Governance strategies in Indonesia for addressing systemic risks: where do we stand and the future outlook
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Governance strategies in Indonesia for addressing systemic risks: where do we stand and the future outlook

Keywords: Systemic risk governance, multi-hazards, Palu, Indonesia
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Introduction

Economic and social science scholars have been long concerned with the risk of globalisation that has increasingly created the world as a ‘global village’. As the world system has been more connected and integrated through financial, banking, transportation and internet networks, contagious effects of a hazardous event such as an economic crisis and/or a pandemic can create a far-reaching unprecedented impact in different parts of the world. Therefore, it is no surprise that economic scholars have coined the term ‘systemic risk’ to suggest the need to understand some of the phenomena where an event can trigger cascading effects that led to widespread disruptions of services and trade and catastrophe. In the last two decades, some economists have defined ‘systemic risk’ as a framework to understand the agential power of a hazardous event that cascades and propagates through a set of interconnected systems (Rochet and Tirole 1996; De Brant and Hartmann, 2000).

Risk and disaster studies scholars have recently adopted such a framework as they see the merits of ‘systemic risk’ framework to both understand the reality of the empirical world and to structure disaster risk governance (e.g. Renn, 2016; Renn et al. 2019; Schweizer and Renn, 2019; Aven and Renn, 2020). Unlike the conventional risk governance framework, the systemic risk approach highlights the interconnected nature of risks, including their interconnected drivers, impacts and vulnerabilities. Moving beyond the multi-hazards concept, the systemic risk approach allows us to understand that the reality of disaster risk is multifaceted, interrelated, context-dependent and sometimes produced nonlinear effects (IRGC, 2017; 2018; UNDRR, 2019).

Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030 highlights the need for systematic interventions that drive disaster risk reduction (UNISDR, 2015 para. 15 and 36c). However, in the context of an increasingly vulnerable, uncertain, complex and ambiguous world, managing disasters and risk reduction to achieve the SFDRR target by 2030 will be tremendously difficult given their polycentric nature of authorities that structure their ways of governing (Lassa, 2011).

There is an increase in global awareness of systemic and cascading risks. Nevertheless, we identify gaps within the current disaster risk governance frameworks where efforts to govern disaster risk and build resilience through four priorities of SFDRR on the ground have been increasingly disconnected. Therefore, we predict that the existing model of disaster risk governance potentially will fail to achieve SFDRR targets by 2030.

We argue that there is a need to create new governing systems at the local level that allow actors and institutions to simultaneously manage the interplays of single and multi-hazards, multi-temporal, multiple dimensions of vulnerabilities, poverty reduction, unplanned urbanisation, environmental degradation and other residual risks. The unprecedented pandemic COVID-19 has revealed our inability to understand the root causes of risk, and thus it stressed the need to understand how to manage systemic risks at local levels.

Meanwhile, in practice, governments and communities are also not well aware of the importance and benefits of perceiving risk from the systemic approach and causes the issue of implementation (including processes and outcomes) on the ground. We identified several disabling factors hampering the governability of systemic risks that are mainly dealing with risk perception and communication, including the lack of systemic risk awareness, understanding of root causes of vulnerability (and risk), risk communication, coordination, mainstreaming in
policy and regulation, consideration of future uncertainties in planning, and resources (see Paton and Sagala, 2018; Djalante et al. 2017).

The rise of systemic disaster risk in the Indonesian context is observable. Unfortunately, the way institutions and organisations were designed, mandated and equipped to deal with such systemic risk are becoming more fragmented (Renn, 2020). Therefore, there is an increase in gaps between the nature of risk that become increasingly complex (Lucas et al. 2018) and the institutional frameworks devised to deal with those risks.

We use a case study from Palu multiple disasters in Central Sulawesi, Indonesia, to demonstrate how inland earthquakes in 2018 create cascading secondary hazards, namely tsunamis, liquefactions and landslides that caused unprecedented disasters. Those hazards interact with floods and residual risks such as conflict over natural resources, religious conflicts, gender-based violence, displacements and terrorism in the last 20 years. It is also well acknowledged that geologically, Palu is laying on the Palu-Koro fault, which should be free from human activities. Against these backgrounds, a more systemic approach to govern systemic risks is needed. We argue that there is a need to create institutional mechanisms that are adaptive and amendable to meet the targets of SFDRR and Sustainable Development Goals (SDGs) at local levels.

The paper hypothesises that conventional risk governance is unfit and needs to be (generated from the local context to represent socio-cultural characteristic/ place-based) to address more systemic disaster risks. A new framework of risk governance is needed. Informed and inspired by a growing literature on the topic of systemic risks in disaster studies and other fields, we will propose several important elements to produce a contextualised SRG framework for the case of Indonesia, to explore how systemic risks and their interaction with residual risks and other existing problems can be managed and how local institutional mechanisms can be tweaked to deal with the complexity of such a risk landscape.
Methods

To reach our objectives, we applied a ‘three-steps approach (see Figure 1 below):

Figure 1. Research design.

We first start with investigating the case of the Palu Multiple disasters in 2018 and analyse the three interconnected systems, including natural, socio-cultural and governance systems. Second, we conducted a systematic literature review using the Scopus database to take stock of various systemic risk governance frameworks and juxtapose the appropriateness to be applied to the case of Palu. We also investigate the feasibility to operationalise the existing frameworks in the current governance system in Palu and Indonesia in general. Third, based on the juxtaposition, we highlighted the way forward by presenting the lessons learned and points for attention to improve the development of the systemic risk governance approach in Palu and Indonesia.

We conducted a qualitative analysis based on the case of Palu multiple disasters in Central Sulawesi in 2018. We utilised the data (primary and secondary) obtained from the ongoing research conducted in Palu collected by authors through a long term observation between the period 2002 until 2020.

