Inter-organizational network in Indonesia during disasters: Examples and research agenda on disaster management

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Abstract. Indonesia is facing various type of disaster risks, each with its own nature (sudden or slow onset, purely natural or man-made) and coverage of affected areas. Whereas science, technology and engineering intervention requires different modalities for each hazard, little has been known on whether the institutional setup and organizations involvement requires a different or similar types of intervention. Under a decentralized disaster management system, potential involvement of international organizations in response and growing diversified organizations involved in responding to disaster, it is important to understand the nature of inter-organizational network during various type of disasters in Indonesia. This paper is mixture of in-depth literature review and multiple case studies on utilization of social network analysis (SNA) in modelling inter-organizational network during various disasters in Indonesia.

1. Introduction

Indonesia is facing various type of disaster risks, each with its own nature (sudden or slow onset) and coverage of affected areas, and it is under an increasing trend under the influence of climate change. Record from 1900 until 2016 shows that there are 429 occurrences of disasters in Indonesia, resulted in total affected people of 29,011,349 and economic losses in 44,360,308 USD [1]. For Indonesia, geophysical disaster occurrences are less compare to hydro-meteorological disaster (40% against 60%), however geophysical disasters are more deadly although in terms of total affected people and total damage hydro-meteorological disaster is more dangerous [2]. Towards the future, from 496 cities/regencies, which being assessed on their disaster risks against nine type of hazards, 322 have been classified of having high risk and 174 have moderate risk to disasters [3]. Accordingly, Indonesian society requires advancement in disaster management to mitigate and lessen the risk, as well as to better responding in emergency situation induced by disaster.

 Whereas the engineering mitigation approach requires different modalities for each hazard, little has been known on whether the institutional setup and organizations involvement requires different or similar types of intervention. Under a decentralized disaster management system, potential involvement of international response and growing diversified organizations involved in responding to disaster, it is important to understand the nature of inter-organizational network during various types of disaster in Indonesia. Djalante [2] has explored the trends of research on natural hazards, disaster risk reduction (DRR) and climate change adaptation (CCA) in Indonesia, by looking at 744 publications in the period of 1978 until 2015. It was found out that major research stream is on hazards, risks and disaster assessment, in comparison to DRR and CCA, with the most-frequent studied hazards are volcanic eruption, tsunami and earthquake [2]. Most of the research are also published in geography, earth sciences or inter-disciplinary journals on disaster, and less on social science, public administration, emergency management, and political science journals. Clearly, there is
a need to investigate more on research of Indonesian disasters from the perspective of social sciences. Thus, Author would like to further promote the need to intensify socio-political research and analysis on disaster management in Indonesia.

Similar situation was observed in the United States over three decades ago. However, started from 1984 situation has change whereas through a joint effort between the Federal Emergency Management Agency (FEMA) and Network of Schools of Public Policy, Affairs and Administration (NASPAA), research in the field of disaster and emergency management become one of the mainstream in public administration, and at the same time there is growth in social science research in disaster studies [3]. There are five issues in disaster management which requires contribution from public administration field; i.e. inter-organizational coordination and collaboration, interoperability in communications, integrated approach, response and recovery, and recognition of the continuing vulnerability. It is in those five issues the scholars in public administration in the US mainly published their scholarly works. Thus, in the period from 1985 to 2009, the general categories of their publications fall into the following: flood hazard, hurricane, and earthquake mitigation; disaster management information technology; policy, communication, coordination, organizational learning; decision making under uncertainty, collaborative leadership, and presidential disaster declarations; intergovernmental relations; and national policy directions. Interesting for us in the developing countries to look at their future research agenda for public administration in relation to disaster studies. In addition to the aforementioned five research issues, future research agenda in the US includes the following: integration of geographic information system (GIS) with public administration architecture for disaster response and recovery; legal and organizational analysis for comprehensive disaster management; network analysis to detect functional and dysfunctional links in inter-organizational response and recovery systems following disaster; intensification of comparative case studies for understanding recurring hazards and reducing risk; sociotechnical systems and decision support which also include the area of incorporating social networking platforms; and complex adaptive systems [4].

2. Objective
The purpose of this paper is to assess whether or not type of hazard that trigger disasters has influence to the structure and characteristics of inter-organizational network pertaining to the disaster management. Alternatively, it intends to showcase that availability of policy and response framework, capacity of local government to respond specific disaster, status of disaster declaration that affect the presence of national government, and involvement of response from international organizations are more detrimental to the inter-organizational network during disaster. Pragmatically, this paper also would like to provide example of social network analysis (SNA) application in several disasters in Indonesia.

