Knowledge and attitudes of the BNPB leaders towards nuclear disaster threat in Indonesia: expectation and reality– ICDM 2020

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Abstract. The Utilization of nuclear technology has an inherent risk due to its radiation hazards that may trigger nuclear technology failure disasters. The government agency designated for coordinating disasters management activities in Indonesia is BNPB. As knowledge on nuclear hazards will influence attitudes and concerns for preparedness towards nuclear disaster, the research aimed to analyse the knowledge and attitudes of the BNPB leaders towards nuclear disaster threat in Indonesia. A case study qualitative method was used to explore and analyse the knowledge and attitudes of the BNPB leaders towards nuclear disaster threat in Indonesia. The research used knowledge and attitudes indicators for dealing with nuclear disaster threat derived from the natural disaster preparedness parameters, developed by LIPI-UNESCO / ISDR (2006), and the nuclear emergency preparedness requirements, develop by the IAEA (2015). In general, the results showed that the knowledge and attitudes of the BNPB leaders are sufficient (56.25%). While knowledge of causes, potential, types of events that may trigger nuclear disaster is sufficient, on the other hand, the attitudes towards nuclear disaster risk is still deficient. Thus, increasing the knowledge and attitudes on nuclear disaster threat, there is a need BNPB to enhance its role as the disaster coordinator to include coordination of exchange of information and knowledge of nuclear hazards with other related ministries/ agencies, such as BAPETEN and BATAN, into its program.

1. Introduction

Nuclear energy utilization is activities related to nuclear energy such as: research and development, mining, manufacturing, production, transportation, storage, transfer, export, import, uses, decommissioning, and radioactive waste management in order to enhance people's welfare [1]. Nuclear energy is any form of energy released in the processing of core transformation, including energy from ionizing radiation sources.
Nuclear technology has been widely used in Indonesia. Data from the Nuclear Energy Regulatory Agency (BAPETEN), as of August 13, 2019 there are 12,496 licenses for nuclear energy use which were spread throughout the country with following details: 6,721 licenses for medical use, 2. 5,754 licenses for industrial use, and 21 licenses for nuclear installation use [2].

Besides being useful, nuclear technology has also inherent risk due to its radiation hazard. Therefore, its utilization may also poses radiation hazards to workers, community and environment if it is not controlled appropriately or being misused. The misuse of nuclear technology or nuclear technology failure may cause nuclear disasters which may disrupt national security, public security as well as human security.

According to Act Number 24 of 2007 concerning Disaster Management, Chapter I General, non-natural disasters are: forest/land fires caused by humans, transportation accidents, construction/technology failures, industrial impacts, nuclear explosions, environmental pollution, and space activities. Nuclear disasters is belong to non-natural disasters. Disaster management includes mitigation, preparedness, emergency response and recovery. Preparedness involves equipping people who might be affected by a disaster or who might be able to assist in responding to a disaster to increase chances of survival and minimize losses [3]. One important aspect of preparedness is knowledge and attitudes. Knowledge is a main factor and is the key to preparedness. The knowledge possessed commonly influence attitudes to be prepare and ready to anticipate a disaster [4].

Knowledge is an important domain in creating one's actions. There are six levels of knowledge within the cognitive domain, namely:

1. Know, is able to remember material that has been studied previously. This include being able to recall something specific and all learned material or stimuli that have been received;
2. Understanding, is able to explain correctly about known objects, and able to interpret the material correctly. People who have understood an object matter can explain, give examples, infer, predict, and explain everything regarding object being studied;
3. Application, is able to use material that has been learned to an actual situation or condition;
4. Analysis, is able to describe material or an object into its components, within an organizational structure, and the connection with each other;
5. Synthesis, is able to connect parts into a whole new form; and
6. Evaluation, is able to justify or assess a material or object. The assessments are based on self-determined criteria, or use existing criteria [5].

Attitude is a form of readiness or willingness to an act. It is not an implementation of certain motives [6].