We have foreseen the limitation of the methodology, understanding that approaches towards systemic disaster risk governance are contemporary. However, the framework has long been applied and assessed in the financial sectors. Therefore, we have been challenged in identifying representable practices to benchmark. On the other hand, we found it useful to reflect on the reality through the case of Palu and observe to which extent a systemic approach to risk governance is realistic. The nature of this paper is mainly descriptive, which opens the possibility to highlight future research directions, including empirical contributions.
Disaster risk context in Central Sulawesi: the interconnectedness between natural, social, and governance system

The 2018 Palu disaster and its cascading impacts

Sulawesi is located in the Sunda block adjacent to three plates; the Australia plates, the Philippine Plate and the Pacific plate, known as the triple junction. This triple junction caused a complex tectonic in Sulawesi, accommodated by strike-slip faulting and thrust faulting. In 2017 PuSGeN considered 50 active faults segments in Sulawesi and the North Sulawesi Megathrust in the north of Sulawesi (Figure 2). The Central Sulawesi region is tectonically active. Historical destructive earthquakes along the Palu-Koro fault zone occurred in 1907, 1909, 1937 and 2012. Paleoseismology study has been conducted by Daryono (2016) and obtained that previous earthquakes occurred in 1909, 1468 and 1338. Abendanon (1917) concluded that the 1907 earthquake was followed by a more destructive earthquake two years later, in 1909. The 1909 earthquake mostly destroyed houses that survived during the 1907 earthquake. The damage runs along with Saluki up to the Donggala region. Abendanon reported a considerable cracking of 7 km with an uplift of 1.0 m. Trenching in Omu Village on Saluki segment shows evidence of sinistral slip of 1.5 m and vertical slip of 1.5 m. Daryono (2016) suggested a plausible recurrence interval of 130 years in Palu-Koro.

The 2018 Palu earthquake occurred on Friday afternoon, 28 September 2018, at 18:02:44 local time (Central Indonesia Time, WITA) with magnitude Mw 7.4, centered 26 km North of Donggala, Central Sulawesi (Figure 2). The earthquake has caused strong shaking, generates a tsunami that hit the city of Palu, in the Palu Bay, and massive liquefaction, especially in Petobo, Balaroa, and Jono Oge area in Palu city and in Sibalaya of Sigi Regency. BMKG automated modeling indicates intensity of VI-VIII in the City of Palu and Donggala Regency, Central Sulawesi. BMKG updated the shake map two days after correction based on modelling, data instrument and macroseismic survey of 30 September 2018, and release the intensity of IX-X in the City of Palu, meaning extensive damage in Palu City. The earthquake was caused by The Palu Koro fault zone, spanning from the northern part of eastern Donggala,
through the Palu Bay, passing Palu City to the south as far as 75 Km (PuSGeN, 2019, Gunawan et al., 2020, Natawidjaja et al., 2021).

The secondary hazards

A large surface deformation was observed by an in PuSGeN (2019) field survey, PuSGeN (2019) field survey conducted in early October 2018 and satellite imagery by USGS/NASA Landsat-8 JAXA. Horizontal offset was found as large as 4-6 meters and vertically offset up to 30-50 cm running passing through the City of Palu from South to North. Ground shaking was observed. The significant rupture and ground are shaking cascade into secondary hazard of landslide and submarine landslide, rapid tsunami, and massive liquefaction (PuSGeN, 2019a, Gunawan et al., 2020, Natawidjaja et al., 2021).

Tsunami was perimarily triggered by submarine landslide induced by the fault rupture in the sea floor of the Palu Bay. This event has proven a new scientific evidence that strike-slip fault can generate large tsunami, in contrary to previous understanding that presume strike-slip faulting, is insufficient for triggering large tsunamis. Socquet et al. (2019) and Bao et al. (2019) has argue that supershear characteristic of this long rupture has cause the seafloor displacement that generate tsunami (Elbanna et al., 2021) that build up a computational framework whose result showed that supershear ruptures propagating along strike-slip faults, traversing a narrow and shallow bays, are prime candidates for tsunami generation, regardless of the submarine landslide. The event had triggered a tsunami warning, but unfortunately did not reached the communities in time. The extremely short lead time, the foreshock occurred few hours before that created false sense of security, and collateral damages including electricity shut down, also affected the failure of the tsunami warning to save lives (UNDRR-UNESCO IOC, 2019). This findings has called a global reevaluation of tsunami risk from strike-slip faulting in bay or offshore, and how it affected the effectiveness of risk reduction measures including warning systems.

The geotechnical impact of this event includes ground cracking along the road near the coastline and mountainous area after the earthquake, including in the airport runway. The two significantly interesting phenomena are liquefaction induced ground failure in Balaraoa, massive lateral spreading in Petobo villages, and Jono Oge Village and Sibalaya village (Gallant et al., 2020, Mason et al., 2020) (See also Figure 3). These hazards buried those four villages. Based on the Center for Groundwater Resources and Environmental Geology research, most of the Palu area has a very high potential for liquefaction with a liquefaction potential index (LPI) of> 15 with a shallow ground water level of around <12m. However, no previous document nor the Risk Assessment document of Palu City mentioned massive liquefaction could occur. However, the locals named it “Nalodo”, meaning “the land that turns into mud and slide”.

Figure 3. Liquefaction induced lateral spreading at Petobo village (Digital Globe)
The 2018 tsunami in Palu has caused cascading effects on the economic, ecological, and social systems. More than 4,100 people lost their lives. Based on an assessment of the National Agency for Disaster Management (BNPB), United Nations Development Program (UNDP), and Local Agency for Disaster Management (BPBD) on 26 October 2018, the significant economic losses and damage were approximately identified around IDR18.48 Trillion or about USD 1.3 Million in four regions of affected places those are Palu, Donggala, Sigi, and Parigi Moutong (Bappenas, 2018). It is noted as the second devastating tsunami after the 2004 tsunami in Aceh (Athukorala and Resosudarmo, 2005).

Extensive agricultural infrastructure, including the primary irrigation system, namely Gumbasa, has been collapsed, leading to severe loss and damage in the agricultural system. It has disrupted the farming activities of 7,356 hectares of areas located in Sigi, Palu, and Donggala. There are about 7,000 farmers directly affected, and the farmers are losing their livelihood and have less alternative to generate income. The irrigation system was built in the colonialism era in 1931 and rebuilt in 1976 by the Indonesian Government through the Ministry of Public Works.