3. Inter-organizational network analysis on disaster situations using SNA
In nature, the paper is using a multiple case studies approach, although without an objective to directly compare one case to another. The selected cases are representing various disaster cases triggered by multiple hazards (earthquake, tsunami, flood, and volcanic eruption) and nature of its suddenness, i.e. sudden onset or slow onset. Another criterion on the selection of a case is on the availability of comparable inter-organizational network model from past research, since it is outside of the scope of this paper to generate new model. From the criteria, the following cases are assessed: the 2004 Aceh / Indian Ocean Tsunami, the 2009 West Java Earthquake, the 2009 West Sumatra Earthquake, the 2010 Mount Merapi Eruption and the 2014 Jakarta Flood.

This paper is limited on inter-organizational network modelling that employ social network analysis (SNA) as the main research tool. The SNA has the ability to represent the structure of relations between actors and to analyse a large number of relations within a network [5], which one of the fundamental properties is the ability to determine, through mathematical algorithms, whether network members are connected one to another, and to what degree, in various relationships [6].
This approach has been known for its versatility to answer many research queries in political and public administration aspects of disaster management; e.g., on the 2005 Hurricane Katrina [7], the 2010 Haiti Earthquake [8], the 2011 Great East Japan Earthquake and Tsunami [9] and the 2016 Nepal earthquake [10]. Table 1 exhibit the landscape of inter-organizational network analysis using SNA on disasters in Indonesia.

| Disaster case (Phase) | Key research question/objective                                                                 | SNA measurements and software used                                                                 |
|-----------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| West Java Earthquake 2009 (Emergency response) [11] | In what ways, inter-organization cooperation creates network? How was the character of the network? To what extent the network can improve institutional arrangement of disaster management? | Degree centrality, betweenness centrality, closeness, density and cliques' identification SNA Software: Ucinet & Netdraw |
| Mount Merapi Eruption 2010 (Emergency response) [12] | How is the coordination structure between organizations during the emergency response of the 2010 Mount Merapi Eruption? Is there any organizational grouping during the emergency response and how was the relationship between organizations? Which are the key organizations during the emergency response period? | Average degree, network diameter, density, average path-length, network modularity, degree centrality and betweenness centrality SNA Software: Gephi |
| West Java Earthquake 2009, focus on housing reconstruction (Recovery) [13] | To understand the stakeholder’s interaction process in housing reconstruction in Pangalengan district | Degree centrality, betweenness centrality, closeness centrality SNA Software: Ucinet & Netdraw |
| Great Jakarta Flood 2014 (Emergency response) [14] | To map groups and actors of government agencies during emergency response and grasp the coordination processes. | Average degree, network diameter, density, average path length, degree centrality, betweenness and modularity SNA Software: GEPHI |
| Aceh Tsunami 2004 (Recovery) [15] | What does the complexity landscape for a typical network of humanitarian aid for large-scale disasters look like? What does it mean for managing complexity in post-disaster governance? | Degree centrality, Betweenness centrality, k-core, diameter, average path length SNA Software: Pajek |
| Comparison between West Java & West Sumatra earthquakes 2009 (Emergency response) [16] | In what ways, did inter-organizational cooperation function and create networks during the emergency response of both earthquakes? What were the characteristics of cooperation in humanitarian operations? Which type of network performed better in the emergency response of both earthquakes? | Degree centrality and betweenness centrality, which weighted and modelled based on Principal-component, density and cliques’ identification SNA Software: Ucinet & Netdraw |
| Event                  | Description                                                                 | Measurement                                                                                   | Software               |
|-----------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------|
| Aceh Tsunami 2004     | To identify who populates the community networks and how they might be      | Betweeness centrality (focus: current flow) and Conductance / Modularity; as proxy to        | Visone                 |
| (Recovery) [17]       | integrated with the formal, government networks responsible for a region’s  | measure social capital in community                                                            |                       |
|                       | disaster management                                                        |                                                                                               |                       |
| West Sumatra Earthquake 2009 | What is the role of transitivity, homophily and brokerage on interorganizational network formation during crises and how does a country’s disaster management capacity influence the patterns of response network formation? | Transitivity, homophily and brokerage, with utilization of quadratic assignment procedure (QAP) in its network regression model and the use of conditional uniform graph (CUG) | Statnet                |