Indonesia has use nuclear technology in many field, as describe above. Therefore, nuclear energy is a necessity for Indonesia. However, nuclear disaster threat can be prevent through preparedness efforts for an effective response. Understanding the risk before any arrangement made for preparedness is one needy. This research aimed to analyze the knowledge and attitudes of the BNPB leaders towards nuclear disaster threat in Indonesia. The research used knowledge theory as explained by Notoatmodjo (2014),
particularly at the understanding level. It is to assess the understanding and the attitudes of the BNPB leaders towards nuclear disaster threat in Indonesia. As mentioned earlier, the knowledge possessed will influence attitudes for preparedness in anticipating disasters. Through carried out this research, it is expected that the understanding of disaster hazards in Indonesia would be more comprehensive to include also nuclear disaster threat.

2. Methodology

The Research used a qualitative research method to explore the knowledge and attitudes of the BNPB leaders towards nuclear disaster threat in Indonesia. A case study approach was used to explain and deeply analyzed the knowledge and attitudes problems. The case studies have been found in evaluation research where researchers develop an in-depth analysis of a case [7]. The primary and secondary data obtained portray of current conditions. Primary data was obtained from interviews and direct observations. Secondary data was obtained from literature study of theoretical books, legislation, reports on activities have been carried out, as well as from requesting data from the informants.

The informants selection used a purposive sampling technique. The key informants were BNPB leaders from Echelon IV to Echelon I as follows: Deputy for Systems and Strategies, Director of Preparedness, Deputy Director of Prevention, Head Section for Equipment Preparation, and Steering Element. To complete the data, other officers from related ministry/ agency were also interviewed. From BAPETEN: Deputy for Licensing and Inspection, Deputy for Nuclear Safety Assessment, Director of Technical Support and Nuclear Emergency Preparedness, and Head of Sub-Directorate for Nuclear Preparedness. From BATAN: Head of the Multipurpose Reactor Center (PRSG), and Head of the Center for Information Utilization and Nuclear Strategic Areas (PPIKSN). From BNPT, Head of Information Systems Management, and from South Tangerang City Local Disaster Management Agency (BPBD), the BPBD Secretary. Data taken from different sources can coherently justify themes and will add validity to the research [7].

The research used a source triangulation technique to validate data obtained. Source triangulation to test credibility of data is carry out by checking the data obtained through several sources [8]. To analyze the data, interactive data analysis technique as proposed by Miles, Hubberman and Saldana (2014) was used, the analysis was carried out continuously since data collection on the field until it was completed and saturated. Data collection was carried out since September to November 2019.

Further, the obtained data from interview and direct observations were compared with knowledge and attitudes indicators derived from natural disaster preparedness parameters developed by LIPI-UNESCO/ ISDR (2006) and nuclear emergency preparedness requirements developed by the IAEA (2015), specifically those relating to knowledge and attitudes as shown in Table 1. Finally, assessments were made based on criteria as follows:

1. Less (0-34%), if the interviews and observations results do not meet the indicators;
2. Sufficient (35-68%), if the interviews and observations results meet some indicators; and
3. Good (69-100%), if the interviews and observations results meet most or all indicators [9].

Table 1. Knowledge and attitudes indicators towards nuclear disaster threats
3. Results and discussions

BNPB designates for coordinating the implementation of disaster management activities in a planned, integrated, and comprehensive manner. Indonesia has a great potency in development. This condition creates a huge demand for energy and technology for the people welfare. On the other hand, it also poses potential threats and risks to people safety and security. The Indonesia's population growth together with technology developments will increase the potential of anthropogenic disasters such as technological failures. The condition may triggered due to the attractiveness of Indonesia as a global investment destination. The rapid industrial growth and development will further increase the potential for technological failure disaster [10].

Indonesia has 12 types of high-risk disaster threats, namely: 1) Earthquakes, 2) Tsunamis, 3) Volcanic Eruptions, 4) Land Movement (Landslides), 5) Floods, 6) Flash Floods, 7) Drought, 8) Weather Extreme, 9) Extreme Waves and Abrasion, 10) Forest and Land Fires, 11) Epidemics and Disease, and 12) Technology Failure [11]. Technological failure is a threat to the business world and individuals today. It is potential to cause environmental pollution and damage to areas that are not ready to face. Technological failure disasters may also be triggered by natural disasters ("natech"), such as earthquakes, floods, storms, extreme temperatures, etc. may trigger fires, explosions and release of poisons or radioactivity in installations that are processing, storing or transporting hazardous substances [12].

