The Twins City of Wellington - Palu and Lessons Learned After the Six Years Sulawesi Earthquake for Build Back Better

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Abstract: Wellington And Palu Cities Are Passed By A Normal Type Fault, The Population Is Around 400 Thousand People, Including A Medium City And Water Front City Predicate On The Bay Area So It Is Vulnerable To Tsunami Disasters Due To Tectonic Earthquakes. Wellington Has Been Categorized As A Resilience City But Palu Has Not. Based On This, Palu Needs To Learn A Lot About Disaster Management From Wellington, Including Building Infrastructure That Is Resistant To Earthquake Disasters. This Article Compares The Geological Conditions, Disaster Risks Including Hazard, Vulnerable And Capacity Of The Two Cities. Observing The Many Similarities Between The Two Cities, There Are Certainly Many Lessons That Can Be Used In Managing Earthquake Disasters And Their Secondary Impacts So That Disaster Risk Reduction Efforts Can Be Achieved Optimally. The Condition Of The City Of Palu 6 Years After The Earthquake Disaster Of 28 September 2018, The Recovery Process Is Quite Significant. The Reconstruction Of Infrastructure Is Similarity To Conditions In Wellington After The 2011-2012 Sequel Christchurch Earthquakes. The Rehabilitation And Reconstruction Of Hospital Buildings, Schools, Bridges And Viaducts, Airports And Other Infrastructure Have Been Partially Completed. An Important Note That Is An Obstacle To The Recovery Process Is The Availability Of Fast And Accurate Data On Building Damage, Relocation Locations, Covid-19 And The Relatively Long Duration Reconstruction Progress.

Keywords-component; Palu earthquake, resilience infrastructure, disaster management, reconstruction

I. Introduction

The city of Palu in Central Sulawesi and Wellington in New Zealand have many similarities, especially their vulnerability to earthquake disasters. The geological and demography with round 400.000 people. Predicate as a water front city very vulnerable to tsunami disasters. Wellington is included in 100 resilience cities this needs to be an important lesson for the city of Palu and other cities in Indonesia with similar threats to earthquake disasters. Below are some comparisons of infrastructure conditions in Wellington and Palu, this is one of the causes of the large amount of damage that occurred. After the Sulawesi Earthquake on September 28 2018 and sequel 2011-2012 Christchurch Earthquakes caused massif structure and infrastructure damaged. Rehabilitation and recovery in New Zealand can be good practices for Palu City [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11].

Table 1. Differences in infrastructure in Wellington and Palu (before the 2018 Sulawesi Earthquake)

| Parameters	Wellington	Hammer
Building standards	Already	Already
Implementation of standards in buildings	Already	Not yet
Control against standards	Already	Not yet
Standard personal controller	Already	Not yet
Building construction mechanisms	Formal, industry driven	Informal, carried out by the owner
Construction personnel	Trained	Not yet trained
Preparedness	Already	Not yet
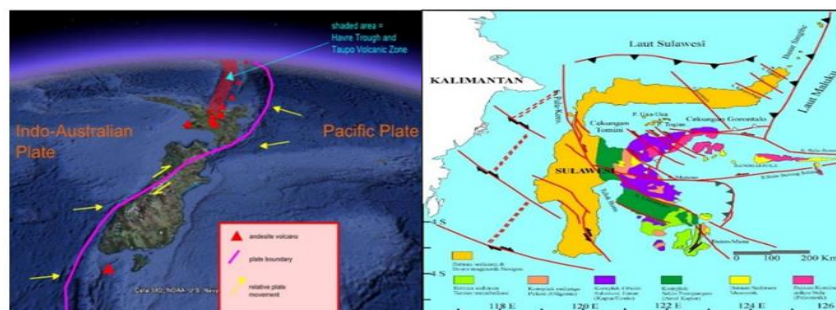
Fig. 1 Normal fault passed to Palu and Wellington[1]

Fig. 2 Resilient of 100 cities in the world [12]

II. Data And Methods

Before the Palu earthquake disaster occurred on 28 September 2018, the vulnerability to disasters in the city of Palu had been widely known and identified, and quite a lot of disaster mitigation efforts had been carried out. After the 24 January 2005 earthquake disaster in Palu, workshop activities, training and dissemination of research results increased significantly. These workshops and training activities received assistance and collaboration with the European Union, USAids, agencies and research institutions at central and inter-university levels. Some of the important things that have been carried out are: tsunami modeling and mapping of areas prone to liquefaction as well as seismicity mapping for the city of Palu [13], [14], [15], [16], [17], [18], [19], [20], [21], [22].

