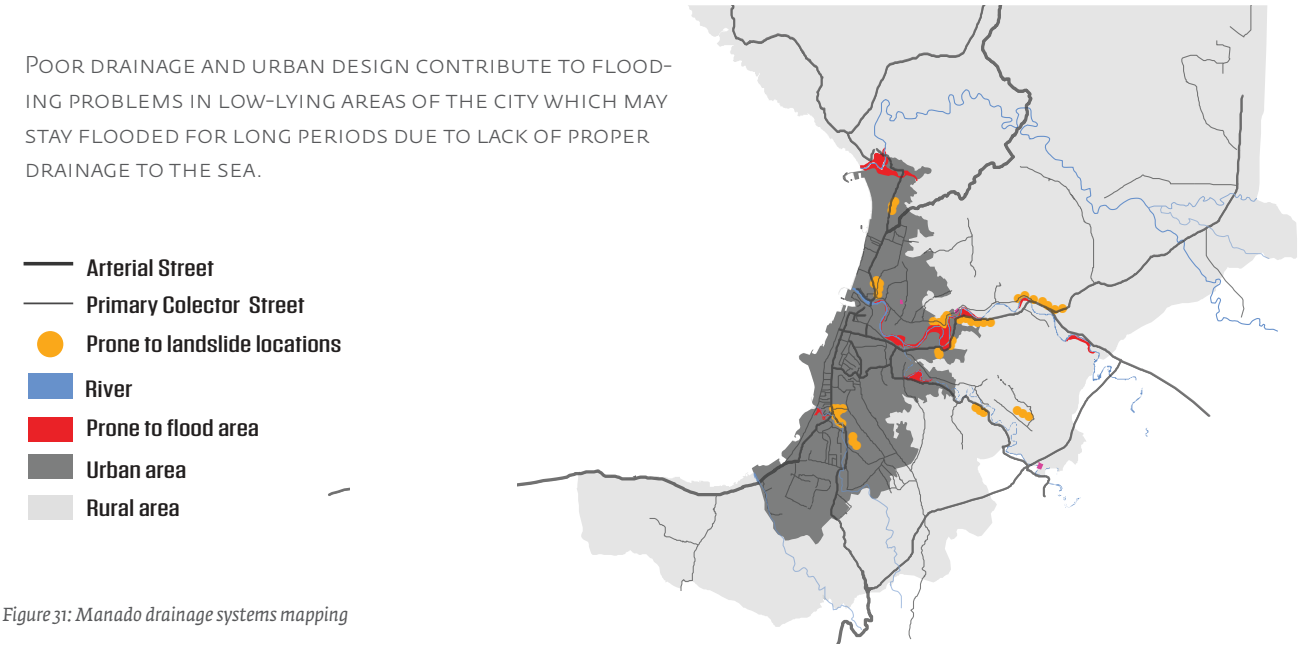


Figure 31: Manado drainage systems mapping

FACTORS THAT AFFECT FLOODING

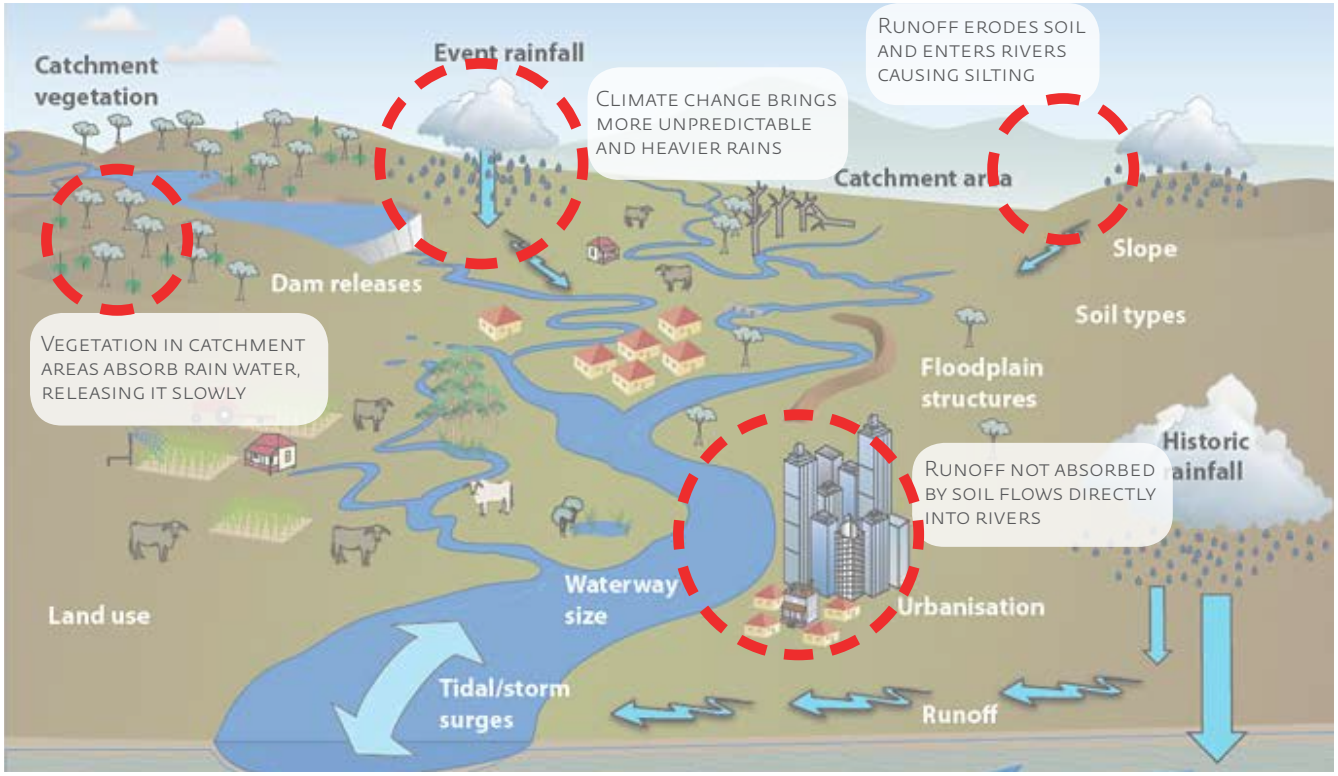


Figure 32: Floodplain structures, preventing deforestation, and maintaining and planting trees and vegetation in the catchment area can all help reduce the risk and impact of flooding. All these interventions encourage rain to be absorbed into the soil rather than flow directly into rivers.

level of the riverbed, causing rivers to have lower carrying capacity. Lack of maintenance of rivers, such as dredging and restoration of degraded riverbanks, is necessary to ensure they function to channel storm water effectively. Dense urbanization of Manado's riverbanks often reduces the capacity of rivers. The dense riverbank communities are vulnerable to flooding as their homes and other assets are at risk and access to evacuation routes are limited.

Urban development along the coastline complicates the drainage of storm water, which cannot flow easily to the sea, leaving low-lying areas flooded long after rain events. Improved drainage to discharge storm water is required, however it can be very costly to do so, and will require additional infrastructure and maintenance.

People Critically Affected

- Business owners and residents of areas in the city center that floods regularly
- Riverbank dwellers and those in hilly areas that suffer from flooding and landslides.
- Fishing communities that are affected and sometimes displaced by coastal development

Areas Critically Affected

- City center (along the boulevard)
- Riverbank communities
- Hillside communities.
- Bunaken Islands
- Coastal areas targeted for further infill development

Impact of Climate Stressors

- Heavy rainfall leads to flooding along riverbanks

4.4 Solid Waste Management

Solid waste management is a critical urban system that removes trash and disposes of it in a way that doesn't negatively affect the health of residents. Such systems consist of regular collection and disposal of trash along planned routes and at disposal sites. Interruptions in service results in unsanitary accumulation of trash in the city's streets, alleys open spaces and waterways. This is very dangerous because unsanitary conditions can promote the the spread of pathogens, such as malaria, and cause epidemics.