The interviewed result with the Deputy System and Strategy of the BNPB portray that there has been awareness of nuclear disaster threat in Indonesia. Furthermore, during the ASEAN Regional Disaster Emergency Simulation Exercise (ARDEX) in 2018 on scenario of hazardous substances (chemical, biological, radiological and nuclear, CBRN), BNPB involved BAPETEN and BATAN in the exercise. Unfortunately, the scope proposed by BAPETEN and BATAN during discussion was less extensive since its only focuses on nuclear reactors. In fact, in addition to nuclear reactors, there are also potential threats from radioactive sources, such as ones used in hospitals which is also vulnerable to crime or terrorism acts. Natural disasters may also trigger disasters in nuclear reactors, hence preparedness of nuclear disaster threat should starts from an understanding of the potential risks of nuclear hazards within
an area. An effort to map nuclear disaster risk has been carried out by BNPB in 2018 as part of the follow-up to ARDEX 2018. Nevertheless, it has not been realized until now. The informant acknowledges that nuclear disaster early warning system is designated to BAPETEN but the authorization to declare a disaster, including nuclear, is entitled to BNPB / BPBD.

The interviewed result with the Director of Preparedness portray that the informant know Indonesia has nuclear disaster threat due to the presence of three nuclear reactors and the use of equipment contain radioactive sources, such as ones use in medicine. Learning from the earthquake and tsunami disaster in Fukushima, Japan, which triggers damage to nuclear reactors, hence, natural disasters may trigger nuclear disasters. In addition to that, crime or terrorism acts may also potentially cause nuclear disasters. Even thought its potential is small, but still remains. Unfortunately, BNPB’s current resources are insufficient to deal with nuclear disaster. It was acknowledged from the interview that BNPB’s knowledge on nuclear disaster threat is still insufficient. Some efforts on preparing and anticipating of nuclear disaster threats are in discussion among BNPB and relevant stakeholders under the concept of multi-hazard early warning system, including the mechanism for delivering nuclear disaster information.

The interviewed result with the Head of Prevention Subdivision portray that the informant was aware of nuclear disaster threat particularly after the ARDEX 2018 that exercised a CBRN disaster scenario at Cilegon industrial area. Unfortunately, at that time, the management of a nuclear hazard emergency was not trained since it was too complicated for BNPB staffs. Up to now BNPB has not yet developed knowledge on nuclear disasters threat. Some discussions and meetings had been carried out with the Ministry of Health, Ministry of Environment and Forestry and other stakeholders, yet there has no follow-up actions particularly for the formation of working groups to develop CBRN preparedness guidelines. Hence, until now BNPB knows the threats of CBRN, including nuclear, but there is no policy or guidelines develop related to it. Relating to nuclear hazard, training received by BNPB staffs is generic, simply to understand that in a nuclear disaster they can coordinate resources. Nevertheless, regarding nuclear disaster emergency response, they do not have the expertise and capability to do so.

The interviewed result with the Head of Equipment Preparation Section portray that the informant is aware of nuclear disaster threats which is part of technological failure based on regulation. The failure may come from nuclear reactors or radioactive sources. According to the informant, radioactivity or chemicals can be controlled during emergencies if the equipment and methods used are appropriate. Conversely, improper response may lead to an escalation of the emergency. The informant gained knowledge of nuclear disaster through independent search and learn. In terms of institutional sharing, such as BAPETEN or BATAN for example, there are no sharing of information or knowledge related to nuclear hazards to the Directorate of Emergency Management so far. Those institutions may have coordinated with the Directorate of Preparedness. Nevertheless, the Directorate of Emergency Management staffs should also have those knowledge since earlier, so they will know what methods and tools use in nuclear disasters.

The interviewed result with one of the 2015-2020 BNPB Steering Elements expertise in hazardous materials portray that up to now, BNPB has not discussed much on non-natural disasters. However, it should be considered since non-natural disasters are included in the BNPB’s responsibility and authority. In general, the knowledge of nuclear hazards is very limited.

