EERI Reconnaissance Trip to Palu, Indonesia: Preliminary Observations and Findings

Robert Olshansky, Ghazala Naeem, Kanako Iuchi, Rahma Hanifa

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$M_w$ 7.5 Earthquake in Palu, Sulawesi, Indonesia

Source: EERI Preliminary Notes on Tsunami Information and Response, February 2019
Tsunami

- Occurred minutes after quake, so early warning did not work
- 9m max runup

Source: EERI Preliminary Notes on Tsunami Information and Response, February 2019
Coastal Slope Failures

Figure 4. Pre- and post-earthquake satellite imagery comparison showing slope failures along the coastline of western Palu Bay, west of the mouth of Palu River, Sulawesi, Indonesia (Planet Labs, 2017). We added notations for use in this report. Shoreline outlines are shown for comparison. The largest slope failures are shown with an orange overlay.

Source: EERI Preliminary Notes on Tsunami Information and Response, February 2019
Liquefaction & landslides (Nalodo)

Flowed as far as 6 km,
Affected > 2.5 sq km total:

- Petobo
  - several hundred houses damaged around
  - 800 m displacement
- Jono Oge
  - Flow slides extended 1.35 sq km
  - Damaged canal and water gate
  - Mud flow traveled 6 km from canal to the Palu River
- Lolu Village
  - Affected 0.22 sq km & stretched over 750 m
  - Relatively intact nature of ground movement aided spinning at the lower end
  - Sand boil reported at several locations
- Sibalaya
  - Affected 0.52 sq km area and extended 1.2 km from irrigation channel
- Balaroa
  - 0.4 sq km and extended around 1 km
  - damaged around 2900 houses

Source: GEER, 3 April 2019
4,845 Total Fatalities

- Earthquake
- Tsunami
- Liquefaction/landslide (*Nalodo*)
- Waterfront landslides
- Surface Fault rupture

<table>
<thead>
<tr>
<th>District/City</th>
<th>Died</th>
<th>Missing</th>
<th>Mass buried victims</th>
<th>Total fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palu</td>
<td>2,608</td>
<td>570</td>
<td>1,016</td>
<td>4,194</td>
</tr>
<tr>
<td>Sigi</td>
<td>289</td>
<td>116</td>
<td>0</td>
<td>405</td>
</tr>
<tr>
<td>Donggala</td>
<td>212</td>
<td>19</td>
<td>0</td>
<td>231</td>
</tr>
<tr>
<td>Parigi Moutong</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>3,124</td>
<td>705</td>
<td>1,016</td>
<td>4,845</td>
</tr>
</tbody>
</table>

Governor of Central Sulawesi, The Impact of the Natural Disaster, 05 May 2019
• Over 63,000 households were moderately or heavily damaged
• Approximately 200,000 people were physically displaced, or were too frightened to stay at home.

<table>
<thead>
<tr>
<th>Housing Damage</th>
<th>District/City</th>
<th>Light damaged</th>
<th>Moderate damaged</th>
<th>Heavy damaged</th>
<th>(lost or gone away)</th>
<th>Total per city or district</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palu</td>
<td>21,078</td>
<td>15,917</td>
<td>11,603</td>
<td>6,504</td>
<td>55,102</td>
<td></td>
</tr>
<tr>
<td>Sigi</td>
<td>13,850</td>
<td>5,960</td>
<td>8,342</td>
<td>0</td>
<td>28,152</td>
<td></td>
</tr>
<tr>
<td>Donggala</td>
<td>7,989</td>
<td>6,099</td>
<td>7,290</td>
<td>0</td>
<td>21,378</td>
<td></td>
</tr>
<tr>
<td>Parigi Moutong</td>
<td>4,191</td>
<td>826</td>
<td>533</td>
<td>0</td>
<td>5,550</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>47,108</strong></td>
<td><strong>28,802</strong></td>
<td><strong>27,768</strong></td>
<td><strong>6,504</strong></td>
<td><strong>110,182</strong></td>
<td></td>
</tr>
</tbody>
</table>

Self Evacuation from House

Formal / informal camps

Huntara (Temporary shelters)

Huntap (Permanent Relocation)
Research Goals of this Trip: Population Movements

• Focus on both short-term population displacement and plans for long-term population relocation following the disaster.
Our Palu Team

• **Robert Olshansky**, Professor Emeritus, Urban Planning, University of Illinois at Urbana-Champaign.
  • Has researched disaster recovery for over two decades, in many countries, and has been to Aceh, Yogyakarta, Merapi, and Padang in Indonesia.