A study by Watkinson and Hall (2019) also mentioned that the density of irrigation infrastructure itself is built in the seismically active location in Palu. This infrastructure may be a proxy for shallow water infiltration, undermining very gentle slopes, thus enhancing liquefaction and landslides’ susceptibility. The Gumbasa Irrigation system covers fivesub-districts located in Sigi District and Palu City to support the 8.180.65 hectares of farmland upgraded in 2016 from 4,731 hectares (Puslitbang KemenPUPR, 2019). The disaster caused severe damage along with the water system from upstream to downstream so that the water supply for agriculture sectors have stopped after the disaster. The recovery of the agriculture system needs more innovation in terms of the solution of the water management system and agriculture variety to cope with a scarcity of water.

The tertiary hazards

The earthquakes compromised the slope stability around Sigi Regency. Following the earthquakes, heavy rainfall occurred in the upstream Bangga River, triggering a high magnitude of flash flood in several areas in the Sigi Regency (Tunas et al., 2020) (see Figure...
Flash floods had impacted agricultural and plantation sectors as well as fatalities at the local level. A recent study reveals that the long duration of 8 hours of heavy rainfall is the main factor that triggered the landslides upstream of the watershed initially triggered by the earthquake (Tunas et al., 2020).

Figure 4. Impact of Flashflood in Bangga River (property right of Tunas et al., 2020). Source: Tunas et al., 2020.

Residual risks from past disasters and conflict

If there is one exceptional place to name, so intricate and at the same time profoundly embedded in a long history of disasters, it would be Palu City, Central Sulawesi province in Indonesia. Palu today is a vibrant multicultural urban city. However, the town was also repeatedly shaped by massive earthquakes, devastating tsunamis, fatal volcanic eruptions, and prolonged social conflicts.

Figure 5. Palu earthquake location in 2018.
Palu has a diverse socio-economic and cultural background since it is growing as one of the most developed cities in Central Sulawesi. Palu inhabited by the local ethnic population, namely Kaili (21.60%) as the majority followed by other local ethnicities (40.6%) and currently has mixed with other ethnic groups from other islands of Indonesia (37.80%). The intense development in Palu has attracted numbers of migrants living in the city following the history of the transmigration program (population redistribution across the country) since the 1970s in Central Sulawesi as part.

Empirical documentation of historical disasters can be traced back to Dutch colonialism and missionary interventions at the end of the 19th century and in the beginning of the 20th century. During the time, Palu and Sigi and Parigi Moutong were merely a tiny part (onder afdeling or sub-district) of the two great lands (afdeling or district); Poso and Donggala. Several West European scientists observed the areas’ natural and geological phenomena and ethnological observations, documented by Wichmann, Abendanon, AC Kruyt, Nicholaus Adriaani, and Waltern Kaudern. Abendanon, for example, noted earthquake events in 1907 and 1909 during his expedition. Most of these events were published in national newspapers in the Netherlands. For the less literate local communities, the earthquakes, tsunamis, and liquefaction events were documented through oral stories, and practices kept alive and circulated in Palu, Sigi, Donggala, and Parigi districts.

The events were also captured in the toponymy of the places affected, suggesting extreme events that were significant enough to rename and memorise places. Few examples are the name of district Kaombona (the collapsed land) in Palu, the district Duyu (landslide), Tagari Lonjo (the liquefied soil), Beka village (wretched/ruptured), and Rogo village (damaged or devastated). The local communities constructed these past knowledge into indigenous terminologies of the phenomena; Lingu in Kaili language for earthquakes, Bombatalu or Lembotalu (which literally means the three big waves) for tsunamis, and Nalodo for liquefactions. The Kaili communities, the largest ethnic group in Palu, shaped their imagined

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1 The local ethic group of Kaili have their own Kayori oral story of the dreadful past, of which the following is one of the example in the following lullaby:
future risks by establishing a safe area named Kinta, which is believed to be safe from liquefaction phenomena in Petobo Palu City. It was later proven that the Kinta are within the Petobo sub-district survived in the 2018 giant liquefaction, and of which houses in Kinta proximity was only mildly affected and was not exposed by significant damages and losses.

At the local community, the risk is perceived differently based on their geographical living areas, demographic characteristics, disaster experiences, and knowledge of earthquakes and tsunamis, including the flow of information. In general, there are two different perceptions of tsunamis. Most of the urban communities in Palu who are migrants, particularly along the Palu Bay, are less aware of the risk of the tsunami, but they recognise that Palu is prone to earthquakes (LIPI, 2019). The domination of migrants in Palu is related to the function of Palu as one of the transmigration programs where thousands of families from Java and Bali as the most populated islands move and live permanently in Central Sulawesi (as well as some other provinces across Indonesia). People have information about the latest tsunami in Aceh. Unfortunately, they perceived that Palu Bay was safe from tsunami because it is away from the ocean.

Meanwhile, elderly of local people who had the information as well as experienced the devastating earthquake in the past perceive that similar events only occur recurrently after a couple of decades; thus, there is no continuous information of the younger generation. Moreover, the younger generation in the city has limited information on historical tsunami events. Still, it is only aware that the city is located along the Palu-Koro faults along the city, and there is no perception of risk to tsunamis in Palu Bay. So, a tsunami is not on their perception as a risk even though the city and its surrounding have two significant tsunamis in this century.

In contrast, in the Labean Village community, Donggala District preserved local knowledge of disaster preparedness, which successfully avoided them from catastrophe in 2018 tsunamis. The awareness is raised based on the tsunami in 1938 and 1968, called a story of three waves or in the local language is bombatalu or lembotatu and constructed by the native tribe of Kaili.

____________________

*Goya-goya gantiro
To kabonga Lolio
Palu Tondo Mamboro
Motayomo
Kayumalue melantomo

Earthquakes in Ganti (part of the Banawa area in Donggala region)
The Kabonga Loli people
Palu, Tondo and Mamboro
Drowned
Kayumalue
Drowned
in Palu (Reksa, 2021). The message of the story is about the 15 meters of waves that cause catastrophe in the villages. The local community is automatically aware that after the earthquake, it will be followed by three high waves so that the people have to go to the highest place.

Moreover, the name of Palu itself has a meaning of lifted soil which is strongly related to the historical account of large-scale hazard events. However, that information is well acknowledged only by historians and yet commonly could shape the risk perception of the local people. The naming of natural hazards can still be found in the communities’ daily conversation. Those naming is rooted in local languages. For example, naledo means buried under mud, soil liquefaction; While lingu means earthquake (or similar to the Javanese, lindu).