From interviewed results with other informants (BAPETEN, BATAN, BNPT and South Tangerang Selatan City BPBD) it was known that nuclear disaster threat may arise from some facilities. They are: facilities use nuclear material, facilities or activities use radioactive sources, transport of nuclear or
radioactive materials, and criminal or terrorism acts uses nuclear or radioactive materials such as radiological dispersal devices (RDD) or dirty nuclear bombs. Transport of radiopharmaceuticals and nuclear medicine also has potential to pose the threat. Although their radioactive activity are small, they are prone to accidents during transport. Improper response at the accident scene may escalate the emergency conditions causing radioactive releases and contamination to the vicinity of the accident scene. Concerning crime or terrorism acts, potential acts are: theft of nuclear or radioactive material, sabotage by insiders, and cyber-attacks on nuclear facilities. The use of nuclear materials is carried out by BATAN in four locations, Serpong Nuclear Area in South Tangerang, Bandung Nuclear Area, Yogyakarta Nuclear Area, and Pasar Jum’at Nuclear Area in South Jakarta. The use of radioactive materials spreads almost throughout Indonesia. The activity of nuclear materials transport is on the island of Java since they only use within the island. The activity of radioactive materials transport spreads almost throughout Indonesia since they are used almost throughout Indonesia given that materials can be transported via land, sea or air modes in accordance with applicable regulations.

Based on above facts finding, the threat of a nuclear technological failure disaster at a nuclear facility may potentially occur in the four locations using nuclear materials. The threat of nuclear technological failure at radioactive facilities may potentially occur in almost all regions of Indonesia. The threat of nuclear disaster due to transport accident involving nuclear materials may potentially occur in Java, while for transport of radioactive materials and crime or terrorism acts may potentially occur in almost all regions, given the distribution of radioactive materials use and the opportunity to use land, sea or air routes for the transportation.

Based on evidences gained, the BNPB leaders has been aware of the potential nuclear disaster threats in Indonesia. However, the knowledge is limited to generic ones. There is no detail and comprehensive knowledge obtained from relevant ministries/ agencies. These facts answering questions they do not know the extent of the nuclear hazards risks. Unwritten arrangement so far, in the event of a nuclear emergency BNPB coordinates with BAPETEN. Those including nuclear disaster early warning sharing that still under discussion with BAPETEN. Since BNPB does not have ability to detect nuclear radiation and its technical capabilities. BNPB relies the ability to BAPETEN, in accordance with BAPETEN duties and functions in terms of prevention and preparedness of nuclear emergencies. However, once a nuclear accident widespread and impact community around, it is the responsibility of the local government (BPBD) and central government (BNPB) to cope with. In regards to nuclear hazard, research found that BPBD as well as BNPB do not have capability to cope with such disaster. To that point, BPBD/ BNPB coordinates existing local and national resources to provide assistance in nuclear disaster countermeasures.

In addition to the primary data gained from interviews and direct observations, the researchers reviewed some related documents such as the National Disaster Management Plan, Renas PB 2010-2014, and Renas PB 2015-2019. These documents guideline ministries/ agencies in preparing their strategic plans and implementation related to disaster mitigation efforts. The review results portray that nuclear disaster has not been included in the disasters threats map of the Renas PB documents. Table 1 shows the resume of overall results based on primary and secondary data.
| Indicator                                                                 | Data obtained                                                                 | Category | Assessment     |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------|----------|----------------|
| 1. Understand causes and potential threats of nuclear disaster in Indonesia | BNPB leaders generally understand the causes and the potential threats which is not only from nuclear reactors but also from radioactive sources | Sufficient | (65%)          |
| 2. Understand types of natural disasters can trigger nuclear disasters    | Having learn from the nuclear accident at Fukushima, BNPB leaders generally understand that various natural disasters can trigger nuclear disasters | Sufficient | (65%)          |
| 3. Understand security threats can trigger nuclear disasters              | BNPB leaders generally understand there are various security threat scenarios can trigger nuclear disasters in public areas | Sufficient | (65%)          |
| 4. Having attitudes and concerns on nuclear disasters risk                | 1. Nuclear disaster has not yet include in the disasters threats map of the Renas PB documents 2. BNPB has not yet coordinate the assessments of nuclear disasters threats in Indonesia with related agencies 3. In 2013, BNPB facilitated stakeholders in the development of the South Tangerang City nuclear contingency plan 4. BNPB has initiated a nuclear disasters risk mapping as follow-up of ARDEX 2018, but it has not been realized until now | Lack     | (30%)          |