Fig. 3 Bird views of Palu and Wellington Cities[1]

Fig. 4 Palu and Wellington tsunami modeling[1]

Activities to identify and map vulnerability to earthquake risk were also carried out in 2018 ahead of the earthquake disaster in this region. However, the obstacles faced before the earthquake in the city of Palu are as described below:

1. Socialization and dissemination of disaster study results is still limited

2. Incomplete training for construction workers

3. Compliance with regional regulations, especially disaster mitigation, is low.

4. Awareness of not building in disaster-prone areas is still low

5. Funds for disaster mitigation programs are still small

6. Preparedness and contingency plans are still lacking

7. There are still not enough people who have a domain on disasters

8. The implementation of disaster-responsive infrastructure development planning is still lacking

9. Coastal safety structures against tsunamis are still limited

Fig. 5 Cyclic model and stretch-purse model disaster management[22]

The new paradigm for disaster management after the Aceh (2004) and Tohoku (2011) earthquakes changed from a post-disaster emphasis to the mitigation and preparedness stage, this is contained in the Hyogo (2005) and Sendai Framework (2015-2030). This change aims to ensure that resources do not run out for emergency processes but are weak in mitigation and preparedness processes. The 2015-2030 target for this paradigm shift is in line with realizing 100 resilient cities in the world which are triggered by the following 3 global trends:

1. Urbanization

2. Globalization

3. Climate change

It is estimated that the world population will be 9 billion in 2050 and 70% of them will live in urban areas. Globalization makes it easier to connect a city with other cities, so that events in one city will have a direct impact on other cities. Currently climate change can change political, social and fiscal conditions. The combination of the 3 parameters above will greatly influence the infrastructure conditions that you want to create in a city. The biggest challenge is to create infrastructure and other supporting facilities that are resilient, responsive and responsive to disaster events. Several areas of management that are directly related to disaster resilient cities are:

1. Continuous availability of clean water, shortages and excesses of water will cause problems. Hydrometeorological disasters will increase with climate change and sea level rise. This causes 40% of urban residents to live under stress.

2. With approximately 70% of urban infrastructure currently unbuilt, urban planners have an opportunity to incorporate resilience design into infrastructure projects.

3. Especially for existing buildings, it is still possible to retrofit and repair them so that when a disaster occurs, damage and loss and loss of life can be minimized.

4. Infrastructure in the fields of transportation, energy, telecommunications, education, health, commerce and other fields must also be strengthened so that more resilient cities can be realized.
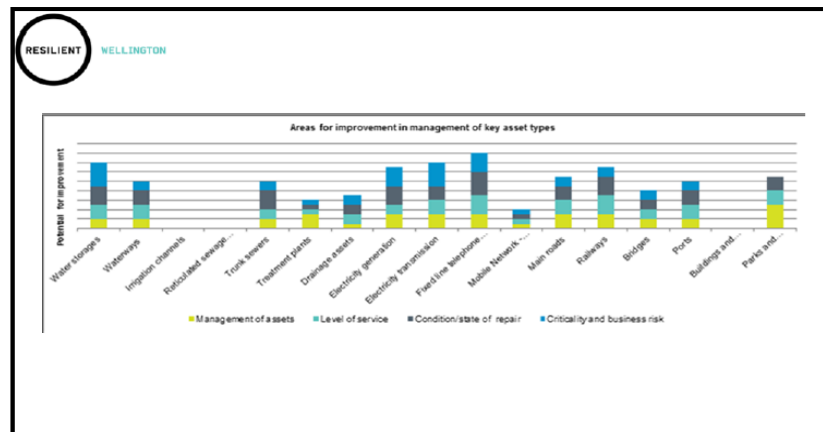

Fig. 6. Areas for improvement in management of key asset types in Wellington[5]

Several key asset management areas in Wellington that can be used as lessons to create a resilient city of Palu include:

1. Availability of clean water

2. Urban irrigation and drainage network systems

3. Waste disposal system

4. Generator and electrical transmission systems

5. Network of major roads and bridges

6. Telecommunication network

7. Airports and ports

8. Emergency building and parking system

Of course, the infrastructure management system in Wellington is different from the one in Palu, but its management has the same principles, namely that it can function well even in the event of a disaster. This can be achieved by good design, construction, supervision and utilization supported by maintenance and operation.