From the table, it can be seen that there are some inter-organizational network models that available for all five of the disaster cases. However, some of the models were done for community level and only focus one sub-sector, instead of organizational level. Accordingly, the inter-organizational network models analysed in this paper are the 2004 Indian Ocean Tsunami [15], the 2009 West Java Earthquake and the 2009 West Sumatra Earthquake, which the Author has conducted own network modelling [11] [16], the 2010 Mount Merapi Eruption [12] and the 2014 Great Jakarta Flood [14].

As such, for each case study, Author is observing comparable SNA measurements that produced by the original research: degree centrality, betweenness centrality, closeness centrality, and density. In simple term, centrality analysis refers to positions of a node (in the context of this paper an organization) within a network whereas the usual measurements are degree centrality and betweeness centrality. Degree centrality is calculated by counting the number of ties (or links) connected to a given node [5]. On the other hand, the betweenness centrality is calculated by counting the number times where a particular node locates in between another two nodes, which this indicate the tendency of functionality as coordinator or leader in a network [5]. For both measurements, the value may fall between 0 and 1, which the greater the value means higher centrality. On the visualization of the inter-organizational model of each case, author is using the original network for soft-comparison purpose. In addition, relevant SNA measurements such as density, average-path-degree and network diameter from the original research are also being mentioned for the interest of the readers.

4. Inter-organizational networks from selected disasters in Indonesia

4.1. Inter-organizational network on the 2004 Aceh Tsunami

The 2004 Indian Ocean Tsunami was one of the deadliest mega-disaster in modern history, which resulted in death of 250,000 people in Indonesia alone, mostly in coastal cities in Aceh and North Sumatra Province. For Indonesia, and Aceh province in particular, the tsunami stricken in the area where domestic conflict took place between the Free Aceh Liberation Movement (GAM) against the Indonesian Government. Accordingly, at the time of the tsunami there was minimal governmental apparatus operated in normalcy, in particular there was no disaster management agencies at local government levels nor (local) disaster response framework put in place at that time. In simple term, at that time the challenge was the absence of authority after such a large-scale disaster [15].

On this, the 2004 Indian Ocean Tsunami was also becoming one of the oldest disasters in Indonesia ever assessed [15] [17]. Jonathan Lassa’s work [15] focus to understand the complexity through the use of network theory on post-disaster reconstruction at the organizational level, while Guarnacci [17] rather focuses at network at community level. Thus, this paper will mostly refer to the former one.
Lassa (2015) visualized the networks of organizations involved in the post-disaster recovery stage from 2005 to 2007. Lassa (2015) used Gephi and Pajek’s network analysis in modelling the network following the 2004 Aceh Tsunami. The network comprises of 797 nodes (organizations), 977 ties (links), which was derived from the database of Aceh-Nias Rehabilitation and Reconstruction Agency and particularly Lassa was analyzing the relationship between donor-partner data. As recorded, there were 472 international NGOs, 147 local NGOs, 25 multilateral organizations and 36 bilateral organizations involved in post-disaster reconstruction of Aceh between 2005-2007.

The inter-organizational network model for the 2004 Indian Ocean Tsunami was carried out using Pajek in mode 1 and treated as a directed network. It was found out the following network characteristics: average path length of 1.715, network diameter of 5, 28 number of loops. According to the analysis United Nations Development Program (UNDP) has the highest degree centrality and betweeness centrality, mainly due to their intermediary roles between donors, governments and civil society. Lassa also provided the sums of degree, outdegree and indegree centrality whereas the value of degree is significantly high for international NGOs (0.695), local/national NGOs (0.180) and multilateral organizations (0.133) in comparison to that of local governments (0.024) and national government organizations (0.012).

4.2. Inter-organizational network on the 2009 West Java Earthquake

The 2009 West Java Earthquake occurred on 2 September 2009 at 14:55 local time with magnitude 7.3 on the Richter scale. It affected 15 municipalities in West Java Province and resulted in death of 81 people, serious injuries to 1,287 people and displacement of 194,805 people. Moreover, according to post-disaster assessment, the the damage and loss was estimated of 7,905 billion IDR, with 89.79% being non-government assets and 10.21% being government assets [18].

