



Research Trends on Natural Hazards, Disasters, Risk Reduction and Climate Change in Indonesia: A Systematic Literature Review

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Abstract. Indonesia is one of the most vulnerable countries from disasters and climate change. While there have been a proliferations of academic publications written on issues related to natural hazards, disasters and risk reduction, and climate change risk in Indonesia, there have not been any review done systematically to determine the progress, key topics discussed

- and which topics needed to be researched further. The author did a systematic literature review on related publications that 10 are indexed within SCOPUS database with the timeline from 1900 to 2016. The findings are outlined in two parts. The first part focuses on the research topics. It is found that the publications can be categorized into three major topics of (1) natural hazard, risks and disaster assessments (HRD), (2) disaster risk reduction (DRR), and (3) climate change risks, vulnerability, impacts and adaptation (CC). More than half are on HRD, focusing on volcanic eruption, tsunami and earthquake. Research
- on DRR focuses on governance, recovery and reconstruction, early warning systems. Those on CC are mainly on emission 15 reduction, forestry, governance, and impacts. The second part focuses on roles of Indonesian researchers and organizations in these researches. Findings show limited progress in research, publications and collaborations. International/ non-Indonesian authors dominate the number of researchers and only half of the publications are co-authored by Indonesians. Moreover, international collaborations took place only by limited Indonesian organizations. This could be contributed by
- 20 limited experiences on collaborations, power play amongst researchers, lack of capacity for research, weak English academic writings capacity, and lack of incentives for international collaborations and publications within the Indonesia higher education system.

1 Introduction

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Disaster events and their associated social and economical impacts are on the rise (EMDAT, 2016). The last decade has shown the highest number and impacts from disasters while 2015 has been stated as the hottest year ever (EMDAT, 2016). The Asia Pacific region has been the place where these disasters occur the most (EMDAT, 2016), while Indonesia is one of the most at risks from disasters and climate change impacts (EMDAT, 2016). Figure 1 shows map of risks from natural hazards in Indonesia, showing the islands of Sumatera and Java are most at risks from multiple hazards. Between the period





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of 1900 to 2016, there have been 429 disasters in Indonesia caused by natural hazards, more than 200 thousands death, more than 29 million people in total affected and the total damage is above 44 Billion USD (Table 1) (EMDAT, 2016).

Figure 1 Risks map of Indonesia (OCHA-ROAP 2011) showing the Islands of Java and Sumatra as most at risks.

Table 1 Disaster impacts in Indonesia from 1900 - 2016 (EMDAT, 2016)

Furthermore, when comparing the impacts between geophysical and those hydro-meteor-climato-logical disasters, while disasters caused by climate occurs and impacts more, the number of deaths is significantly caused by earthquake and volcanic activities (Figure 2).

Figure 2 Comparing between the impacts of geophysical and hydro-meteoro-klimatological disasters (modified from EMDAT, 2016)

This paper aims to systematically review literature related to natural hazards, risks and disaster risks reduction, and climate change vulnerability, impact, and assessments in Indonesia. Systematic literature review is briefly defined as a method to

- 40 systematically reviewing evidence or literature with explicit and transparent methods (Gill and Malamud, 2014). A systematic review method has been used widely in the field of health (Moher et al., 2009a), software engineering (Kitchenham et al., 2009), and engineering (Gosling and Naim, 2009). There have been studies that use this in the topic related to natural hazards, disasters, and or climate change. Examples are review on different natural hazards such as drought (Woodhouse and Overpeck, 1998), landslide (Aleotti and Chowdhury, 1999), wildfire (Neale and Weir, 2015), tsunami
- 45 (Chiu and Ho, 2007), and the interactions of natural hazards (Gill and Malamud, 2014). Others focuses on the impacts (Hunt and Watkiss, 2011) and risk reduction strategies from social sciences perspectives such as ecosystem-based adaptation (Brink et al., 2016;Kabisch et al., 2015), education (Johnson et al., 2014), health and psychology after disaster (Kõlves et al.;Harada et al., 2015), volunteerisms (Whittaker et al., 2015), disaster management and risk reduction (Goldschmidt and Kumar;Beerens and Tehler, 2016;Lettieri et al., 2009;Gall et al., 2015). Some recently review roles of science and
- 50 technologies for DRR (Aitsi-Selmi et al., 2016). A notable study on systematic review of climate change studies is done by Berrang-Ford et al (Berrang-Ford et al., 2015;Ford et al., 2015;Ford et al., 2012). Even though there is a vast material on these topics on Indonesia, there has not yet a literature review that examines these materials in a comprehensive and systematic way. By reviewing published works in this fashion, researchers can build upon others' works, avoiding bias (Khan et al., 1996) and avoid reinventing the wheel so that not only determining which areas and topics that have been
- 55 heavily researched, but also which further areas that needed more researches (Moher et al., 2009b). It is also important to gauge who, how and which way have the researchers been conducted. Determining this will enable consideration for strengthening research capacity in the future (Mallett et al., 2012).

