Slum upgrading based on flood mitigation for resilience of Manado City

W J Mononimbar
Urban and Regional Planning Study Program, Sam Ratulangi University

*E-mail: wmononimbar@yahoo.com

Abstract. The resilience of a city is created by the resilience of all parts of the city that are able to adapt on occurred changes, whether climate change or natural disaster, unexpected development changes and social and economic turmoil of urban society. One area of the city that has a high level of vulnerability to these changes is the settlement that is located around the riverbank area. It is generally identified as slums that have irregular settlement patterns, unsuitable housing conditions and not equipped with infrastructure and facilities of settlements adequate, which cause the settlements can’t survive when the floods occurred. Manado City as the capital of North Sulawesi Province, according to Decree of Mayor of Manado Number 163 of 2015 on Determination of Slum Area, there are 13 slum areas around the river border with high flood vulnerability level. Recorded in January 2014 there has been a massive flood in Manado that caused damage and huge losses and even casualties in these areas. This is due to irregular settlements and lack of infrastructure. This study was conducted in one of the slum-heavy at Sindulang Satu District covering aspects of land use analysis, river and coastal boundary conditions, building conditions and disaster mitigation infrastructure systems (river embankments, drainage channels, circulation systems and evacuation routes, green open spaces, electricity, etc). The results show that the boundary area of the river needs to be restructured, the river embankment and drainage channel are repaired, the high density of the building needs to be reduced to provide sufficient open spaces, the need to build disaster evacuation routes, improved building conditions and provide an alternative source of electricity and clean water so that if there is a disaster then the area can survive.

Keywords: flood mitigation, resilience, slum upgrading

1. Introduction

1.1. Background

Urban resilience is the capacity of individuals, communities, institutions, enterprises and systems within a city to survive, adapt and grow with various shocks and pressures experienced both physically and socially. It means that the resilience of the city encompasses all aspects of the physical area to the social and economic aspects. City resilience is also created from the resilience of every part of the region that is capable to survive. The resilience is decreasing survive when the physical and social pressures are slum areas. According to the Law of the Republic of Indonesia Number 1 of 2011 about Housing and Settlements, slums are unfit settlements due to building irregularity, high building density and quality of buildings and infrastructure that are not eligible. This condition causes the residential area to be
vulnerable to disaster and to other physical pressures. When a large scale disaster occurs, it can cause damage. Though a resilience city is when all parts of the city can survive and adapt to all kinds of physical and social pressures.

Manado City as the capital of North Sulawesi Province has a number of slum areas located in the river border area. Based on Decree of Mayor of Manado Number 163 of 2015 about Stipulation of Slum Area in Manado City, there are 13 slum areas located in Tondano watershed area, with high level of disaster risk, this is due to high population and building density, house condition is mostly non-permanent, irregular location, almost no distance between buildings, unclear circulation system, lack of drainage and river embankment and lack of space open green.

1.2. Objectives
Objective of study is to analyze the slum upgrading based on flood mitigation in Sindulang Satu District located between the mouth of Tondano watershed and the coastal area. It is expected the risk of flood disaster can be minimized and can create a resilient area.

1.2.1. Understanding of City Resilience, Slum Upgrading and Flood Mitigation System
City resilience describes the capacity of cities to function, so that the people living and working in cities - especially the poor and vulnerable - survive and thrive no matter what stresses or shocks they encounter [10]. The resilience is created from the resilience of all parts of the city that is able to change the happenings, whether the climate change or natural disasters, unexpected development changes and social and economic turmoil of urban society. One area of the city that has a high level of vulnerability to these changes is the slum.

Defines slum is informal settlements within cities that have inadequate housing and squalid, miserable living conditions [9]. They are often overcrowded and lack basic municipal services such as water, sanitation, waste collection, storm drainage, street lighting, paved sidewalks, roads for emergency access and durable housing that protects against extreme climate conditions. Many slums are built on the river border area and has a very high flood vulnerability, as it is usually not equipped with durable housing and adequate infrastructure, so that when the floods come the settlements can not survive [5].

This condition has a negative impact on the whole city because it deals with city issues by containing environmental degradation. Therefore it is necessary to slums upgrading. According to Cities Alliance, slum upgrading is a process through which informal areas are gradually improved, formalized and incorporated into the city itself, through extending land, services and citizenship to slum dwellers. It
involves providing slum dwellers with economic, social, institutional and community services available to other citizens. These services include legal (land tenure), physical (infrastructure), social or economic. In correlation with flood mitigation, the above aspects can be categorized into two aspects of flood mitigation system, including structural flood mitigation, ie physical structures that are built or modified to reduce flood impact such as embankment infrastructure, drainage system, etc., and flood mitigation non-structural such as land use planning controls, etc. These aspects are included in the framework of resilience city especially on infrastructure and environment aspect [10].