One of the significant earthquakes triggering tsunamis occurred on 1 December 1927 in Palu Bay. The event later followed by the 20 May 1938 massive earthquakes and tsunamis, which occurred in two different coastal plains; from the Makassar Strait in the west part of Palu and Donggala and in the Tomini bay the north of Parigi and Poso. In July 1983, the Colo volcanic eruption in Una-Una island, approximately 180 km from Palu, yet strong enough to devastate the great land, and impacts stretched to the south Sulawesi island. There were at least 7,000 displaced people due to the eruption, with poor quality of barracks and permanent housings, and failures in response governance in general, leaving lingering mocks of the narrated PUMA among themselves, abbreviated from ‘Pengungsi Una-Una Masuk Ampana’ (the Una-Una survivors are entering Ampana district). Many chose to return to their old settlements.

Historically, Central Sulawesi also has had a traumatic communal conflict, particularly in Poso, a neighbouring city of Palu. Just after the reformation in 1998, for almost three years, the conflict has caused nearly a hundred thousand people to become refugees in the surrounding areas and remain a depth of traumatic experiences among the people. The inequality and power relation are considered as the underlying factors of the racial conflict. At the end of 2001, the Peace Agreement, namely the Malino Agreement, was signed to build reconciliation between the groups, but the violence persisted. The immense challenges to extinguish the embedded social problem were worsened by corruption practices, terrorism, and criminal acts, forcing the establishments of the Presidential Instructions No. 34/2005 on the Comprehensive Management of Poso Conflict. The local government had faced the most extended period of management of displaced people they have ever experienced.

Two years after the ignited conflict, another earthquake occurred on 4 May 2000, bringing 3 meters tsunami devastated neighbouring communities in Banggai islands, resulting in 26,682 people were recorded as Internally Displaced People (IDPs) scattered in different places, inhabiting informal settlements. There were intentions to preserve the memory of the tsunami event in Totikum sub-district, Banggai Islands, which is the village's name by ‘Kampung Tsunami’ or tsunami village. But similarly, in the case of Una-Una communities, the local communities in Banggai resettled their devastated land again (Muhammad et al., 2020).

One would assume that the following 2005 earthquake that devastated Palu could have been a wake-up call on risk governance inspired by the 2004 Indian Ocean tsunami. The earthquake occurred on 24 January 2005, shortly after the mega-tsunami event. Narratives of the Aceh-Nias catastrophe through the media shaped dreadful imaginations and raised anxieties that tsunami will also attack Palu bay. The massive public evacuation occurred with no plans on where to go and for how long. Some abandoned their houses and ran against the coastline,
to the hills, or even approaching the earthquake's epicentre in Bora, within Donggala district. At least there were three casualties and several infrastructure collapses and failures.

In 2012, another destructive earthquake occurred with the epicentre proximate to the Lindu lake in Sigi district. The tremors were felt in Palu, afternoon time, during the last day of Ramadhan fasting month. The earthquake was significant enough to cut the main and only road network that links Palu with the other four neighbouring districts: Lindu, Kulawi, South Kulawi, and Pipikoro. Limited logistics were dropped by helicopters. At least six fatalities reported from this event lead local communities to recall the tragic 2005 earthquake event. The three latest earthquake events in 1996, 2005, and 2012 were tied by one active fault: Palu Koro. Even until the latter, there were no local disaster management agencies in place. Table 1 and Figure 6 present the summary of historical events related to social changes in Palu.
<table>
<thead>
<tr>
<th>Year</th>
<th>Event(s)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1927</td>
<td>Earthquake</td>
<td>Tsunami waves reached 15 meters, 15 died, 50 injured.</td>
</tr>
<tr>
<td>1 December</td>
<td>Tsunami</td>
<td></td>
</tr>
<tr>
<td>1938</td>
<td>Earthquake Mag 7.6</td>
<td>Houses and coconut trees along Mamboro in Donggala washed away by 2-3 meters of tsunami waves. 18 died, 942 houses destructed.</td>
</tr>
<tr>
<td>19 May</td>
<td>Tsunami</td>
<td></td>
</tr>
<tr>
<td>1968</td>
<td>Earthquake Mag 7.8</td>
<td>200 villagers on the Tambu coasts were washed away and devastated. 800 houses devastated. Inundations in Tuguan island 300 meters inland, with 8-10m runups.</td>
</tr>
<tr>
<td>10 August</td>
<td>Tsunami</td>
<td></td>
</tr>
<tr>
<td>14 August</td>
<td>Earthquake Mag. 7.4</td>
<td>Tuguan island and its population vanished entirely.</td>
</tr>
<tr>
<td>1978 - 1994</td>
<td>Growing urbanised Palu</td>
<td>From very few housings built by the Palu river in the 1900s to 1952, approximately 40-50% growth of housings in 1973-1978, and 60-70% in 1978 to 1994. Increase in migrants residing in (90% coming from South Sulawesi, some occupied illegal urban lands and working in informal sectors), along with the development of infrastructures and trade areas around and near the river.</td>
</tr>
<tr>
<td>1930s – 2016, or still occurring</td>
<td>Long history (3 generations) of communal conflict between Nunu and Tavanjuka clan/village</td>
<td>Both are from the same ethnicity (Kaili), and the same religion (Moslem) includes the same religious affiliation. Identities are relatively homogeneous. Reasons for conflict are varied, shaping cultures of violence.</td>
</tr>
<tr>
<td>Year</td>
<td>Event</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1996</td>
<td>Earthquake</td>
<td>10 fatalities, over 60 injuries, and local buildings damage.</td>
</tr>
<tr>
<td>1998</td>
<td>Inter-religion, communal violence and ethnic conflicts</td>
<td>Internally displaced people due to conflict: 93,254 people, death 1,129, destroyed houses 1,754.</td>
</tr>
<tr>
<td>2018</td>
<td>Earthquake Mag. 7.4 Liquefactions Tsunami</td>
<td>4,100 loss of lives, 1,016 was unidentified. 110,000 houses destroyed. Internally displaced people: 63,359</td>
</tr>
</tbody>
</table>


UNDRR-UNESCO IOC, 2019
Figure 6. Historical events related to social dynamics in Palu, Central Sulawesi, drafted by authors from various sources.
Governance system and relevance of systemic risk governance as a diagnostic tool

Governance reflects the steering action to reduce disaster risk (Lassa, 2013), avoid new risks (UNDRR, 2017), and find opportunities to deal with future disasters. However, the effectiveness of governing efforts to reduce risk relies on ‘the goodness of fit’ of governance structure (actors and institutions), policy instruments (financial, infrastructure, legal, communication), synergies between the structure and instruments in responding to certain disaster risks.