There are two research questions adopted. First is on progress of research on natural hazards, risks, disasters and climate 60 change in Indonesia within the timeframe from 1900 to 2016. The importance of conducting literature on these topics is





several folds. First, the Sendai Framework for DRR (SFDRR) has just been adopted and there are extended scope of hazards and risk reduction strategies adopted. The SFDRR now calls for inclusion of hazards from biological and technological on top of the common natural hazards from geophysical and hydro-climatological hazards (UN/ISDR, 2015). This review will enable identification of hazards that have been the focus of research and those that do not yet receive examination. Second, there is a move from integrated approach to DRR which calls strategies and actions to reduce risks and impacts of those

- 65 there is a move from integrated approach to DRR which calls strategies and actions to reduce risks and impacts of those risks, as well as the role of multi actors for DRR. This review will enable identification of strategies that have been undertaken for DRR and hence able to suggest strategies for future DRR and to implement the SFDRR. Third, there is an increasing focus on the impacts of climate change into changing profile of hazards and disasters, and hence the calls for integrated DRR and CCA to manage climate risks, This review will try to capture whether consideration of climate change
- 70 risks have been considered as part of research progress in Indonesia. Hence in this paper, the topics considered are grouped into 3 major ones of those on (1) natural hazard, risks and disaster assessments (HRD), (2) disaster risk reduction (DRR), and (3) climate change risks, vulnerability, impacts and adaptation (CC).

The second research question is related to the roles of Indonesian authors in contributing for research, international publications and collaborations, within the timeframe from 1900 to 2016. Determining the progress of Indonesian scholars is important and relevant for several reasons. First, these scholars have most likely lived in Indonesia for considerable amount of time. They have experienced and assessed and examined those social and environmental changes that caused natural hazards and disasters in the first place. These experiences will help them to be more focused and sharp in terms of documenting. This study can determine whether progress towards more specific studies on national and local level have been available. Also, in Indonesia, there is increasing pressure for scholars to write for international journal publications and callaborate. Any outputs from these multications and callaborations are used toward ecurities their ranks as academics in

- collaborate. Any outputs from these publications and collaborations are used toward counting their ranks as academics in universities and research institutions (GoI, 2014). Hence identification of this progress through this systematic review will enable us to determine recent progress undertaken mostly by Indonesian researchers, and hence, can help outlining recommendations for further actions in the future to increase the quality and roles in international spheres.
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The structured of the paper is as follows. The first section of this paper outlines the rationale, aim and research questions adopted. The second section outlines research method related to data sources and document selection. The third section gives the analysis and presentation of results. It is divided into two sub sections, the first on key research topics, and the second is on progress of Indonesian researchers and organizations. The last section describes the conclusion and recommendations for forthere are a section.

90 further research.





2 Research method

Based on their extensive review on climate change literature, Berrang-Ford et al (2011;2015) suggested an analytical approach for systematic review and research synthesis as presented in Table 2, which is adopted in this paper.

Table 2 Analytical approach for the systematic review (Berrang-Ford et al., 2015)

95 The research questions and aims have been outlined in the introduction. The following describes methods for data sources and collection, and results and analysis.

2.1 Data sources and document selection

The author conducts a multi-layered literature review to study publications using the Scopus research engine, with the timeframe from 1900 to 2016. There have been several studies comparing strengths and weakness of PubMed, Scopus, Web of Science and Google Scholar (e.g., Bakkalbasi et al., 2006;Bar-Ilan, 2008). Scopus research engine is selected because it is the largest abstract and database of peer-review literature (Leydesdorff et al., 2010). Additional information is gathered from Google Scholar (Google, 2016a), Research Gate (Gate, 2016) or researchers' profiles (if available) to give the full extent of particular scholars' works. The author checks the organizations, nationalities and genders of the researchers in the Internet

through Google.

105 2.2 Research terms and inclusion and exclusion processes

Multi-staged processes are taken to determine inclusion and exclusion for more relevant findings.

2.2.1 First stage

The author inputs the following search terms which gives a total hit of 5253 publications, (TITLE-ABS-KEY(hazard*) OR TITLE-ABS-KEY(risk*) OR TITLE-ABS-KEY(disaster*) OR

110 KEY(disaster risk reduction*) OR TITLE-ABS-KEY(climate change*) OR TITLE-ABS-KEY(climate change adaptation*) OR TITLE-ABS-KEY(resilien*) AND TITLE-ABS-KEY(Indonesia)).

2.2.2 Second stage

The author applies the second stage to further refine the results. This gives a total hit of 1748 publications. The exclusion include refinement in subject areas, in document types, in language (only in English and Bahasa Indonesia), and source title

115 which do not directly related to the topic in DRR in Indonesia.