2. Method

2.1. Study Field
The field of study is in Sindulang Satu District located in Manado City. Sindulang Satu District located right at the mouth of Tondano watershed (between Tondano watershed and coastal), where floods flooded to a height of 2 meters so that many houses and businesses which was damaged and was washed away by the flood.

2.2. Aspects of Analysis
Aspects of analysis are focused on infrastructure and environmental aspects related to flood disaster mitigation infrastructure, with the following description:

| Main Aspects                              | Sub Aspects                              |
|-------------------------------------------|-------------------------------------------|
| Condition of river and coastal border area|                                           |
| Land use                                  | Density and distance of buildings         |
| Buildings conditions                       | Structure and construction                |
| Flood infrastructure system               | Embankments                               |
|                                           | Drainage channels                         |
|                                           | Roads and evacuation system               |
|                                           | Signage system                            |
|                                           | Open space                                |
|                                           | Rescue/escape hill                         |
|                                           | Electricity                               |

2.3. Method of Collecting Data
The primary data collection method is observation to see the condition of settlements such as buildings condition, availability of flood infrastructure and river border area and survey through structured interview to respondent (dwellers) with purposive random sampling technique to see their preference for slum upgrading. Secondary data collection is through the collection of government information and policies such as regulations of river borders, etc. The research instruments are questionnaires, maps, photographs, drawings and documents on the condition of the study sites.

2.4. Data Analysis Method
The method of analysis is qualitative to describe the existing settlement conditions and then can be recommended to improve the settlement better than the previous condition. For spatial analysis and map plan using ArcGis 10.3 software.

3. Results and Discussion
To analyze the slum upgrading it is necessary to see the condition of the whole settlement including the condition of river border area, land use, buildings condition and flood infrastructure system.
Regional Overview

Sindulang Satu District is one of the most strategic parts of Manado City because it is located at the mouth of Tondano watershed, called Kuala Jengki, which is the largest river in Manado City. Thus the area lies between Tondano and coastal areas. In addition, this area is also located between densely populated settlements in Tuminting District with a central business district of Manado City in Wenang District. There are several important urban infrastructure namely Sukarno Bridge (icon of Manado City), Megawati Bridge and Boulevard II street (coastal areas). Sindulang Satu District has 5 Neighborhood with an area of 24.9 ha, the population of 8,306 people and a high population density of 334 people/hectare.

3.1. River and Coastal Border Condition

According to data from the Regional Disaster Management Agency (BPBD) of Manado City in 2017, Sindulang Satu District is one of flood-prone areas with a risk of flood height of 1-4 meters. Based on the analysis, this is cause by the topography of the sloping area (0-8% sloping), with elevation elevation <0,5-4 m asl. Measured from the height of the river that is about 15 cm-0.5 meters. This means that almost all settlements are at low levels of sea and river levels, especially in the Neighborhood II and Neighborhood IV (riverbank area) and Neighborhood I & Neighborhood III (coastal area / Boulevard II street). This is due to the last few years there is an increase in river and sea surface altitude consequently if the rain water intensity is high enough and overflow of the dike the floods directly occur in the area, especially because street in the coastal areas and river borders are built higher than settlements. The river has a width of about 40 meters and the depth of the river ranges from 1-2 meters. River condition is not very good because there has been silting by mud sediment and pile of garbage and constriction of river body. As for the coast is good enough because the street along the coast (Boulevard II street) has a width of 12 meters and has been built dikes with a height of 2 meters.

Most of the side of the river has been built dikes with a height of 1.7 meters, with rebound concrete material. But at some point the condition is damaged so it needs to be fixed. River border distance does not meet the standard / very minimal i.e. 0-2 meters and has been built inspection line with a width of 2
meters but almost along the river border and the line inspection has been placed boats, where raising livestock, porch, motorcycles, a place to store goods, dry clothes, place to sell and others. This led to the border area as a river basin and the protective settlement area almost ceased to exist. Whereas based on Spatial Planning Regulation of Manado City of 2014-2034, Kuala Jengki which is a Tondano watershed including large river with embankment in urban areas that must have at least 5 meters border in the right-left body of the river.