• **Kanako Iuchi**, Associate Professor, Tohoku University, International Institute of Disaster Science.
  • She is an urban planner who researches community and housing relocation after disasters. She has worked as a planning consultant in Indonesia, involving disaster recovery and international development.

• **Ghazala Naeem**, Architect and disaster risk management consultant from Pakistan.
  • She has a specialty in tsunami warning and preparedness.

• **Rahma Hanifa**, Center for Earthquake Science and Technology, Research Center for Disaster Mitigation, ITB, our collaborator, host, and guide.
Our Palu Team: Local Partners

- **Andri Mardiah**, BAPPENAS
- **Muhammad Syathiri**, UNDP - BAPPENAS.
- **Rahma Hanifa**, CEST ITB / PuSGeN
- **Sukardan Tawil**, Nalodo Center, Universitas Tadulado
- **Hilman Arioaji**, U-Inspire
- **Ama**, Forum Sudut Pandang / U-Inspire
Temporary Relocation (Camps)
Official Estimate of 173,000 people

<table>
<thead>
<tr>
<th>District/City</th>
<th>Camps</th>
<th>Households (Family card)</th>
<th>Total Displaced Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palu</td>
<td>127</td>
<td>11,165</td>
<td>40,738</td>
</tr>
<tr>
<td>Sigi</td>
<td>160</td>
<td>29,867</td>
<td>93,187</td>
</tr>
<tr>
<td>Donggala</td>
<td>98</td>
<td>11,478</td>
<td>36,346</td>
</tr>
<tr>
<td>Parigi Moutong</td>
<td>15</td>
<td>662</td>
<td>2,728</td>
</tr>
<tr>
<td></td>
<td><strong>400</strong></td>
<td><strong>53,172</strong></td>
<td><strong>172,999</strong></td>
</tr>
</tbody>
</table>

These were generally self-organized, where people spontaneously gathered, fearful of additional tsunami waves, liquefaction, or shaking.

Source: Governor of Central Sulawesi, May 2019
Relocation (Temporary Shelter) Huntara

• 72 Huntara sites established by Government accommodating nearly 700 units (HH), as of May 2019

<table>
<thead>
<tr>
<th>District/City</th>
<th>Huntara</th>
<th>Unit (HH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palu</td>
<td>22</td>
<td>288</td>
</tr>
<tr>
<td>Sigi</td>
<td>29</td>
<td>221</td>
</tr>
<tr>
<td>Donggala</td>
<td>21</td>
<td>190</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>72</strong></td>
<td><strong>699</strong></td>
</tr>
</tbody>
</table>

• Around 30 NGOs established Huntaras by accommodating 8,425 units (HH)
  • Quality and design of shelters vary considerably

Source: Governor of Central Sulawesi, May 2019
With so much population displacement and economic disruption, all levels of government levels committed to quickly completing hazard assessment, planning, and reconstruction.

All new construction would be safer, and would involve relocation from tsunami and nalodo areas.
A systematic, deliberate process for
• assessing hazard,
• devising mitigation measures, and
• recommending land use and development regulations.
Master plan completed 31 December 2018

• Prepared by the National Development Planning agency, along with
  • Geophysical Agency,
  • Ministry of Energy and Mineral Resources,
  • Ministry of Spatial Planning and Agrarian Affairs,
• With technical assistance from JICA.
• Proposed policies accepted by Central Sulawesi Province.
Master Plan Proposed:

- Four permanent relocation areas (Huntap)
- Regional infrastructure plan, and
- New regulations for building construction in Central Sulawesi
• Hazard map wasn’t official until signed by
  • 6 ministries,
  • Provincial Governor and disaster agency,
  • 3 affected Districts.
• But implementation of policies has been difficult, because map has no green zones.
  • Where is it okay to build? And how?
  • They had recommended simplified criteria, but not yet accepted by Governor.
### Site Survey