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2.2.3 Third stage

The third layer search involve the author download the results into xml format, save it and import it into Microsoft Excel, with using all delimiters factors. The results in the Excel format are examined line by line to further determine exclusion from the lists. Materials that are excluded in this final round is related to analysis of research in mining industry in Indonesia, those that discuss on the science of climate change and those that touch on the issue on disasters but not directly on Indonesia and when the author judges that the scope is too broad to be included are finally 744 materials selected. The final

Indonesia and when the author judges that the scope is too broad to be included are finally 744 materials selected. The final list is analyzed in terms of authorships, references, citations, keywords, places of focus, types of publications, impact factors, time of publications and topics and sub-topics of research.

2.3 Analysis and presentation of results

125 2.3.1 Description of method for analysis

Data from Scopus are analyzed in terms of time, citation, keywords, and authorships. SCOPUS has within its features the capability for search, discovery and analysis (SCOPUS, 2016a). The author uses these features to analyze search results, article metric module, citation overview, and author profile page (SCOPUS, 2016a).

2.3.2 Critical appraisal of information quality

- 130 After the second stage is done, the author downloads to material into xml format and later imports it into the Microsoft Excel format. When importing into the Excel format the author chooses all delimiters to enable particular information goes to the right column. However, the results are not always consistent and hence a manual check on each entry row needed to be done. However the author finds that the number counts on the authors' publications and citations presented in the SCOPUS search is sometimes different to the actual check of the excel sheet. It is also different when examining the profile of one particular
- 135 author. Hence, to ensure consistency, the number of counts obtained from the list in excel sheet is used.

Moreover, the author cross-checks the number of citations from Scopus to the Internet, and adopts the higher citation counts. It is generally the case that data from Google search on the publication and author leads to higher and more up to date citations counts. The author also consults total citations and publications of researchers in Google Scholar or Research Gate or from other website to make sure that the full list of publications are captured.

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3 Findings and Analysis

This section is structured into two main parts of research topics on the first part, and on progress of Indonesian researches and organization on the second part. Before presenting the progress of research in terms of key topics and contributions of Indonesian researchers, the paper first identify key periods and timelines by which publications were published. There are





145 several periods of development in the publications, which are thought to be corresponded to the occurrence on major hazards or disasters events in Indonesia Although the SCOPUS timeline of search is set between 1900 and 2016, the year by which publications on these topics are found to be from 1977 to 2016 (Figure 3).

Figure 3 Number of publications over the year (modified from SCOPUS, 2016b)

- The first period is within the 1970s-1980s period. In this period, there were no significant changes in the numbers of publications produced. Researches in this period were heavily done on the topics of geophysical hazards and risks related to earthquake and volcanic eruption (SCOPUS, 2016b). Within these years, 22 out of 58 events recorded by EMDAT were earthquakes and volcanic activities (EMDAT, 2016). Bali earthquake occurred in 1976 and 1979, which in total caused 1764 deaths, affected 563,150 people, and caused USD 215,150 damages (EMDAT, 2016). The year 1979 was also the year by which the earthquake happened the most (6 times) which occurred in Bali, Lombok, and Biak (near Papua) (USGS, 2016).
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The second period 1990s to 2000s shows a notable increase in literature where on average there were 10 publications per year. This gradual increase in literature mainly corresponds to the literature related to the assessments of hazards, risks and disasters and there is a sharp increase in literature which reached its highest point in 2000 (SCOPUS, 2016b).

- 160 The third period of 2000-2010s was the most dynamic period within the publications on literature. While there was a sharp decline since it reached its first peak in 2000, a surge of publications was started in 2004 which correspond to the Indian Ocean tsunami which hit Indonesia the most. This increase continues ever since. This is also the period when not only publications related to understanding the risks of earthquake and tsunami, but also those related to examining DRR and climate change impacts. The peak occurs between 2010 and 2016 which shows soaring published materials in all topics.
- 165 There are 104 publications in 2015 which is the highest ever produced in a single year. In this period, publications related to climate change and their impact on Indonesia has started to be considered and is expected to still increase in the future. While both publications on hazards group and climate change group are expected to raise, the publications on the DRR shows a trend of decline (SCOPUS, 2016b).

3.1 Major research topics

170 This section presents the more detailed findings of each of the research topics. The author categorizes the final list into three groups (Table 3) in order to show and outline how changes in directions on research have taken place over the years and to reduce heavy unbalance towards findings on hazard and risks assessments toward earthquake and volcanic eruption research.

Table 3 Classifications of findings based on topics of research





175 Table 4 shows the EMDAT-CRED categorization of disaster groups and hazards that is used in this study to help more details analysis related to major research topics. Natural-disaster groups caused by geophysical, meteorological, hydrological, and climatologically hazards are included. Those excluded are disasters caused by biological, extraterrestrial and technological hazard.