![Figure 3. The condition of river border area, damaged and misuse of embankment](image)

3.2. Land use
Based on the analysis of the existing condition, from the area of 24.9 hectares approximately 87.8% (21.86 hectares) has been utilized as an area built with occupancy and mix use (residential and business ie shop/stall, restaurant, shophouse, etc), about 10% is street designation and the rest about 2.2% (0.54 hectares) is the designation of public open space. This means the designation of open space is very small. Spatial Planning Regulation of Manado City of 2014-2034 requires green open space is 30% of the area, therefore it is necessary to reduce the density of buildings by 27.8% by way of relocation of buildings in high density areas and uninhabitable on the river banks (Neighborhood IV and part of Neighborhood II) and hilly areas with slope ≥ 25% (part of Neighborhood V).

From the survey results, 100% land ownership status is illegal (no land certificate) in both areas. Based on data from Head of Lurah and Head of Neighborhood II and IV, in 2016 there has been a housing relocation program in river border to Pandu District (10 houses in Neighborhood II and 40 houses in Neighborhood IV). From the interviews of 25 respondents in Neighborhood II and IV, all are willing to relocate. Likewise with respondents in Neighborhood V states ready to be relocated. Building density arrangement can be done with land sharing system and flat development to be available enough land for public open spaces (parks, children's playgrounds, sports fields, etc.).
Table 2. Land use of existing and planning

|                        | Existing (hectare) | Planning (hectare) |
|------------------------|-------------------|--------------------|
| Buildings              | 21.86             | 15.69              |
| Roads                  | 2.5               | 2.5                |
| Open Spaces:           |                   |                    |
| 1. Open space in Neighborhood II (behind Polairud office) | 0.33 | 0.33 |
| 2. Open space in Neighborhood V (hilly area/Sindulang Park) | 0.14 | 1.13 |
| 4. Sport field in Neighborhood IV | 0.07 | 0.07 |
| Percentage of open space | 2.2%             | 27%                |

Figure 4. Map of land use existing (left) and land use planning (right)

3.3. Buildings condition

- **Density and distance between buildings**
  Vulnerability to flood hazard is also influenced by the very high building density of 334 buildings/hectares with a distance between buildings about 0-1 meters. Building density causes loss of water catchment areas and green open spaces in the area and the absence of flood evacuation routes. In addition the position and orientation of the building is not clear because it develops sporadically. It is necessary to relocate for non-habitable buildings in the border area of the river in order to construct green open spaces and construct residential areas outside the river boundary with riverfront or waterfront settlement concept.

- **Structure and Construction**
  Overall, the structure and construction of buildings in Sindulang Satu District is in ratio of 20:80 (permanent: non permanent), where non-permanent buildings are mostly found in Neighborhood II and IV (riparian area) and Neighborhood V (hilly area). This leads to non/semi permanent buildings around the river border at high risk of being damaged or washed away by floods. In Neighborhood I and III (coastal area / Boulevard II street) the structure and construction of about 70% buildings is permanent.
3.4. Flood infrastructure system

- **The embankment**
  It has been built with concrete rebound material, with a height of about 1.7 meters along the river side. The condition of most of the embankment has been damaged, and the function is diverted so that the benefits of the embankment as a safety of the river border become less.

- **Drainage channels**
  At some point locations there are drainage channels with varying channel dimensions: 30-40 cm high, 20-30 cm wide, concrete material and partial condition not working because it is covered with soil sediment, grass, garbage or converted function into parking lot, terrace, and others.

- **Roads and circulation or evacuation system**
  The main (primary) street on study sites are 12 meters wide (Boulevard II street) and 5 meters (Hasanudin street). Secondary local street have widths varying between 3-5 while tertiary local streets are 0.5-2 meters so that they can only be accessed by motor on certain street segments. The circulation or access system is not clear because there are many forbidden street. This makes it difficult for residents to evacuate in the event of a flood. The material on primary and secondary local streets is asphalt, whereas tertiary streets are paving and some are still compacted soils.

- **Signage system**
  Signal systems or disaster mitigation signs are not located at the study site. In accordance with the standards for disaster-prone residential areas, signage system should be built for environmental orientation and disaster evacuation to minimize loss of life and material. Disaster mitigation signs include evacuation route information boards, hazard alerts, river level monitoring posts and others.