#### HUNTARA
- Government: Huntara Gunung Balai & Petobo
- Community-Based: Huntara Pombewe
- NGO: Haluan

#### Tsunami Affected
- Desa Boya, Kec. Banawa, Kab. Donggala
- Kel. Lere, Talise, Palu City
- Desa Wani, Kab. Donggala

#### Liquefaction Affected
- Petobo
- Jono Oge
- Balaroa

#### Fault Rupture Affected
- Kel. Donggala Kodi, Jl. Cemara, Palu City

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[Map of affected areas]
## Stakeholders

### Government
- BAPPENAS (Director PTTB Dr. Velix and Dr. Suprayoga)
- Ministry of ATR
- Ministry of PUPR - PUSKIM
- Provincial ATR (Head)
- PUPR Task Force
- BAPPEDA Palu City (Head)
- BPBD Kab. Donggala (Head)
- BAPPEDA Donggala, Sigi, Parigi Moutong

### Academia
- Prof. Masyhur (PuSGeN)
- Prof. Widjojo (UI/HATTI)
- Dr. Dicky Pelupessy (UI)
- Dr. G. Ayu Ketut Surtiari (LIPI)
- UNTAD: Dean & Vice Fac. Engineering, Dr. Hendra, Dr. Rivai, Dr. Fuad, Dr. Abdullah

### UN, LSM, community, and others
- UNESCO
- Sekdes Lonca, Kulawi
- Forum Sudut Pandang, Sikola Pomore, Sikola Mombine, PARCIC, Nemu Buku
Context for ongoing decisions:

• Tsunami and *Nalodo* processes still not understood.
  • Two unusual phenomena killed, frightened, and displaced people, into camps and temporary huntara.
  • Lack of understanding of the phenomena creates uncertainty for all stakeholders.

• Still, government focused on providing safe housing quickly
  • Could quickly adapt existing housing programs for permanent reconstruction
  • Decided to build 3 huntaps right away, other housing later on:
    • Satellite huntaps in process.
    • *In situ* reconstruction in process.
5 Key Findings and Issues
1. Without understanding the causes of the tsunami and *nalodo*, it is difficult to decide on reconstruction policies.

- Was the tsunami caused by the fault in the bay, underwater landslides, or something else?
  - How often do such events occur?
  - How far inland is “safe”?

- To what extent is the liquefaction a natural phenomenon, and to what extent exacerbated by human causes?
  - How often can it occur?
  - What is the risk in adjacent areas not affected in 2018?

- Both of these are confounded by human activities:
e.g., Slide occurred on old filled land in Boya Village
Irrigation contributed to liquefaction, Jono Oge
Balaroa was built on an existing wetland area
2. Tsunami building restrictions create uncertainties for residents, and....
...uncertainty is affecting livelihoods of Fishermen
• Many fishermen would like to rebuild on the coast, but are not allowed. They must move to a huntap or satellite huntap.

• What uses should be allowed here?
  • The 100m and 200m zone distances are arbitrary, based on this one event. Don’t know cause, height, or frequency.
3. Liquefaction made huge areas unlivable...

Petobo Liquefaction Area
Leaving farmers without land, without water
• Lack of irrigation has stopped farming on intact lands near the liquefaction areas.

• Idle farmers for 14 months is a huge problem that needs to be addressed immediately in some way.

• Paradox: need water to farm, but high groundwater is a liquefaction hazard.
4. Huntaps are incomplete communities
• Huntaps are built on leftover lands.
  • Land was empty and available, because no one has wanted to build there to date.

• Need water.

• Need better access to services (more services, or public transportation)
5. Complexities of many other hazards! For example, can people rebuild next to the fault?
Summary

• Major effect of the disaster: thousands of displaced people.
• In a context of extreme uncertainty regarding future risks.
• These have required tradeoffs between solving the housing crisis and making quick risk decisions, using simple rules.
• This housing provision process has paid insufficient attention to livelihoods.
• In particular, farmers idled by the *nalodo* problem is a crisis situation for the region.
• This case has many unique challenges and issues that are unusual in the world of earthquake recovery.
Terimakasih - Thank You – Arigatou - Shukria