Table 4 Categorization of disaster groups included in this study (Source: EMDAT-CRED, 2016)

180 A more detailed examinations on the keywords used are mostly related to place followed by those related to hazards, and risks and disasters. If we look at the locations within Indonesia, the region of Java and Sumatera are the most research locations. This is understandable since both islands are the most at risks from geophysical hazards (USGS, 2016).

The following sub-sections outline research issues discussed within the three groups of topics. Within each, the paper discusses timelines, key discussions and focus areas of the research.

3.1.1 Natural Hazards, risks and disasters assessments

The first sub-section explains findings on the topic of hazards, risks and disasters assessments and identifications. In this study, the hazards, risks and disasters are caused by hydro and hydro-climato-meteorological ones (see Table 4). There are 413 publications in this category (SCOPUS, 2016b).

190 Timeline

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The finding shows that there has been a gradual increase on the number of published materials since 1978 to 1998. It is only in 2000 that the research in this topic reached its first significant outputs of 25 publications, and continued to decline sharply after that. In 2004 the Indian Ocean tsunami occurred and hit Indonesian the most. Publications related the tsunami continued to be published until it reached its peak in 2006. Then in 2009, the publications started to increase rapidly ever since and reached its peak in 2015 of 47 publications in a single year (SCOPUS, 2016b).

Discussions

Most of the literature around this period focuses on the impacts of volcanic eruptions in Java and Sumatera. The oldest publications related to hazards in Indonesia listed in Scopus are those by Neall (1976) on Lahars as major geological Hazards published in the Bulletin of the International Association of Engineering Geology, and one by Nakamura (1978) on

200 the Statistics of tsunamis in Indonesia in the Southeast Asian Studies. In terms of contributions by Indonesia researchers, the earliest papers are by Sudradjat and Tilling (1984) on the Volcanic hazards in Indonesia: the 1982-83 eruption of Galunggung, and Suryo and Clarke (1985) on the occurrence and mitigation of volcanic hazards in Indonesia as exemplified at the Mount Merapi, Mount Kelud and Mount Galunggung volcanoes in the Quarterly Journal of Engineering Geology.





- 205 The study finds that there are the majority of publications are related to volcanic eruption, dominated by the study of volcanoes in Java such (almost half) as Merapi (Verstappen, 1988;Lavigne, 1999;Voight et al., 2000;Andreastuti et al., 2000;Charbonnier and Gertisser, 2008;Gertisser et al., 2012), Semeru (Siswowidjoyo et al., 1997;Carn, 1999;Thouret et al., 2007;Solikhin et al., 2012), Kelud (Lubis, 2014;Nakada et al., 2016) or Ijen (Heikens et al., 2005;Trunk and Bernard, 2008;van Hinsberg et al., 2010). The other hazard that receives many studies is related to examination of earthquakes (more than 30%), how they happened, and methods to assess the impacts. The research on tsunami received gradual attention
- especially after 2004. There are also a small numbers of publications related to landslide (SCOPUS, 2016b).

Focus areas

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The study examines where these researches are focused worldwide, regionally or within Indonesia. The islands of Java and Sumatera are the two areas which receive examinations from the study (more than 70%) (SCOPUS, 2016b). The studies in these two islands are mostly correlated to the study of volcanic eruption, earthquake and tsunami. This is not surprising

considering that Indonesia has the most numbers of volcanoes, is located at the geographical ring or fire where earthquakes occur the most (USGS, 2016). The island of Sumatera has experienced and been impacted by one of the most powerful earthquake of 8.9 R.S which caused tsunami in 2004 and hit Aceh, which is located in the island of Sumatera (Ishii et al., 2005).

220 3.3.2 Disaster risk reduction

The second sub-section is on the topic of disasters risk reduction (DRR). In this study, DRR include those strategies that are aimed to reduce disaster risks which range from risk management, risk reduction and disaster preparedness activities. The definition is listed in Table 3 previously. There are 177 publications in this category (SCOPUS, 2016b).

Timeline

225 There have been very little publications published between 1978 and 2003. It is only after 2004 then there is a gradual increase of publications. The publication reach its peak in 2008, after that it slightly reduced, and then continue to increase and reach another peak in 2013. Only then publications have started to reduce. The oldest publications on DRR category is by Sudibyakto and Haroonah (1997) reviewing how disasters are managed from a social science perspective in the Indonesian journal Geography.

230 Discussions

Figure 4 summarizes the key topics in DRR category.