Climate hazards such as heavy rain, flooding and droughts can hinder solid waste management systems by making collection difficult (for example in the case of landslides or floods restricting access) or dispersing trash.

If the solid waste management system is interrupted or does not cover the full extent of the city, serious health risks and environmental damage can result. As cities grow and the population increases, communities generate more trash and collection systems must be able to expand to keep up with the demand.

CRITICAL ISSUES

Obstructed storm water drainage	Trash in ditches and rivers block the drainage of storm water and contributes to flooding
Hilly areas are difficult to access	Many settled areas on hillsides are remote and difficult to access by trash collection trucks. Without adequate service households resort to dumping trash down hillsides or rivers.
Inadequate trash management system	The trash management system is not keeping up with demand due to a shortage of trucks and insufficient management capacity; this leads to dumping of trash in the rivers and public health issues.
Riverbank settlements and markets dumping	Those communities and markets without trash collection service often dump straight into the river, which then flows to the sea and pollutes the coral reef.
Ships dumping trash into the ocean	Ships traveling to and from Manado often dump trash in the ocean.
Siting of trash dumps	Trash dumps located in vulnerable areas is an issue as flooding can spread waste and contaminate water systems, causing public health outbreak

People Critically Affected

- Those living along the riverbanks who can't use the rivers due to the pollution, island dwellers because trash washes up on their shores, and inhabitants in general who suffer the smells, public health threats, odors, and other issues that have not been dealt with.

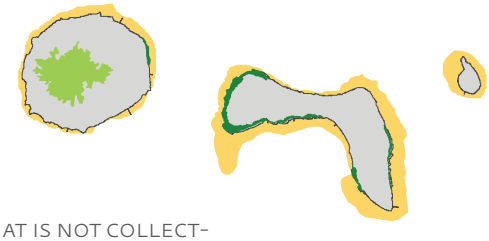
Areas Critically Affected

- The areas affected are the rivers and the markets that are along rivers. Critical areas of concern are Minahasa (the Tondano River) and Minahasa Utara (Sario River).
- Trash also affects coastal communities and island communities.

Impact of Climate Stressors:

- Heavy rains can sweep trash into rivers and then out to the sea, causing pollution and damaging marine life. This can only be avoided with comprehensive trash collection throughout the city.

CRITICALLY AFFECTED PEOPLE AND AREAS

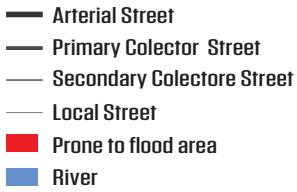


Trash and other solid waste that is not collected and disposed of adequately accumulates in ditches and rivers, blocking drainage of storm water, which contributes to flooding. Eutrophication of the sea water caused by sewage will threaten Manado Bay and the Bunaken National Marine Park.

Figure 33: Manado sensitive ecosystems mapping

ROAD NETWORK AND POPULATION GROWTH PROJECTIONS

Adequate trash collection is required in dense riverbank areas and steep hillside communities which have fewer resources and services. They are more vulnerable to public health epidemics and often lack information about climate change impacts.