Average Value of the knowledge and attitudes

**Source: Processed by researchers (2019)**

Based on above recapitulation result, the BNPB leaders knowledge and attitudes towards nuclear disaster threats is sufficient (56.25%). The BNPB leaders understand and able to explain the potential
threat of nuclear disasters in Indonesia, types of natural disasters that may trigger nuclear disasters as well as type of security threats that may trigger nuclear disasters. However, the research found that this understanding is limited to generic ones that has not understand risks of nuclear disaster threat in Indonesia and the basic goals of its management comprehensively, that is to prevent the deterministic effects of radiation and to minimize the stochastic effects of radiation. Deterministic effect is an effect occur in a particular organ or body tissue received high doses of radiation, while stochastic effect is effect due to reception of low doses of radiation throughout the body which is only suffered after certain period of time, or suffered by their descendant [13]. Cancer is a stochastic effect often found in children who exposed to radiation compared to adults [14].

A limited knowledge of nuclear disaster threats causes lack of attitudes and concerns on its risk. Disaster risk relates into three main things, namely disaster hazards, vulnerability and capacity, explained by following formula:

\[ R = H \times \frac{V}{C} \]

**Figure 1.** Disaster risk formula [15]

By using the above formula approach, concerning nuclear disaster risk management can be describe as:

a. Hazard (H), is any incident at a nuclear facility/ activity that can endanger workers and surrounding community;

b. Vulnerability (V), are conditions caused by various factors, such as physical, social, economic, and environmental factors that make people vulnerable to the impacts of hazards [16]. For nuclear hazards, physical factors such as conditions of settlements, offices or public services (schools, hospitals, government offices, etc.) located close to nuclear facilities. Social factors such as the level of public education, the risk of nuclear hazards not considered as important by the local/ central government impact to no preparedness effort. Economic factors such as growth of villages and trade centers near nuclear facilities due to economic motives. Environmental factors such as environmental degradation due to radioactive contamination to the environment. Vulnerability is a pre-disaster condition that potentially become a disaster when it encounters a hazard. If an area has high vulnerability, the risk of being exposed to hazards will be higher which will ultimately increase the risk of disasters; and

c. Capacity (C), is a condition of readiness/ability to respond to an emergency that may occur. Capacity includes the role of all components in disaster management, the business world, local/ central government, community, academia and the media. For nuclear hazards, the role of the business community, for example, having a nuclear disaster risk assessment, having capability to prepare for and response to nuclear emergencies, carry out training and exercise on nuclear emergency regularly. The role of local/ central government, for example, having a comprehensive nuclear disaster risk assessment which taking into account all potential threats within their jurisdiction, having preparedness towards nuclear disaster threats, conduct training and exercise on nuclear emergency regularly particularly for first responders such as: fire brigade, ambulance, and local Police. The role of community, for example, through an active role of community leaders in partnership with nuclear
technology users and local government in efforts to prepare for nuclear disaster threats. The role of academics, for example, through engagement in nuclear disaster risk studies develop by nuclear technology users, and local/central government. The role of the media, for example, through dissemination of information related to the advantages and disadvantages of nuclear precisely, accurately and in balance.

In the context of understanding nuclear hazards knowledge, the government needs to carry out a nuclear hazards assessment on facilities and activities use nuclear energy. The assessment should considers:

1. Events with very low probability;
2. Event that is a combination of a nuclear disaster and a natural disaster;
3. Results of the nuclear security threat assessment; and
4. Events that can affect several facilities and activities, as well as interactions between the two that affect each other [17].

Evident found in the IAEA Emergency Preparedness Review (EPREV) mission report of 2016, BAPETEN as the nuclear energy regulator has conducted a hazard assessment only for nuclear facilities. The assessments are based on the Safety Analysis Report of nuclear facilities as part of the licensing process. No hazards assessment has been conducted for radioactive materials that are widely used in health and industrial fields [18]. Meanwhile, the research portray that BNPB had attempted to map nuclear disaster risk in 2018 as a follow-up of the ARDEX. Nevertheless, it had not been realized. The research found there are some difficulty to BNPB to transform the data provided by BAPETEN into a disaster risk map, since:

a. There are many short half-life radiopharmaceuticals with dynamic distributions or transportations. These licenses data changes daily, since their will soon use by the hospital for patients treatments.
b. There are many radioactive materials used in industry with dynamic distributions data due to imports, exports and transfers. These dynamic data due to temporary storage of the materials in the importer/exporter storage warehouse for further distribution to users.
c. Other challenging relates to mobile radioactive sources, commonly use in industrial radiography. Due to its mobile characteristic, one radioactive source can be used in five different regencies/cities for a certain period and should be registered in the license system [19].