Indonesia has adopted decentralised governance mechanisms to allow the central government to distribute some authorities, responsibilities and resources to the sub-national levels. In practice, decentralisation remains challenging due to a lack of capacity/resource at the local level and lack of coordination. On top of that, some argue that it is simply difficult to brush off the ‘centralisation’ culture with the domination of national authorities that have been long embedded in Indonesia (see also Trias et al. 2019; Putra and Matsuyuki, 2019). While decentralisation has, to some extent, allowed diversification of actors and introductions of new actors in decision-making processes, in practice, it has yet to fully enable participation, especially local participation (Sofyan et al. 2020). These problems are also applied to disaster governance in Indonesia. Disaster management in Indonesia was only institutionalised in 2008 when the National Disaster Management Agency established as mandated by Law 24/2007 on Disaster Management.

We will briefly discuss the disaster risk governance challenges and opportunities during pre-disaster, emergency response, and post-disaster stages.

Pre-disaster

Pre-disaster phase is a very crucial phase in disaster management. This is the phase where the capacity for preparedness is cumulated. It includes the cumulation of knowledge (e.g. risk assessment, scenario and forecast model) and the responding policies to prepare for future disasters. In this phase, it is crucial to enhance the detailing of scientific uptake for evidence-based policymaking.

for Central Sulawesi districts is available before the 2018 earthquake followed by tsunami and liquefaction. The Disaster Risk Assessment (DRA) documents are available for Central Sulawesi, Palu City and Donggala District for 2016-2020, followed by Sigi District for 2017-2020. Those three areas in Central Sulawesi were affected the most during the tsunami 2018. The risk index composed of hazards, vulnerability and capacity at the district level with the unit of analysis at sub-district levels. From 1910 to 2015, at least 10 types of disasters, namely floods, extreme wave-abrasion, epidemic and pandemic, technology failure, drought, eruption, extreme weather, landslides, and flash flood have happened in Central Sulawesi. The 2015 DRA uses historical disaster data as a baseline and added tsunami and forest fire as a potential disaster, but liquefaction was not mentioned in the document. Instead of assessing multi-hazards, the DRA is a single hazard-based assessment. Reflecting from Palu earthquake case, several gaps we found includes: limitation in understanding tsunami hazard, failure to incorporate flow-liquefaction potential, limitation in understanding the size of earthquake rupture and precise location, failure to predict it’s cascading and compound risk, and limitation in incorporating the detail build environment to the risk assessment, including the existence of irrigation channel. The DRA of Palu City has mentioned the high level of
earthquake and tsunami hazard, high level of vulnerability, low level of capacity, without mentioning any further detail of the earthquake and tsunami source, characteristic, the lead time people have, and no mention that the Palukoro fault is actually crossing the City. PuSGeN (2017) has released a national earthquake and hazard map of Indonesia, showing the Palukoro fault crossing the city. Field investigation has revealed the Palukoro fault location is passing exactly in the same location as the trenching investigation prior to the 2018 earthquake located in the southern part of Palu City (Natawidjaja, 2020). Yet in Palu City, the surface rupture is found 1 kilometer to the west of the mapped fault (PuSGeN, 2019a, 2019b). The corridor along surface rupture of 10 meters is now categorized as a red zone, in which no buildings are allowed, as well as tsunami impacted are and flow-liquefaction areas.

The complexity as a nature of risk is still unable to be integrated in the assessment and the knowledge inputs are still incomplete and dominated by natural science. For example, vulnerability assessment limited on the measured indicators that directly related with the population namely demographic characteristic (population density and vulnerable group), productive land and GDP per sector, health and critical facilities, and environment aspect (forest, mangrove). Although it represents socio-culture, economic, physical, and environmental aspects, it is unable to capture the comprehensive socio cognitive and culture perspective and the decision making process among the actors. The precise exposure of build environment is not well assessed in DRA. For example, 1,299 schools damaged by the earthquake in Central Sulawesi (Hanifa et al., 2019) was not anticipated in prior, also the case for hospitals and most of other infrastructures. Institutional aspect also is not considered in the vulnerability assessment and social conflict issues that have been identified as potential disasters. These issues have contributed to the lack of awareness of the community of the tragedy that they might face in the future (see Sofyan et al. 2020).

In addition, there is a low priority and lack of capacity of the government to manage the disaster. The city has enacted the contingency plan to respond to the tsunami, but it is not on the priority in the development program. The authority argues that the limited local budget is insufficient to implement the contingency plan. The dissemination of the preparedness through evacuation drill has conducted however without real simulation but rather as formalisation of the activities. Almost all policy makers have no information and understanding on the respective documents therefore there is no appropriate implementation as well as disaster preparedness.

However, it is important to mention that the training for the community conducted by the Local Agency for Disaster Management in 2017 in Palu had sporadically engaged local and religious leaders. People involved in the activities are aware but have no clear and precise information about the evacuation route. The fatalistic evacuation behaviour during the 2018 tsunami shows less preparation of the authority to inform the local community about the evacuation route and effective response during a disaster. This was also added by the failure of the tsunami warning system in reaching out to communities within minutes due to the nature of the atypical underwater landslide tsunami. Local knowledge from past experiences existed mostly in sub urban areas, while in the urban Palu, most communities were caught by surprise (UNDRR-UNESCO IOC, 2019).