- **Open space**
  As described above, the existing open space is 2.2% (0.54 hectares) consisting of open space in the hilly area (Sindulang Park) and open space behind the Polairud office. This means that the availability of open space is very less, so it needs to add open spaces in residential areas, in the form:
  1. Green open space in the form of park or urban farming. Urban farming can be one source of economic improvement of citizens. The suitable location for the park or urban farming is in the open space behind Polairud's office (Neighborhood II) and on the hill of Sindulang Park (Neighborhood V).
  2. Water catchment area. It is necessary to build a water catchment pond and plant water conservation plants and soil conservation such as bamboo or banyan or pine or other types of tree stands as well as grasses such as grass roots that can absorb water. Both plants can also function as water retention and can neutralize river water from contamination / water pollution. Proposed location in an open space in a riparian area (behind Polairud's office).
  3. Green line along the border of streets and rivers.
  4. Sports field or children's playground. The proposed location for the sports field is on the existing sports field (Neighborhood IV) while the child's playground can be built on the hill of Sindulang Park (Neighborhood V) or behind Polairud's office.
Figure 6. Natural hill in centre of district can be used as a rescue hill

- Rescue/escape hill
  One of the required disaster mitigation infrastructure is escape or rescue hill, as a place for disaster evacuation. There is a natural hill (Sindulang Park) located in the center of district with a height of 10-30 meters and can be reached from many ways. This hill can be used as a rescue/escape hill.

- Electricity
  100% occupancy and streets using electricity source from State Electricity Company. However, to anticipate the electricity crisis when disaster occurs, it is necessary to build solar cell system in every neighborhood.

4. Recommendation
Based on the above analysis it is proposed the concept of slum upgrading to overcome or minimize the risk of flood in the study location, as follows:
- Setting the boundary area of the river by improving the embankment and normalizing the river.
- Restoration of land use by increasing the percentage of open space up to about 30% through controlling or restructuring of river boundary area and reduction of building density through relocation of houses in riparian areas and hills with slope ≥ 25%.
- Build flats for people who have not been included in the relocation program to Pandu District in 2016.
- Application of riverfront or waterfront settlement concept. This is so that the river can be kept clean. However, this should be monitored (the river border utilization control system must be assertive) so as not to occur over the river border function.
- Improving the quality of infrastructure systems including improving drainage channels, repairing damaged dikes, adding to the construction of tertiary local streets that can serve as evacuation routes, building environmental signage systems and evacuation signs, adding green and non-open spaces green, arranging hilly area in Sindulang Park as public open space or playground or escape hill and building solar cell system in each Neighborhood.
5. Conclusion
The results of the study in Sindulang Satu District are irregular settlement conditions with very high building density, non-durable houses, unclear circulation system, improper river bank embankment, inadequate drainage network and lack of green open space. Therefore, improvement efforts need to be taken to restructure the river border area, arrangement the overall settlement utilization, improvement the condition of the buildings and the quality of infrastructure based on flood mitigation system such as improvement of river embankment, drainage channel, construct evacuation path and green open spaces.
or rescue hill, etc. It is expected that the results of this study can be one of the solutions to realize the resilience of the region from various vulnerable physical pressures. Thus can realize the resilience of Manado City as a whole. This result needs to be followed up with studies on other aspects / areas, such as social, culture and economics studies. It aims to make slum upgrading efforts to be integrated and comprehensive.

References
[1] Bakornas PBP 2002 Direction of Urban Disaster Mitigation Policy in Indonesia
[2] Brown A and Junmookda K 2014 How Urban Resilience Can Make Cities and Nations Safer from Disasters The Rockefeller Foundation New York
[3] Directorate of River and Coastal Directorate General of Water Resources Ministry of Public Works in collaboration with JICA 2012 Action Guidance and Flash Flood Disaster Mitigation System Semarang
[4] Hakim, Rustam 2004 Landscape Architecture, Human, Nature and Environment. Jakarta: FALTL Trisakti University
[5] Mononimbar, W.J. 2014 Handling Flood-prone Settlements in River Border Area. Scientific Journal of Media Engineering Vol. 4 No.1, 26-31
[6] Regulation of the Minister of Public Works of The Indonesian Republic No. 63 / PRT / 1993 on River Border Lines, River Use Areas
[7] Government Regulation of the Republic of Indonesia No. 38 of 2011 on River
[8] Regional Regulation of Manado City No. 1 of 2014 on RTRW of Manado City 2014-2034
[9] The Cities Alliance 2016 About Slum Upgrading UNOPS Brussels, Belgium
[10] The Rockefeller Foundation 2014 100 Resilient Cities New York
[11] The Laws of The Republic of Indonesia Number 1 of 2011 on Housing and Settlement Areas