Those challenges in understanding nuclear disaster hazards requires discussion to find solutions among relevance ministries/agencies. Research found that existing nuclear disaster risk assessments are limited at the nuclear technology users level as part of BAPETEN requirements of licensing process. Those assessments further can be used as inputs and contribute to local and national nuclear disaster risk assessments, which is so far undeveloped yet.

It was evident that the South Tangerang City BPBD has been mapped nuclear disaster threat within its territory. The mapping was facilitated by the Directorate of Preparedness, BNPB in 2013 through the activity of developing of nuclear contingency plans. However, the locus is limited to South Tangerang City and no national nuclear contingency plan develop so far.
In regards to Sendai Framework for Disaster Risk Reduction (SFDRR) concept, understanding risk is one of important thing in disaster risk reduction [20]. Likewise, understanding of nuclear disaster threat is important for nuclear disaster risk reduction. It could be done by assessing potential risks of nuclear disaster within Indonesian territory. Since current disaster management paradigm has been shifted from responsive to preventive approach, that is through strengthening DRR as combination of technical and scientific perspectives on social, economic, political and environmental conditions. Hence, the preparedness for dealing with nuclear disaster threat begins by analysing the nuclear disaster risk based on hazards, vulnerabilities and existing capacities. The analysis results further use to establish governance priorities for enhancing capability to manage and reduce the risk of nuclear disasters impact on society, to improve DRR investment in resilience, and to improve risk management at all levels since preparedness, response and recovery.

The results found that even though BNPB leaders have limited knowledge on nuclear disaster threat, other relevance agencies such as BAPETEN and BATAN have it in more detail. Acknowledge this fact, hence BNPB can increase its knowledge and improve its attitude towards nuclear disaster threat by carry out an active coordination on sharing of and exchange of nuclear disaster threat information with those relevance agencies. The organizing of joint exercises, such as ARDEX 2018 with “natech” scenarios trigger CBRN technological failures is one of a concrete efforts to enhance BNPB knowledge in disaster management of CBRN technological failure. Nevertheless, this kind of exercise should be carried out regularly to maintain and enhance the possessed knowledge.

Another effort could be conducted by carry out a cross training among BNPB, BAPETEN and BATAN lecturers. Through this training, BNPB lectures can share their expertise in disaster management, meanwhile BAPETEN and BATAN lectures can share their expertise in radiation protection and nuclear emergency response. The experience further can be share and disseminate with leaders in their respective agencies. Hence, more comprehensive of knowledge on nuclear disaster threat can be share from bottom up. It is expected that the more comprehensive knowledge gain on nuclear disaster threat, the more attitudes towards it would be concerned of the BNPB leaders. As nuclear disaster is part of non-natural disaster, understanding nuclear disaster threat is part of an effort to understand disaster risk comprehensively as required by the priority one of the SFDRR, 2015-2030.

4. Conclusion

Knowledge and attitudes of the BNPB leader towards nuclear disaster threat in Indonesia is categorized sufficient (56.25%). The assessments were based on knowledge and attitudes indicators derived from the natural disaster preparedness parameters developed by LIPI-UNESCO/ISDR (2006) and the nuclear emergency preparedness and response requirements developed by IAEA (2015). Results showed that the BNPB leaders knowledge on causes, potential, types of events that may trigger nuclear disaster is sufficient. Nevertheless, facts found that the attitudes towards nuclear disaster threat is still deficient.

To increase the knowledge and attitudes towards nuclear disaster threat, there is a need BNPB to enhance coordination on sharing of and exchange of nuclear disaster threat information and knowledge with relevance agencies such as BAPETEN and BATAN. In addition to that, there is a need BNPB to facilitating and coordinating nuclear disaster risk assessments in Indonesia, as one of the efforts to understand the disaster risks in Indonesia comprehensively.

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Acknowledgements

The Authors wish to thanks the BNPB, BAPETEN, BATAN, BNPT, BPBD Tangerang Selatan and the Disaster Management Study Programme, Faculty of National Security of the Indonesia Defense University for their full support and facilitating this research.