The neglect of risk can be seen from the development of the Waterfront City project in Palu and the promotion of Palu Bay as the centre of tourism destination, which led to massive development along the coast without significant proper evacuation information. The modern city concept has neglected the local knowledge on the risk of a tsunami even though some
studies have informed the risk of geology hazards on the Palu Koro Fault. At the same time as the 2018 tsunami in Palu, a scholar from a local university has published a book on the Palu Koro fault movement, which explicitly describes the high risk of Palu to tsunami triggered by the fault’s activity. Scholars and practitioners on disaster have informed respective risk to the local authority. Still, there is no follow-up to reduce risk but rather focus on the city’s attraction as a tourism destination.

Emergency-response phase

The shelter provision faces several concerns in terms of timeline, process, quality and maintenance. Social inequality has raised regarding the absence of standardisation of shelters. There is many support from non-government organisations, civil society and private sectors to provide shelters with the minimum standards from the government, but in the implementation stage, it is difficult to control as lack of coordination is another issue. Yet, several social concerns such as security issues, sexual abuses, and unsafe environment for children.

It is also reported that there was no leadership shown by the local governmental authorities right after the disaster strikes Palu in 2018. Some argued that this happens due to the lack of ownership by the local government to handle a disaster of this large scale. The 2018 tsunami in Palu case causes cascading risk to the communities. It has left a story of chaos in the first three days of the disaster including the massive looting in many places. Not only in the places of basic needs supply but also despoilment of many assets across the city in many areas (LIPI, 2019).

This, again, touched upon the decentralisation issues, manifested in the dependency to national government and limited capacity of the local governments (see also Paton and Sagala, 2018) to deal with multi-disasters in their administrative jurisdictions (Putra and Matsuyuki, 2019).

Post-disaster

Post disaster can be observed from the rehabilitation and reconstruction stages which consists of infrastructure, social, economic and cultural aspects. Based on the timeline provided by Bappenas, the socio-economic recovery was started after disaster response about three months after the extreme events. Unfortunately, the affected communities have limited alternatives to recover after disaster. After the tsunami destroys all sources of their livelihood, farmers, fishermen, and employees with short term contracts, informal workers are the most severe groups in terms of economic impact. There is no sufficient social protection that could provide better recovery except appropriate external support (LIPI, 2019).

In terms of rehabilitation, the priority is still on the infrastructure rehabilitation. There is also social assistance programme (i.e. in a form of cash assistance) provided by the government and relief organisations. The cash assistance program is useful for the people who have lost their livelihood and economic assets, however, yet to reach out to all affected communities. More programme can involve more participation of affected communities, including shelter and public facilities constructions. It is important to consider the integration of infrastructure and socio-economic rehabilitation to support the transition build back better (LIPI, 2009).

Based on study conducted by LIPI (LIPI, 2019) it is found that fishing communities along the coast were also affected severely by the disaster and lost almost all their livelihood assets. Only after the government provides incentives for boats, they can start to go fishing. In
addition, the informal workers along the coast are also losing their livelihood without any social protection and have less exit strategy. The slow recovery process of the economy has forced many survivors to return to the coastal areas which are prohibited for human activities and places for living, just to be able to start economic activities. This strategy is bringing them back to a new risk condition.

In terms of risk perception of tsunami risk in Palu, it is mainly related to the misperception of the risk, leading to the mismanagement of disaster preparedness until post-disaster. In addition, the recovery stage also faces a challenge to consider the chance to rebuild the areas. The risk mapping raises its controversy as many local communities have returned to their original place as livelihood is one of the most reasons to neglect the relocation away from the coast. The location of relocation areas is also located in hazard-prone areas and this issue is still under debate among policymakers, scholars, and disaster risk practitioners.

Two years after the catastrophe, the shelter issues remain a big challenge. Limited basic facilities in shelters is one example of problems in the transition of rehabilitation stages and the challenge of shelter provision. The delay to provide shelter has started after the emergency response period where the survivors have to stay in tents as temporary shelter for more than 3 months. Moreover, the quality of shelter varies depending on the organisations including the lack of minimum standard of sanitation and access to health and education facilities (LIPI, 2019). There is a standardisation from the national government but in fact, it is less likely to be fulfilled without integrated coordination and clear regulation. The problems during the post disaster stage have been creating a new risk on top of the pandemic to the people that are already at risk of disasters.

Another concern on recovery related to livelihood is the irrigation system that was significantly damaged during the earthquake and tsunami 2018. The delay of the rehabilitation of the irrigation system is to assess avoidance of future risk. It is recognised that the failure of infrastructure during tsunami triggered by the water saturated in the surrounding areas as a result of continuous water infiltration from the water canal. Therefore, building back the infrastructure should be better compared with the previous construction considering sustainability of the social and environmental systems.

Disaster risk reduction strategies to build back safer

We have explained disaster risk governance based on the three phases of conventional disaster risk management stages in the previous sections. However, we noticed that to understand disaster risk governance from a systemic risk perspective, one should incorporate an integrated understanding of the interconnectedness of the three phases. Disaster risk reduction concepts particularly address this siloed thinking by aiming to prevent new and reducing existing disaster risk and manage residual risk, all of which contribute to strengthening resilience and, therefore, achieving sustainable development (UNDRR, 2019). DRR strategies are focusing on policy objectives with concrete timeline and procedures by reducing risk and at the same time aiming at strengthening economic, social, health and environmental resilience.

One of the strategies considered to reduce disaster risk and increase socio-ecological resilience in Palu is by using ecosystem approaches. In terms of the coastal ecosystem, Central Sulawesi is covered by 40,083 hectares of mangrove forest and the 608 coastal villages (BPS, 2019). Mangrove forest has continuously decreased as the city urbanised fast. It is noted that in 2010 about 50 % of it was seriously damaged (e.g. 5,652 hectares out of
7,387 hectares and 605 hectares out of 762 hectares in Pagiman). Based on the KITLV’s documentation, the picture of Palu city shows a mangrove forest from Kale (Layana) until Mamboro sub-districts that currently has been utilised as residential areas particularly\(^2\). The local community mentions that the land use change has occurred massively in the 1980s, and in the 1990s, Palu Bay has been developed as one of the tourist destinations, including reclamation projects.

The rehabilitation of mangrove forest in Palu coastal area was first started in 2015 (BPS, 2019). The role of mangrove as a strategy to mitigate the city and its surrounding from disasters is revealed in the UNDRR resilience scorecards assessment conducted in December 2020 (interview, 2021). The evaluation however, has also revealed that the monitoring of such a strategy is still lacking a structured plan, and there is no action to control the environmental quality regularly. Moreover, there is only limited identification and recording of ecosystem assets which causes a challenge to be considered in the spatial plan.