Figure 4 Key topics in DRR group (Source; modified from SCOPUS results)





The topic that receive most attention in this category is related to the governance of DRR nationally (Bakkour et al., 2015;Chang Seng, 2013;Djalante et al., 2013;Djalante et al., 2012;Guarnacci, 2012;Lassa, 2013). The next topic that receives greater attention is on the evaluation of recover and reconstruction that have taken place after the 2004 Indian Ocean tsunami which hit Aceh, located in the Island of Sumatera (Chang et al., 2011;Daly and Brassard, 2011;Godavitarne et al., 2006;Guarnacci, 2012;Karan and Subbiah, 2011;Telford and Cosgrave, 2007). Within the period after 2004, other topics that are also related to the impacts of tsunami and disasters in general is the role of culture, gender, or religion in helping the community to be resilient in facing disasters, and also how various disasters in Indonesia have impacted various community groups differently in relation to their culture or gender (Baumann, 2008;Donovan, 2010;Donovan et al., 2012;Gaillard et al., 2008b;Islam and Lim, 2015;Balgos et al., 2012;Guarnacci and Di Girolamo, 2012;Hiwasaki et al., 2015;Siagian et al., 2014;Sagala et al., 2009).

Other topics that have been discussed were related to examination of early warning system especially in relation to tsunami early warning system that has been one of the focuses of the Indonesian government to install them around Indonesia. One notable initiative was the German Indonesian Tsunami Early Warning Systems (GITEWS) (e.g. Schlurmann and Siebert, 2011;Steinmetz et al., 2010). There are also a large number of publications which examine the role of knowledge and information to help the community be more prepared to disasters (Dicky et al., 2015;Hiwasaki et al., 2015;Rafliana, 2012). There are 13 publications comparing Indonesia and Sri Lanka in regards the impacts of the tsunami on how it either become

- 250 the precursor for peace process in Indonesia but still take time for the process in Sri Lanka (Enia, 2008;Gaillard et al., 2008a;Hyndman, 2009;Kelman, 2005). Some lower numbers of papers examine community-based DRR which is strongly related to community preparedness (Adiyoso and Kanegae, 2013;Birkmann et al., 2015;Hidayati, 2012;James, 2008;Kusumasari and Alam, 2012), and others examine how children are affected psychologically from continuous exposures to hazards and disasters (Du et al., 2012;Lawler and Patel, 2012;Taylor and Peace, 2015;Vignato, 2012), and on
- emergency management at the local or national level (Esteban et al., 2013;Kusumasari and Alam, 2012;Djalante et al., 2012).

Focus areas

There are more than half focus on Sumatra and Java. However, there are also studies that examine Indonesian from the worldwide, regional or national assessment (SCOPUS, 2016b).

260 3.3.3 Climate change risks, vulnerability, impacts and adaptation

The third sub-section is related to climate change risks, vulnerability, impacts and adaptation. The research on climate change is interpreted broadly in this paper. The author include all materials that discuss on impacts of climate change not only on disasters caused by natural hazards but also those in different sectors such as agriculture, forestry, water and health. This is done since the current Sendai Framework for Action calls for multi-risks perspectives (UNISDR, 2015) .The





265 definitions of these particular topics are listed in Table 3 previously. There are 154 publications in this category (SCOPUS, 2016b).

Timeline

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There have been few publications within the period between 1978 and 1990. The second period between 1990 to 2000 see a slight increase in literature, then there were 5 literatures published in 2001. These are related to examinations on the causes and impacts of the forest fires in Indonesia. The numbers of publications did not change in general until 2008. It is only after 2010 that there is a sharp increase in the numbers of publications and reach its peak in 2015 of 35 papers. The earliest publication was in 1992 by Subijakto (1992) who examine the facts and future trends of climate change: a case study of the

eastern part of the Indonesia islands. Other paper that examine the management of climate change impacts in Indonesia is written by Murdiyarso (1993), in the Chemosphere Journal on the Policy options to reduce CO2 release resulting from
deforestation and biomass in Indonesia.

Discussions

The author categorizes the 154 publications in this group into three major discussions related to the impacts of climate change on Indonesia (almost 60%), on the governance of climate change adaptation (less than 25%), and also on there is a significant numbers of publications related to the issues of deforestation and land degradation which has taken enormous

280 impacts on Indonesian rain forest. Indonesia is one of the countries that house some of the largest coverage of rainforest in the world especially in the islands of Sumatera and Kalimantan. Since the majority of materials published in this category are related to the review on the impacts on climate change in Indonesia, this paper examines deeper on those literature (Figure 5).