On the 2009 West Java Earthquake, the author conducted an inter-organizational network modelling based on 343 emergency response activities that took place during the first-month after the earthquake, which compiled from situation reports published by National Disaster Management Agency (BNPB), United Nations Office for Coordinating Humanitarian Affairs (UNOCHA) and Indonesian Ministry of Health. It should be noted that officially the Governor of West Java, and supported by BNPB, set a two-weeks period of emergency response, and yet it was extended for another two weeks given the poor performance of the initial response, which also include acceptance of international aid and UN-lead activation of humanitarian clusters. In the end, there were 192 organizations involved in the emergency response, comprises of 50 local/national NGOs, 45 local government agencies, 22 international NGOs, 21 universities, 18 provincial government agencies, 10 central government agencies and 16 private companies.

Based on the data, the Author generated inter-organizational network model using UCINET version 6.4 that comprises of 192 nodes and 729 ties [16]. On the network, degree centrality and betweenness centrality measurements were performed to analyze the characteristic of actors within the network. In addition, SNA also calculated the network density, i.e. 5.005, and identified 37 inter-organizational cliques in the emergency response of the West Java Earthquake 2009.

On both degree centrality and betweenness centrality, the Satkorlak West Java ranked the highest (normalized degree centrality of 6.702 and normalized betweenness of 69.793). From central government side, the BNPB ranked second on degree centrality and fourth on betweenness centrality, which indicates that it has relatively high cooperation and yet lower level of coordination function, and Ministry of Health was ranked fifth on degree centrality and thirteenth on betweenness. Health Agency of West Java, on the other hand, ranked third from both degree centrality and betweenness centrality values. From the UN agencies side, UNOCHA was ranked fourth on degree centrality and eleventh on
betweeness centrality while UNICEF was ranked eight on both measurements. Furthermore, in the
remaining ranks of the top-fifteen organization with high value of degree centrality and betweeness
centrality, it has more less representatives from international and national NGOs, local government
agencies and military. Based on principal-component analysis, it was clear that the inter-organizational
network in West Java was a lead-agency type of response [16].

4.3. Inter-organizational network on the 2009 West Sumatra Earthquake

The 2009 West Sumatra Earthquake occurred 30 September 2009 and measured on 7.6 Richter scale,
it was followed with two major aftershocks and a subsequent landslide which destroyed three villages
in Padang Pariaman Regency. The first aftershock measured 6.2 on the Richter scale 22 minutes later;
and the second one measured 6.8 on the Richter scale with an epicenter located 225 km southeast of
Padang city in the early morning of the following day. In total, the earthquake affected 13 cities and
districts in the province. The government reported that the earthquake caused 1,117 deaths and 2,902
injuries [19]. In addition, there were 250,000 families (around 1,250,000 people) being internally
placed and affected by the earthquake. In total, there were 249,653 houses damaged; i.e. 114,797
homes severely damaged, 67,198 moderately damaged, and another 67,658 lightly damaged [19]. The
total damage due to the earthquake is estimated at 19,369 billion IDR and total economic losses stand
at 2,198.7 billion IDR.

On the 2009 West Sumatra Earthquake, the author conducted an inter-organizational network
modelling based on 431 emergency response activities that took place during the first-month after the
earthquake, which compiled from situation reports published by BNPB, UNOCHA and Indonesian
Ministry of Health. It should be noted that officially the BNPB announced that the emergency
response was set for two-months period with acceptance of international assistance and involvement
of international organizations to co-lead the humanitarian clusters with provincial government
agencies. Much of the decision was created based on performance in the emergency response of the
2009 West Sumatra Earthquake and the fact that the latter earthquake gave additional burden to the
state resources. De facto, however, the emergency response was effective for one month, which is
faster than the original plan. In the end, there were 223 organizations involved in the emergency
response, comprises of 29 local/national NGOs, 40 local government agencies, 63 international NGOs,
12 agencies of the United Nations, 3 universities, 18 provincial government agencies, 17 central
government agencies and 6 private companies.

Based on the data, the Author generated inter-organizational network model using UCINET version
6.4 that comprises of 223 nodes and 865 ties [16]. On the network, degree centrality and betweeness
centrality measurements were performed to analyze the characteristic of actors within the network. In
addition, SNA also calculated the network density, i.e. 5.259, and identified 40 inter-organizational
cliques in the emergency response of the West Sumatra Earthquake 2009.