Mangrove ecosystems along the coast are natural protectors against coastal disasters (Triyanti et al. 2017), including tsunami waves (Ismail, Wahab, and Alias, 2012). One of the areas along the Palu Bay, namely Kabonga District, has been saved by the mangrove forest (See also Goda et al. 2019). The village only experienced 10 damaged houses and one death of people. The important role of mangrove in Palu Bay has been modelled based on tsunami inundation modelling reveals that the addition of 0.072 ha of mangrove forest could reduce 2858.8658 ha of inundation along with the East Palu (Novitarima and Saputri, 2019). The local knowledge allowed wisdom in preserving mangrove beds and its ecosystem for decades, particularly in Donggala district.

Sendai Framework for DRR addresses build back better as one of priorities to reduce risk of disaster. The transition from emergency response to recovery and reconstruction plays a significant role to support the success to take opportunity to reduce underlying and driver risk. Nevertheless, the concept of transition as a process is still lacking to be considered.

The master plan of rehabilitation and reconstruction after the disaster of Central Sulawesi addresses the importance of the mangrove forest, urban forest, and greenbelts as natural protectors to tsunamis. The master plan provides land utilisation direction along the coast and the city to prioritise ecosystem-based solutions as one of mitigation strategies to disaster (Kementerian PPN/BAPPENAS and Pemerintah Provinsi Sulawesi Tengah, 2018). However, the sea dyke construction as a solution to protect risk areas from tsunamis has raised pros and cons among scientists and practitioners as it tends to constraint the plan to implement ecosystem as the priority in development planning. Moreover, from the local people’s side, the sea dyke has raised a new challenge for them to observe the change around the sea to indicate the upcoming disaster.

Perhaps the most challenging, underlying problems in disaster risk governance in Indonesia is related to the asymmetric power relations. After all, the governance process in disaster risk reduction is expected to facilitate different actors and institutions, but at the same time also dealing with managing vested interest. For example, in the case of the growing role of international donors in emergency response and recovery in Indonesia. Presidential regulation (Perpres) number 22/2008 has provided a basis to regulate disaster management budget (national and local) which consists stages of pre- disaster, emergency and post-disaster.

\(^2\) https://lokadata.id/artikel/mangrove-yang-meredam-tsunami-di-donggala
Social assistance resources is available from national loan. Regarding case of Palu, the contingency plan budget is limited and it became a challenge, especially to implement the contingency plan (LIPI, 2019). In addition to the Perpres, Head of disaster management agency (Perka BNPB) Number 22/2010 regulates the contribution of International donor during emergency response. There are some prerequisite needed especially to ensure sovereignty, respects, and trusts. In the case of Palu, Indonesia has tightened the role compared with the case of Aceh. The International donors are unable to independently entered the areas without local assistance and should avoid to visit with the attendance of their national’s army. This case in itself needs further exploration, for example, to what extent the governmental authorities could play a coordinating role in managing the donors and international support in the emergency and recovery process? What would be the most effective control mechanism?

In addition, disaster risk governance in Indonesia is not yet programmatic, since it is still focusing on short-term political goals in one political cycle. For example, in Indonesia, there are some cases where local governmental leaders are only focusing on their political period and not prioritising the continuity and sustainability of disaster management policies (LIPI, 2019).

Despite the dominance or preference for more centralised modes of governance, several practices of self-governance have been reported at the local level. For example, through social movements, by initiating petitions to challenge certain disaster related policy in responding to the Palu 2018 disaster. This type of practice should be seen as an opportunity for incremental transformation.

Systemic risk governance framework as therapeutic tools

After identifying the systems in Palu, we reflect on several existing concepts yielded from our literature review on systemic risk governance and its assessment frameworks. The result of our preliminary literature review shows that there is still a dearth of study on systemic risk and subsequently on potential strategies to govern such risk within the disaster risk reduction body of literature. We found several concepts that are useful to increase our understanding of systemic risk governance and its components. First is the notion of systemic risk. The definition of systemic risk has been first coined through the economic system perspective. It is defined as “the risk that an economic shock triggers, through panic or otherwise, either the failure of a chain of markets or institutions or a chain of significant losses to financial institutions, resulting in increases in the cost of capital or decreases in its availability and
substantial financial-market volatility” (Schwarcz, 2008). When expanded to more comprehensive systems beyond the economy, systemic risks have been studied through different lenses. OECD published a report in 2003 mentioning five types of emerging interrelated risks in the 21st century, including disasters, industrial accidents, infectious diseases, terrorism, and food safety (OECD, 2003). These are risks produced by the global changes, including increasing population, global environmental change (i.e. climate change), technological development, and competitions (OECD, 2003; pp 30-31).

The Global Assessment Report produced by UNDRR in 2019 (UNDRR, 2019) has provided new insights on understanding a systemic risk in disaster risk reduction contexts. It further describes the topology of risk by understanding and realising the multiple and interconnected root causes, context, and drivers of risk. These perspectives widen our understanding of systemic risk beyond the economic and financial systems and considers socio-ecological systems, including environmental degradations and causal relations with poverty and poor governance.

Second, is the concept of Systemic Risk Governance. Understanding the systemic nature of risk is only a first step. Next, it is crucial also to know how to deal with this type of risk. The governance concept is essential here as it reflects the way we steer our actions. Governance can be defined as a process of more or less institutionalised interaction between public and/or private entities, ultimately achieving collective goals (Lange et al. 2013). The systemic risk governance concept further contextualised the specific governance feature, including actors, institutions, mechanisms needed to deal with and manage systemic risks (IRGC, 2005; 2018).

Several characteristics laid the normative considerations to govern systemic risk. It includes uncertainty, complexity, and ambiguity (van Asselt and Renn, 2011). These are additional characteristics to the dynamics, diversity, and scales commonly used in socio-ecological system studies (see, for example, Chuenpagdee and Jentoft, 2013). In addition, systemic risk governance studies have also incorporated the inclusive governance approaches, focusing on the involvement and participation of wide-range actors beyond government, including non-governmental organisations, civil society, and private sectors (see, for example, Schweizer and Renn, 2019).