Figure 5 Key discussions on impacts of climate change (modified from SCOPUS, 2016b)

- It is shown that the impact on crops production, mainly on rice has been the majority of those researches (Caruso et al., 2016;D'Arrigo et al., 2011;D'Arrigo and Wilson, 2008;Kawanishi and Mimura, 2015;Keil et al., 2009;Naylor et al., 2001;Sano et al., 2013;Shofiyati et al., 2014). This is strongly related to the examination of too much water which can cause flood (Marfai and King, 2008;Marfai et al., 2008;Marfai et al., 2015, 2014;Muis et al., 2015;Neolaka, 2013, 2012;Sarminingsih et al., 2014;Shrestha et al., 2014)or too little water which can or have caused drought in Indonesia
- (Aldrian and Djamil, 2008;D'Arrigo and Smerdon, 2008;D'Arrigo and Wilson, 2008;D'Arrigo et al., 2006;Keil et al., 2009;Keil et al., 2009;Keil et al., 2008;D'Arrigo and Smerdon, 2008;Shofiyati et al., 2014) and fire occurrences (Usman and Hartono, 1997;Fang and Huang, 1998;Brauer and Hisham-Hashim, 1998;Jim, 1999;Stolle and Tomich, 1999;Page et al., 2002;Stolle and Lambin, 2003) especially those on forest fire. There are also research on sea level rise and its impacts on coastal areas. A small number of
- 295 research focuses on temperature, rainfall (D'Arrigo and Wilson, 2008; Aldrian and Djamil, 2008; Chrastansky and Rotstayn,





2012). The impact on health (Coughlan de Perez et al., 2015) and animal (Purnomo et al., 2011;Morwood et al., 2008) has also received some attention.

Focus Areas

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In relation the area by which this research is located, the islands of Sumatera and Java has become the two major locations on the research of the impacts since they are the area where greatest paddy fields and crops productions are located (McCulloch and Peter Timmer, 2008). There are also increasing research related to climate change impacts on different sectors at various locations in Indonesia such as those in Sulawesi and also eastern part of Indonesia have received examinations in some of those studies (SCOPUS, 2016b).

3.2 Progress of Indonesian researchers and organizations

305 Having presented findings on progress of research based on the key topics, timeline and locations in the previous subsection, this sub-section examines the roles of Indonesian researchers and Indonesian organizations in contributing the production of those literatures, and also on how the Indonesian researchers have been in collaborating with other International / non-Indonesian organizations, and also in producing high quality papers.

3.2.1 Authorships

- This study examines authorships of the publications in terms who published the most numbers of papers, and how Indonesian authors have been progressing in terms of publications. There have been extensive discussions on the roles of international and local authorships and collaborations which show that although it rapidly increases, there are still more efforts needed to strengthen and advance those existing collaborations (Bordons et al., 1996;Wagner and Leydesdorff, 2005b, a;Gazni et al., 2012). Studies show that there is still imbalance on the ratio of male to female scientist globally and on an energies and collaborations (2001:Kennel et al., 2002;Sugimete et al., 2013). The importance of
- 315 specific country in general (Sidhu et al., 2009;Lewison, 2001;Koppel et al., 2002;Sugimoto et al., 2013). The importance of science communication and the increasing demand for researchers to publish their works not in traditional methods such as journal articles, but also through blogs, websites, policy briefs, and popular media is now encouraged (Gu and Widén-Wulff, 2011;Thelwall et al., 2013;Bik and Goldstein, 2013).
- 320 Table 5 compare the list of top ten authors with highest number of publications and also the Indonesian authors with 10 highest publications. The comparison shows that out of the 3,000 names obtained from the SCOPUS search, there are more than 2 international authors for every Indonesian author. In general, the contribution of international / non- Indonesian authors dominates the productions of publications. A more striking examination of Indonesia authors with more than 2 publications shows that there are only 54 names, with majorities work for organizations that are located in Java where high
- 325 quality education providers are mostly located (OECD and ADB, 2015), dominated by male researchers and only small minority of these researchers have social media.





As shown in Table 5, Lavigne from Université Paris 1 Pantheon Sorbonne published the highest numbers of papers (Google Scholar, 2016f). Lavigne worked closely with Thouret from Laboratory Magmas et Volcanis, who is in the 4th list (LMV, 2016). Gertisser is a senior lecturer in Keele University (Google Scholar, 2016a). Voight is a renowned geologist and volcanologist in USA who have worked on the Mount Merapi since 1980s (Google Scholar, 2016b). Sieh has long collaborated with Natawidjaja on their works on seismology in Indonesia (EOS, 2016). Surono and Hendrasto are both affiliated with the PVMBG (PVMBG, 2016). Marfai is affiliated at the Gadjah Mada University who has written on the topic of DRR, and also examination of hydro-meteorological hazards and disasters (Google Scholar, 2016c).