The result of degree centrality and betweeness centrality in the 2009 West Sumatra Earthquake
emergency response seems to support that humanitarian clusters approach was functional. In addition
to UNOCHA (normalized degree of centrality at 4.762 and normalized betweenness centrality at
11.601), BNPB (2.902 and 8.054), and Satkorlak West Sumatra (2.530 and 7.652), among the top-
fifteen of organizations with highest degree centrality, almost all of them are the lead agency in each
cluster, i.e. UNICEF, International Organization of Migration (IOM), International Federation of Red
Cross (IFRC), Save the Children (STC), United Nations Development Program (UNDP), Bappeda
West Sumatra (provincial development planning agency), World Food Program (WFP), and Food and
Agriculture Organization (FAO). Furthermore, by observing the normalized degree centrality and
normalized betweeness centrality value of those organizations, it can be seen that the difference was
not significant. Analyzed in its principal-component mode, the inter-organizational network in the
2009 West Sumatra Earthquake was in lead-partnership type of network whereas the network has
several lead agencies represented by lead and co-lead agencies of humanitarian clusters, instead of single and powerful lead agency [16].

4.4. Inter-organizational network on the 2010 Mount Merapi Eruption

The 2010 eruption was the largest and most powerful in the past 100 years of Mount Merapi, with the affected areas of within 15 km radius. It resulted in the death of 277 people and the numbers of internally displaced people were 125,563 people [12]. The status of Mount Merapi was alleviated from the beginning of October 2010, and in particular large-scale evacuation was organized from 26 October 2010 and reached its peak on 5 November 2010. Officially the emergency response was defined for one month from 26 October until 25 November 2010, however due to the fluctuated and prolonged eruptions, thus the emergency response was extended until 9 December 2010.

Esterly (2012) created an inter-organizational network model of the 2010 Mount Merapi Eruption, which mainly derived from attendance list, coordination minutes of meeting and who-where-what matrix of emergency response activities documented by FPRB Yogyakarta (DRR forum of Yogyakarta province) that covers the emergency period from 26 October until 9 December 2010. It was found out that the network comprises of 177 organizations, with 39.98% of them are local/national NGOs followed by 19.21% local government agencies, 14.12% international NGOs, 6.21% education institutions, 4.52% central government agencies, 3.95% of UN agencies and private companies each, as well as 9.04% other organizations.

According to her model, from the interaction between 173 nodes, there were 340 ties identified. At the network level, it was found out that the network diameter is 9, average path length at 3.12, network density at 0.011 and average degree around 1.782. This implies that the network was rather large, only around 11% of total possible ties were formed and in order to coordinate an organization must through around three intermediaries. Esterly also identifies that 62.71% of the responders are extending organizations, meaning those which present at the community on a daily basis even though does not assume main responsibilities to handle disasters, and 29.38% are established organizations, i.e. those which established before the disaster and does have main responsibility in responding to a crisis.

Furthermore, to understand the structure of the network calculation on degree centrality and betweenness centrality was also provided. Based on degree centrality, the top-ten of organizations with high value were established organizations such as BNPB, Yogyakarta health agency, UNOCHA, Save the Children. The BNPB, as it was expected, has the highest degree centrality. However, interestingly, based on betweenness centrality, Oxfam GB has the highest value and followed by extending (local) organizations that was rather new to disaster emergency response, such as PSB, SAPDA, Plan, Hijau GPL and others. As a whole, the network shows that the disaster created a complexity where formal organizations that have been established before gave to adapt by structural change or alternation of tasks in interacting with new organizations in carrying emergency response [12].

4.5. Inter-organizational network on the 2014 Jakarta Flood

Jakarta Capital Region has a long-history of seasonal flood, whereas in the last ten years alone there were flood occurrences in 2007, 2013, 2014 and 2015. The 2014 Jakarta Flood reached the peak on 21 – 22 January 2014 where several rivers that flows through the capital could not handle the volume of water and created inundation area in 33 districts in Jakarta. In total, according to Jakarta BPBD, the flood affected 119,397 people with 89,334 of them have to take refuge in 307 evacuation points [14]. Various news reports also suggested that the economic losses reach IDR 5 trillion.