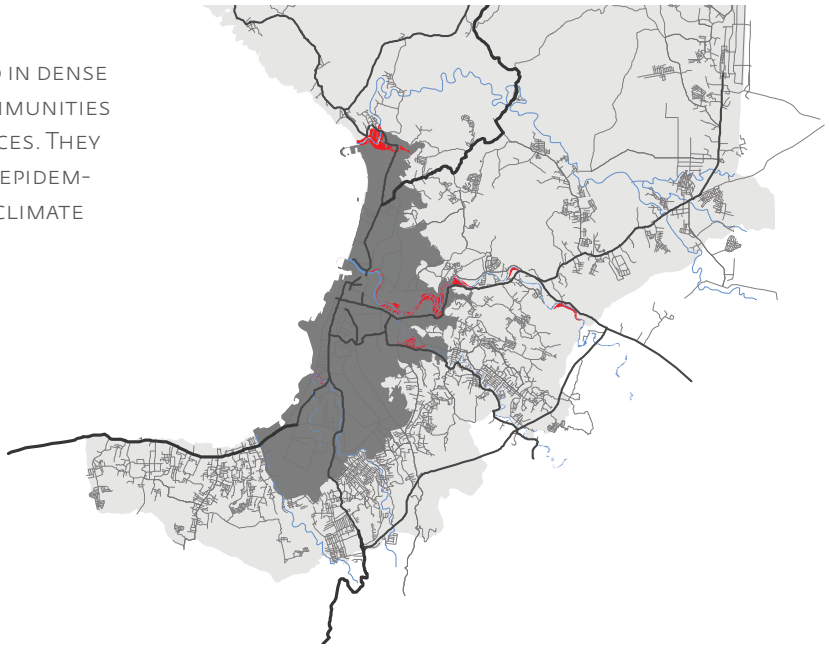


Figure 34: Manado urbanized area and road network

Figure 35: Well mantained roadways and an efficient road network is critical to the functioning of a city. Manado is buidling a ring road that will relieve traffic congestion in the city and improve access within the region.

5 Recommendations

The following recommendations have been gathered from a workshop, held on Tuesday June 17th 2014 in Manado, to raise awareness about this Climate Change Vulnerability Assessment. The Workshop was an inter-sectoral discussion between leaders of various government agencies concerned with climate change adaptation issues, as well as representatives of civil society organizations and Sam Ratulangi University. The Workshop was held to present the findings of the assessment, to raise awareness about the issues and challenges that climate change brings to Manado, and facilitate discussion about what measures should be taken. The following recommendations result from working group discussion sessions that occurred at the Workshop.

The Workshop brought together 36 participants including 17 local government officials. Local government officials came from the Departments of Coordinating Planning (BAPPEDA), Environment, Water (PDAM), Disaster Relief (BPBD), Community and Neighborhood Empowerment (BPMPK), Urban Planning (DTRK), Public Relations (HUMAS), Public Hygiene and Parks (DKP), and the Mayor's Economic and Development Office. The Department Heads of the Environment and Public Parks and Hygiene attended, as well as the second assistant of the Mayor (from the Economic and Development Office). Five different local NGOs were represented, as well as the head of the local university's Department of Urban Planning.

The working group session sought to discuss how critical urban infrastructure systems, the main focus of this vulnerability assessment, are affected by climate change and what measures are necessary to strengthen them. Participants were asked to describe the problems and challenges facing each system as well as put forward needed solutions. Discussion was facilitated by using the different lenses of a 'physical infrastructure' approach, as well as a 'policy and planning' approach. Participants split into the following groups (i) the traffic and road system, (ii) the solid waste system, and (iii) the water supply, drainage systems and coastal development. By mixing the participants from different agencies and sectors the session was designed to encourage cross-sector discussion and build consensus amongst stakeholders about conclusions and necessary recommendations for the city leadership.

5.1 General and Specific Recommendations

The following set of recommendations are directed towards the government of the City of Manado. The first set of recommendations is general, they apply to the government as a whole and relate to strategic approaches to adaptation and vulnerability reduction. A shorter and more detailed set of recommendations refers more specifically to each of the infrastructure systems discussed in this report.

General Recommendations

1. Campaigns are needed to raise public awareness

Currently, little is understood about the impacts and necessary responses to climate change amongst government, private sector and civil society. The release of the Manado Climate Change Vulnerability Assessment should prompt more widespread awareness of the challenges of adapting to climate change, in order to build capacity about key issues. Follow up activities include: incorporating climate change adaptation into planning processes and documents, building capacity amongst government staff and departments, and raising community awareness amongst citizens about the trash, water and drainage issues.