Several studies have also suggested a framework to assess such a systemic risk governance system in terms of operationalisation and assessment. The IRGC Guidelines for the government of systemic risks 2018 (IRGC, 2018) are one of the commonly known frameworks, especially in disaster risk reduction (see also GAR, 2019). It listed seven steps of guidance including 1) Explore the system; 2) Develop the scenario; 3) Determine goals and level of tolerability for risk and uncertainty; 4) Co-develop management strategies; 5) Address unanticipated barriers and sudden critical shift; 6) Decide, test, and implement strategies, and 7) Monitor, learn from strategies implementation, review and adapt. The framework has attempted to clearly define specific actions required, expected outcomes and success factors to follow each step.

We observed six elements that are important to be emphasised in several steps of the SRG framework for the case of Palu. First, to explore the system and obtain a systemic understanding, more attention should be given to conducting a social scanning to get a complete overview of the local context, including local culture and social capital, which will affect the sustainability of risk reduction efforts. It is also essential to highlight the complexity that drives the inability for a system (social and natural) to synergistically function. In addition,
it is extremely important to have a clear understanding of different typology of risk, including multi-, compound, cascading, and residual risk. These are concepts that are interchangeably used and difficult to be defined. Second, the development of scenarios should incorporate multiple time horizons. Longer time horizons would enable the effect of the reflectiveness and learning process over time. Third, to determine goals and level of risk tolerability, expert judgement can be a valuable means. Diversification of expertise is also important, especially to ensure meaningful participation of diverse science and policy actors. Fourth, when deciding, testing, and implementing strategies, the local context should be considered. For example, during the recovery process, one should think about ensuring the sustainability of local livelihood and shelter quality. Fifth, in terms of monitoring, learning, review and adaptation, cognitive aspects should be taken as parameters to measure success. This includes the aspect of risk perception, self-efficacy and self-evaluation. Finally, it is important to set the normatives as a ‘yardstick’ to guide the implementation of a systemic risk governance approach. It includes norms of social justice, transparency, accountability, and appropriateness.

**Limitation and opportunities for systemic risk governance: broader reflections**

While the SRG framework has been helpful to diagnose the empirical phenomenon in Palu, we believe that it is still very difficult to be operationalised and used by the disaster managers and stakeholder on the ground. Based on our analysis, we argue that disaster risk governance in Palu — especially reflecting on the multiple disaster events of tsunami and liquefaction in 2018 — is still using a conventional approach. The governance system in Palu could not move towards a probability risk approach, let alone a systemic approach. Several limitations are hampering the efforts to incorporate a systemic approach:

1) The highly dynamic and complex social and ecological systems. This is manifested in the typology of risks and disasters becoming more complex, compounded, unlinear, systemic, and unpredictable.

2) The limitation in the current risk assessment. There is a strong need for improvement in risk assessment process and models anticipating a more dynamic and complex
socio-ecological systems and risk. This will also require a comprehensive and regular risk assessment update and incorporation of local and indigenous knowledge.

3) Unmatched political and planning process. The systemic disaster risk governance approach's efforts and continuity depend largely on the current political and planning cycle (5-year plan). In addition, there are asymmetric power relations due to vested interests (see section 2.3.4), which lead to a lack of meaningful and coordinated participation of non-state actors in disaster risk reduction efforts.

4) Inappropriate governance systems. To ensure a systemic and coherent approach, there is a need for more inter-agency coordination. For the case of Palu and Indonesia, governance systems should be transformed.

5) The contingency plan foresaw the tsunami close to reality in 2018. It provides the scenario of a 7.4 earthquake magnitude followed by a tsunami along Palu Bay. However, there are lacking priorities to follow up the contingency plan. It is found that there is no follow up by distributing action plans to related local agencies across the city government.

6) Limited protection/disaster reduction strategy options, including degradation of coastal ecosystems, leads to reduced capacity of coastal ecosystems to provide services for climate regulation and protection (e.g. degradation of mangrove, reducing its services as a barrier to reduce the impact of tsunami).

7) Post-disaster to focus on building back better by considering shelter as a process rather than physical infrastructure per se.

Despite the limitations, there are several opportunities that can bring Palu a step forward to a more systemic risk governance approach.

1) Indonesia has already long experiences of disasters and has shifted its disaster management paradigm. The current law number 24/2007 on disaster management has provided mandates to govern disaster in Indonesia, including the establishment of Regional Disaster Management Agency (BPBD), budget allocation, and support from international donors. There is a window of opportunity for taking the first step to adopt a more systemic risk governance approach by emphasising and enhancing collaboration among related stakeholders to address the high complexity and uncertainty of future disaster risk.

2) Lessons from Central Sulawesi in 2018 suggests the need to consider disaster risk from the perspective of systemic risk framework.

3) Ecosystem service-based solutions have been mentioned in the master plan for rehabilitation and reconstruction, but it needs to be fit with the spatial program and risk-based development pathway.

4) Local knowledge identification. Palu has various local knowledge dictionaries to recognise disaster risk. More ambitious documentation and sharing of local knowledge are needed.
Conclusion and recommendations

This study has attempted to investigate the systemic characteristics of disaster in Central Sulawesi multiple disasters in 2018. We explained the different systems in play, including the natural (hazard), socio-cultural (vulnerability), and governance systems (vulnerability and capacity).

We concluded that Indonesia has yet to incorporate a systemic risk governance approach through the case of Palu. Political will is required for Indonesia to adopt more appropriate risk governance modes that promote the systemic risk paradigm (see Djalante et al. 2017). A fit for purpose SRG framework contextualised and adjusted to country conditions is needed for further exploration and operationalisation in the policy domain. However, such SRG framework needs to be informed by further research, investigation, reflective-action, and creative approach to co-design, co-develop, and co-produce a policy a relevant and contextualised SRG framework with governmental authorities and societal stakeholders.

Finally, we argue that the focus of systemic risk governance should be directed towards productive transition and local transformation. However, for Indonesia, incremental change through hybrid governance arrangement, balancing informal and formal; self- and horizontal and vertical modes of governance (see for example Lassa, 2019) is deemed more realistic and feasible.
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