On its emergency response period, one network model during the 2014 Jakarta Flood was analyzed by Esterly and colleagues (2014) who focuses on inter-organizational and inter-personal coordination instead of cooperation during emergency response, of which the model was generated using survey result to individual responders [14]. This in itself is different and important network data compilation
process in comparison to previous cases. However, albeit the production network models in several modes, the research of Esterly and colleagues (2014) does not clearly identified the number of nodes, both at organizational and individual levels.

Based on their measurements, the average degree of the network is 1.29, which implies actors only coordinate with one or two other actors during emergency response period. The network was also rather large, diverse and has a rather vertical relationship, indicated with the network diameter size, 8, and network density of 0.002. They also measured the average path length, 3.47, which implies for an information to travel to all nodes in the network, thus it generally travels through 3 – 4 intermediaries. Furthermore, in the inter-organizational network during the 2014 Jakarta Flood, there were 10 sub-groupings identified with modularity value at 0.485, which indicates that grouping during coordination was not random phenomena, yet representative to the field situation.

Based on the degree centrality that being calculated, the top-ten organizations with highest value are comprise of four local government agencies, Jakarta Disaster Management Agency (BPBD), Social Agency, Health Agency, Firefighter Agency, in addition to three district (kecamatan) offices and three sub-district (kelurahan) offices. While betweeness centrality value for organizations was not provided, Esterly and colleagues (2014) calculated degree centrality and betweeness centrality of individual actors within the network. They found that from both calculations, officers from BPBD Jakarta were dominating the individuals with high degree centrality and betweeness centrality value. However, they noted that the results were rather based on “friendship and personal” relationship, rather than formal coordination channel.

4.6. Comparative perspective on inter-organizational network modelling from disasters in Indonesia

To this point, we have learned that there are several disasters in Indonesia of which inter-organizational network has been assessed. The network images can be found in Figure 1.

Prell (2012) noted that direct comparison of network is difficult to objectively conducted, if not impossible, due to rare identical two or more networks with same size. Therefore, to identify learning points from networks described in this paper, it is not on the real or normalized value of degree centrality and betweeness centrality, but rather on which organizations are recorded of having relatively high value on both measurements relative to the other nodes. Also, to what extent those organizations were established or recognized within the disaster management regulations and frameworks existed at the time of those disasters.

Among the five cases, only the 2004 Tsunami that occurred before the Law 24/2007 on disaster management enacted, which at that time disaster management in Indonesia was basically coordinated through the National Coordinating Agency on Disaster Management (Bakornas PB) and at the time of actual disaster there was no single agency that assume ultimate responsibility. However, as Lassa (2015) pointed out, it was not the Bakornas PB nor the BRR that recorded having the highest centrality and rather the UNDP. This clearly shows that at the time absence of national framework made no domestic organization capable of managing a mega-disaster at such magnitude.

On Aceh case, as Lassa himself noted, the inter-organizational network does not reflect the whole picture of how a coordinating agency played roles in the field as its much derived from the database of “who does what supported by whom”. However, it does confirm the significant distance and indication that at least five intermediary agencies are needed in order to nurture a cooperative tie between organizations, i.e., as indicated that the diameter of humanitarian organizations network is 5. This post serious concern on how to reduce the structural gaps as well as to foster closer and foster ties between humanitarian organizations immediately after mega-disaster, even with the existence of humanitarian clusters. Nevertheless, Lassa’s work (2015) was mostly on post-disaster reconstruction period took place in 2005-2007, and not the emergency response period itself. Thus, it is incomparable with other disaster cases due to a difference on disaster management stage.
On the other hand, the other four disasters occurred after the Law 24/2007 was established and its subsequent detailed regulations, which mostly enacted through Head of BNPB regulation, including on acceptance of international aid (Head of BNPB Regulation 21/2008). Thus, the detrimental factor is whether or not the local government has established their BPBD and the political decision taken by both central and local governments on whether accepting international assistance and how it is managed. The West Java and West Sumatra earthquakes in 2009 and Mount Merapi Eruption in 2010 best explained this, particularly when the centrality values of BNPB are scrutinized. In all three disasters, the provincial governments have not established BPBD or its BPBD was still infant, yet BNPB decision was different in all three. In West Java, BNPB was ranked second due to its decision to support provincial government, which already determined response plan through West Java Governor Decree SK 360/kep.1260-Hukham/2009. Yet, both Satkorlak West Java and BNPB can be seen as the centre of the network, due to its significant difference with other organizations. On the other hand, when the 2009 West Sumatra Earthquake occurred the BNPB and provincial government agreed to welcome international assistance immediately after the earthquake and consequently the UN-led humanitarian clusters were activated. Accordingly, as shown the network was rather formed a lead-partnership type where humanitarian clusters lead agency and co-lead agency led the network, mostly one government agency and one non-government (UN agency or international NGOs). In the case of the 2010 Mount Merapi Eruption, the BNPB took leadership, and consequently ranked with
high centrality values. However, still many local organizations and international humanitarian organizations have high centrality values above the local government agencies, due to their high level of engagement in the emergency response.