Some important lessons learned from Wellington's disaster preparedness are:

1. Disaster research data is complete, updated and easy to access

2. Comprehensive research is supported by adequate funding and equipment

3. Solid cooperation between government, researchers, private parties and disaster care groups

4. Having a good structural system for disaster management, including civil servants and volunteers involved in disaster management.

5. The field of disaster research is an important field and is supported by institutions that are experts in the field.

6. Insurance is part of the 4 pillars of disaster (Planning, engineering, disaster management, and insurance)

III. Results and Disscussion

After the earthquake of September 28 2018, after 6 years the city of Palu has improved quite well, although progress has been slow due to several inhibiting factors such as the availability of inaccurate data due to the tsunami and liquefaction so that files have disappeared. The availability of land for safe and legal relocation is also another inhibiting factor. The presence of Covid-19 is also another obstacle. Apart from that, some of the achievements that have been completed and are currently being worked on are:

1. Construction of shelters for survivors of tsunami and liquefaction disasters

2. Repair and construction of road and bridge networks including the Palu Inner Ring Road (PIRR)

3. Repair of the Gumbasa Irrigation Network

4. Reconstruction of Anutapura District Hospital

5. Reconstruction of schools and health centers

6. Reconstruction of the Tadulako University and UIN Datokarama campuses

Fig. 7 Gumbasa Irrigation, settlement relocation, main road and UIN Datokarama University[2]

Until now the rehabilitation and reconstruction process is still ongoing, it is targeted that in 2024 all these processes will be completed. The challenges that still exist to complete this work are relatively lighter than before. The availability of skilled workers, equipment and ready-to-use funds is still the main obstacle. Some of the work that has been completed includes the reconstruction of the Anutapura hospital, the construction of the UIN Datokarama campus and the construction of a 7.2 km long coastal embankment. Meanwhile, work that still has progress is the Gumbasa Irrigation network, building roads and bridges, building permanent housing for disaster survivors and building schools and health centers. It is hoped that by 2024 all this work will be completed. Based on the previous description, several things that are worthy of being used as discussion material include:

1 Research and technological innovation must be used as the basis for decision making in designing a city that is resilient to disasters.

2 Disaster prone maps on a more detailed scale such as micro zonation and research on the location of important infrastructure development must be a must.

3 Development restrictions on fault lines, areas prone to tsunamis and liquefaction in the city of Palu must have legal force so that all parties must comply with them.

4 The city of Palu, which is vulnerable to disasters, must be developed so that it is able to adapt to disasters, in this case the use of technology, development of research and innovation as well as compliance with regulations are the supporters.

5 Earthquake-resistant buildings that follow the latest standards must be an obligation for every building in the city of Palu, both simple buildings and multi-stories buildings.

Fig. 8 Anutapura Palu and Wellington Hospital with base isolation system[1]

Fig. 9 Break water on Wellington and Palu Coastal[1]

Fig. 10 Signs and markers for evacuation routes and the Palu-Koro fault route[1]

Some things that have not been implemented in Palu after the disaster are as follows:

1. Determining the width of the track on the fault line, it should be a minimum of 20 m free from permanent buildings.

2. Controlling coastal areas prone to tsunamis.

3. Strengthening public buildings that are still vulnerable to earthquakes.

4. Arrangement of clean water and urban drainage networks

Meanwhile, some things that have gone quite well are:

1. Controlling applications for Building Approval (PBG).

2. Arrangement of the outer ring road of Palu

3. Waste and household waste management

4. Supervision of building construction

5. Public building design that refers to the latest standards especially for public building, likely hospital, school, market.
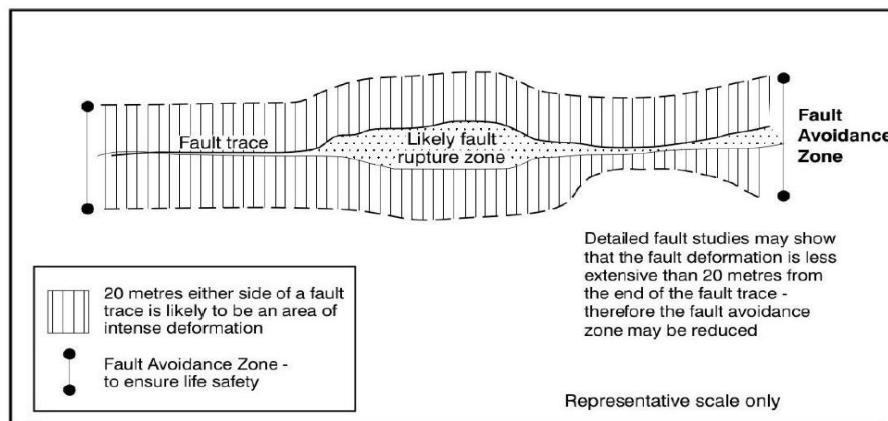

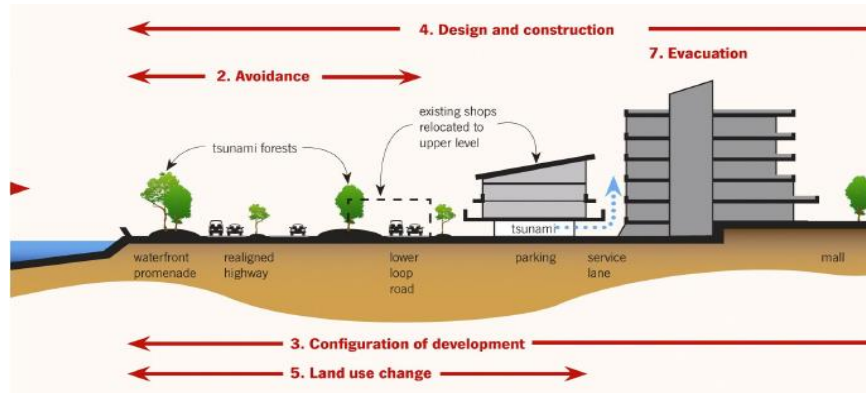Fig. 11 The width of the fault track that must be free from permanent structures[21]

Fig. 12 Based principles Land Use Planning for Vulnerable Tsunami Region[21]

Fig. 13 Permanent banner describe the fault of and tsunami evacuation route on Island Bay[3]

Some added values that can be taken as lessons from Wellington as a resilient city for the city of Palu:

1. City planning must be carried out in a comprehensive manner, including both objects, subjects and all stakeholders.

2. The role of all fields of science from geophysics, engineering, economics, social and politics will greatly determine the results of the design.

3. Disaster management must be carried out in stages for all stakeholders so that disaster risk reduction efforts can be achieved.

4. It is necessary to involve the world of insurance as one of the pillars in creating a society that is safe from disasters.

5. Involvement of local communities, especially those with local geniuses, needs to be re-introduced.

Interesting things that can be proposed as conclusions include:

1. The city of Palu, which is prone to disasters, still needs capacity building in its infrastructure to realize its hopes of becoming a city that is resilient to disasters.

2. Learning from Wellington as a resilient city to be applied in the city of Palu still requires adjustments due to different conditions both in terms of government capacity and the availability of funds and equipment for research.

3. Of the 4 main pillars in realizing public safety against disasters (planning, engineering, disaster management and insurance), these things still need to be strengthened for the conditions of Palu.

4. To create a resilient city requires consistency and hard work from all stakeholders and requires time and joint commitment.

5. The challenges of urbanization, globalization and climate change are closely related and are a big challenge to create infrastructure that is resilient to disasters.

IV. Conclusions

Based on the description and discussion above, several conclusions can be found, namely:

1 Post-disaster management in New Zealand can be used as good practice for the city of Palu and other regions in Indonesia.

2 There are 3 main things that will become topics for disaster management in the future, namely: early warning systems, increasing preparedness and involving researchers and practitioners in disaster mitigation.

3 Reducing vulnerability to disaster risk includes holistic issues from the fields of education, economics, politics, governance, involvement of the private sector and non-governmental organizations.

4 A Disaster Resilient City of Palu can be achieved by collaborating with all stakeholders in an integrative and sustainable manner.

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