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On the Indonesian authors review, the highest publications finally selected for the review of an Indonesian author is 18 publications by Surono of PVMBG. Abidin of the ITB has been listed to have 16 publications in this review, while his Google scholar profile shows that he has published extensively of 172, and with 1513 citations (Google Scholar, 2016d). There are a limited numbers of authors had been involved with publications to the highest IF journals such as Nature and Science. One of these authors is Natawidjaja who has 147 publications with total citations of 2964 based on his Google

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This results show a great deal on the need for increasing the capacity of Indonesian authors to have the skills and experiences in writing in English and submit for internationally regarded journal publications. Indonesian authors largely lack the experience in international collaborations and the language and writing skills necessary for submitting their works into internationally accredited journals. Despite some Indonesian researchers who have been strongly influential within the study of hazards, DRR or climate change in Indonesia and could potentially contribute to the global development of knowledge in these fields, they only published in Bahasa Indonesia and did not submit their works into international English written journals.

Table 5 List of top ten authors with highest number of publications, and top ten Indonesian authors (SCOPUS, 2016b;Google, 2016b;Research Gate, 2016)

3.2.2 Affiliations

Scholar profile (Google Scholar, 2016e).

This section examines the place and organizations by which the researchers are affiliated, systematically from the regional, to national, and amongst organizations in Indonesia. The organizations which house ten most productive publications related

355 to this review are shown in Figure 6. In general, there are equal number of organizations that are based in Indonesia, and their contributions is comprised slightly more than half the overall contributions amongst these most productive agencies. The paper looks deeper on the contribution of different organizations within Indonesia. It is shown that ITB and UGM dominate almost half the total publications. There are also more twice universities in Java that those outside Java, while the rest of publications are contributed by national level organizations such as LIPI and PVMBG.





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360 Figure 6 Organizations with highest number of publications (source: modified from SCOPUS results)

3.2.3 Publications sources

This section presents where the publications are published. It is clear that publications from journal are those that got indexed the great majority, compared to conference proceedings, books, or others. A closer look on the journals shown that journals related to geophysical hazards (related to volcano, earthquake, tsunami, etc) identification and assessments dominate the numbers of papers published on Indonesia (Table 6).

Table 6 List of most submitted journals (source: modified from SCOPUS results)

A very striking finding, however, is when comparing the fifteen of Indonesian journals that got indexed in SCOPUS. The Indonesian Journal of Geography is the only Indonesian journal included in the search with 7 papers listed. The journal was
established in 1961 by the Faculty of Geography, Gadjah Mada University in cooperation with the Association of the Indonesian Geographers. The director of the editorial board is Sudibyakto, with Sartohadi, Lavigne and Marfai as members of the editorial board (UGM, 2016). There are no clear counts on the number of academic journals in Indonesia, however, there are only 245 are accredited by DIKTI (Higher education directorates of the Ministry of Education) (DIKTI, 2016b) and 17 indexed in SCOPUS (DIKTI, 2016a). There are also none of these journals that have obtained an impact factor yet, and hence a Scientific Journal Ranking (SJR) Score is presented (SJR, 2016).

3.2.4 Citations

This section presents the research quality of the publications, measured through the journal impact factors and the number of citations. Most importantly, it evaluates the progress of the Indonesian scholars through comparing their research outputs between papers first authored by Indonesian and overall papers. It does so through comparing the overall progress, and through examination of each research topic group.

In general, the publications in the research topic related to hazards, risks, and disasters outweigh the other two categories. There are more than half materials are written on the topic of hazards, risks and disasters, and the rest is divided almost equally between those on DRR and climate change. The hazards, risks and disasters category also have the highest total

385 numbers of citations, and have more than two third of the citations. An examination on the citation average however show a quite different story, while the climate change literature category has the least number of papers published, the citation average is similar to that of the hazard, risk and disaster category (Table 7).

Table 7 Total numbers of papers, citations and citation average (source: modified from SCOPUS results)





390 10 most cited papers

The paper further examines 10 most cited publications through comparing the roles of those published in general by any authors, and those publications that are published by an Indonesia first author. Figure 7 shows the comparison between the progress of Indonesian researchers in 10 most cited papers overall and those first authored by Indonesian. Important observations are that there are more authors in 10 most cited papers, more international authors in most 10 cited papers, more

395 Indonesians in 10 cited paper first authored by Indonesian, 10 most cited papers have higher impact factor, and 10 most cited papers have higher citations. This might suggest that Indonesians researchers tend to work with other Indonesians and hence needed to expand their collaborations with international scholars as a strategy to increase the number of citations and ability to submit for higher impact journals.

Figure 7 comparing the roles of Indonesian researchers in the 10 most cited papers (source: modified from SCOPUS results)

Table 8 shows the list of 10 most cited papers of all publications. With the 10 most cited papers, the total citations is 3,427 with combined impact factor (IF) is 256.013, and there are only 32% of the authors are Indonesian, and none of them are first authors. It is shown that they are published in high impact factor journals such as Nature, Science, or those related to geophysical hazards. The two highest cited papers are published in Nature Journal and discussed the impacts on the forest fires in Indonesia. The paper related to the examination of the amount of carbon released from peat and forest fires in 1997 has the highest citation of 1156 by Page et al (2002), published in Nature. The majority of the paper discussed major hazards from earthquake in Sumatera (Ishii et al., 2005;Briggs et al., 2006;Hsu et al., 2006;Konca et al., 2008), and the rest review the impacts of Toba (Rampino and Self, 1992) and Merapi volcanic eruption (Voight et al., 2000).