The 2014 Jakarta Flood was at a different scale in comparison with the other cases whereas the repetitive disaster classified as a local (provincial) disaster. On this, with more mature organizations and better local government capacities, as expected, Jakarta BPBD and three other agencies (health, social and fire fighter) recorded high values on both centrality measurements. This indicated a working emergency response framework and social trust to those local government agencies in responding to disaster. For a more locally managed disaster, it is important to further strengthen the capacity of BPBD and other agencies in the local government for managing emergency situation and enhance ties with other non-government organizations that potentially contribute in emergency response.

In the end, none of the example above map the inter-organizational network within the total disaster management cycle, which in reality may provide hints on the societal and institutional capacity of the area throughout the overall disaster management cycle. Author in this paper is showcasing preliminary attempt to showcase such approach on inter-organizational network in West Java Province. Here, author built a database of all DRR programs and projects in the province two years before the 2009 Earthquake, use the initial model of inter-organizational network during emergency response and mapped post-disaster reconstruction activities two years after the earthquake, in similar fashion of that of Lassa (2015). The result can be seen in Figure 2. It clearly can be seen that before the earthquake, due to absence of provincial BPBD, the network was not fully connected and there are two big hubs on DRR programs and projects, i.e. the West Java Province Development Planning Agency (Bappeda) and Bandung Institute of Technology (ITB). On the other hand, the network during recovery stage, interestingly does not indicate a pure continuation of the network during emergency response. Rather, it was centred around UNDP (agency of the UN), BPBD West Java, which eventually formed in 2010, and BNPB (central government agency), thus similar to that of in the 2004 Tsunami (Lassa, 2015). While, the emergence of BPBD West Java shows a change in institutional setup, it is important to further assess on next big disaster in West Java whether the BPBD continue assume the leadership.

Figure 2 Inter-Organizational Network in West Java Province before, during emergency response, and after the 2009 Earthquake (Created by author)
Conclusions and Research Agenda for Disaster Management in Indonesia

This paper confirms that existence of policy and response framework, capacity of local government to respond specific disaster, status of disaster declaration that affect the presence of national government, and involvement of response from international organizations are detrimental factors to the inter-organizational network during disaster; and not solely the type of hazard. However, the time dimension that bring about by each type of disaster may provide different implications to the network formation. Therefore, in addition to the need to continuously develop local (organization) capacity to multiple hazards, specific resources, policy and organizational rosters need to be prepared for the most urgent and frequent hazard of each localities in Indonesia.

Throughout the paper, Author has briefly discussed the development and utilization of SNA as analytical tool for analysing inter-organizational network, which further grow as a mixture of political science, public administration, and sociology. SNA as a tool can now be utilized by political scientist and public administration scholar to manage and visualize big data of inter-organizational relationship in many development sectors, including disaster studies and disaster risk management sector. To repeat Berry and colleagues (2004), the future importance is to contextualize SNA result on various development sector, including disaster studies [20]. On the other hand, modification and improvement on the way public administration practices (such as in reporting and data management) are needed to feed quality data for SNA.

To further strengthen an evidence-based policy making, SNA can also contribute significantly with its characteristics, as proven in the three examples provided here; i.e. 1) it can be done to analyse nationwide network for shading lights on institutional trend organizational involvement at the time of disaster, 2) it can be used to track dynamic of inter-organizational relation in a particular development sector over time, as in the case of West Java, 3) it can be used for a comparative study within a country, and possible extended to a cross-country comparison, given the objective view of the network, as in the case of West Java and West Sumatra in Indonesia. All five research examples in this paper gave evidence that SNA can be used for policy making on disaster risk management, particularly on governance design, both at local and national level. For a more evidence-based policy making and institutional design, Author would like to call upon the importance of intensifying political science and public administration research using SNA, and network modelling in general for disaster studies in Indonesia.

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