2. Better maintenance and management of systems are necessary

To ensure that urban infrastructure systems can best cope with climate hazards that threaten the city, such as flooding, temperature rise and sea-level rise, better maintenance and management of these systems is necessary. Government approaches to managing essential services like the municipal landfill and drainage system should be reviewed and improved, and a larger portion of the budget should be allocated to maintaining the functioning of such systems. Improving maintenance can also involve community approaches, since residents are well-positioned to collaborate at the local-scale and participate in campaigns where each citizen's involvement is required. Citizens can also be involved in early warning systems. The emphasis on the management and maintenance of infrastructure systems should also include natural systems, as the need for restoration and preservation of the city's watershed is urgent.

3. Strategic infrastructure is needed

Key urban infrastructure is needed for the city to cope with urbanization and reduce social, physical, and economic vulnerability to climate change. Projections of climate change impacts in the future helped participants recognize the need for the following infrastructure: water treatment plants, the widening of existing drainage, the strengthening of riverbanks, a bus transportation system and transfer, and trash landfill sites. These projects should be accompanied by other interventions, such as social policies and maintenance schemes.

4. Regulations are needed and existing laws should be enforced

In order to ensure that urban infrastructure systems function properly, new regulations are needed. Stronger regulations about water management, new housing development and conservation of natural resources are necessary. At the same time better enforcement of a number of existing regulations could significantly reduce vulnerability to climate change. The city has a number of regulations that are not adequately enforced, such as those concerning management of trash and drainage systems, and the failure to do so enhances vulnerability.

5. Improved coordination is required

Physical and social vulnerability often results from a lack of coordination between different institutions and levels of government. Coordination is lacking in terms of network infrastructure, for example between the water and electricity agencies, as well as between planning and management processes. Coordination should be improved between different municipalities, such as: those of Manado and the surrounding regencies; between Manado and provincial and national government; and between the city government and the neighborhood-level of government.

Specific Recommendations by Sector

Specific recommendations by sector have been divided into two groups: Short-Term, which are practical changes that are feasible for the city to implement; and Longer-Term, which are more complex changes often involving concesus and coordinated efforts among multiple stakeholders that will be more difficult and time consuming to carry out.

Water supply and drainage systems

Short-Term

- Seawater desalination plants could support water supply for residents of the Bunaken islands.
- Rainwater harvesting and ponds could be considered to support improved access to water, especially in areas with low service levels.
- Conduct a study about the drainage system and seek to improve its connectivity.

Long-Term

- Widen the primary drainage system and expand it along Jl. Sam Ratulangi.
- Conservation areas of the watershed must be protected to ensure more steady supply of water.

Solid waste management system

Short-Term

- Propose the creation of an inter-regional waste management strategy in coordination with provincial government and other regencies.
- Launch a campaign to reduce, recycle and reuse trash at the neighborhood level by coordinating with Lingkungan government and public markets (Karombasan, Bahu and Bersehati). Involve community members in raising awareness and local clean-up activities.

Long-Term

- Build temporary transfer points (in Wenang, Tikala, Sario and Singkil) and expand the existing landfill to up to 10 Ha to increase its capacity.

Road and traffic system

Short-Term

- Encourage the use of public transportation to reduce the use of cars, and provide improved pedestrian areas, bicycle paths and green spaces in the city center.
- Restrict the number of cars and traffic in the city center through enforcing parking and

Long-Term

- Seek to disperse job concentration and settlement pattern so that not all economic activity is concentrated in the city center.
- Build transit centers for people entering Manado from surrounding areas to leave their cars/ buses and use local public transportation.

Drainage systems and coastal development

Short-Term

- Improved coordination between local governments along the watersheds of the rivers entering the city to conserve vegetation and reforest hillside areas.

Long-Term

- Create a regulation for all new housing developments and settlements within and outside the city to install infiltration ponds to absorb rainfall.
- Raise awareness and improve the enforcement of government regulations.