There are 6 papers which also have Indonesians to contribute. Jaya and Limin are both lecturers from the Palangkaraya University in Kalimantan, where this forest fire occurred across the rain forest and impacted not only Indonesia but also the countries in the region such as Singapore (Tay, 1998) and Malaysia (Khandekar et al., 2000). Subarya, Natawidjaja, along with Sieh contributed the most (Briggs et al., 2006;Hill et al., 2012;Horspool et al., 2014;Hsu et al., 2006;Konca et al., 2008;Muhari et al., 2010;Nalbant et al., 2005;Philibosian et al., 2012;Prayoedhie et al., 2012;Schlurmann et al., 2010;Singh et al., 2010).

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A closer examination on the list of ten most cited publications with Indonesian as first author shows a very striking picture. The total citation is only 720, with combined IF of only 23, 492, with 80% of the authors are Indonesian. The papers are much more varied in terms of topics they discussed. There is no single paper in this Table that become the 10 most cited paper overall. The first two most cited papers are related to impacts of climate change in Indonesia. Aldrian (2003), Susanto (2003;2001) and Amien et al (1996) authored papers related to climate change or its impacts on Indonesia. There are papers that examine impacts of volcano (Andreastuti et al., 2000;Widiwijayanti et al., 2009), earthquake (Irsyam et al., 2008) and





tsunami (Muhari et al., 2011), while the rest examine land subsidence in Jakarta (Abidin et al., 2011) and progress of DRR governance nationally (Djalante et al., 2012).

Table 8 Comparing citations authored in general and those first authored by Indonesian in 10 most cited papers (source: modified425from SCOPUS results)

4 Conclusions and recommendations for future research

This paper has outlined an overview of current research trends and progress related to natural hazards, disasters, and disaster risks reduction, as well as increasingly on climate change impacts and governance in Indonesia.

- 430 The first recommendation is that future research agendas need to focus on different hazards, different locations in Indonesia, and other topics in DRR and climate change. It has been shown in this paper that the research have focused mainly on the geophysical hazards and those related to hydro-meteorological hazards only receive attention recently. Assessments of multihazards that combined risks and the associated impacts from geophysical and hydro-meteorological hazards simultaneously are suggested.
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It has been seen that majority of research focus on the Islands of Java and Sumatera. This is expected since both islands are the most at risks from natural hazards in Indonesia. However, other islands in Kalimantan, Sulawesi, Maluku and Papua in eastern part of Indonesia have also been impacted by droughts, floods or strong winds. This is needed to be addressed in the future. The impacts of sea level rise on small islands, drought on forest in Kalimantan and Papua, increase sea water and

440 ocean acidification on fisheries industry in Sulawesi and eastern part of Indonesia, are some of the increasingly worrisome expected from climate change.

More research is needed on the context of urban areas by which social risks and risks from natural hazards play out simultaneously, and the impacts on the urban dwellers are to be understood. As world is increasingly urbanized, there is strong attention on focusing and reducing risks in urban areas through concerted action in a New Urban Agenda from the HABITAT III (UN HABITAT, 2016). Cities in Indonesia like Jakarta, Surabaya or Makassar are rapidly urbanizing and environmental and economic pressures increasing risks the inhabitants (Firman et al., 2011;Larson et al., 2013;Santosa, 2000;Firman, 2016).

450 The governance of DRR has not received many researches especially on the interplay with decentralization which put responsibility for disaster risk management and reduction at the local government level. Many activities done by international and development agencies have focused on the community level. There is abundance of activities reports by





donor and international agencies on their implementations for DRR or CCA programmes (e.g. USAID, 2016;USAID Indonesia, 2011, 2015), however, those reports rarely be made available or submitted for academic publications.

455 There is still greater need for research on climate change topics related to linkages between poverty and disaster vulnerability (Suryahadi and Sumarto, 2003), security (CSIS, 2016), loss and damages (Warner et al., 2012), impacts on key sectors such as fisheries (USAID Indonesia, 2015), coastal communities (Marfai, 2014;Marfai et al., 2008), food security (Measey, 2012;WFP, 2015) and health (Ady Wirawan, 2010;Haryanto, 2009). Strategies and actions for integrating DRR and CCA needed to be explored further (Djalante and Thomalla, 2012), while governance for DRR especially at the local government 460 level has just been initially investigated (Kusumasari and Alam, 2012).

The next recommendation is on the need to strengthen the capacity of research collaborations between Indonesian and international researchers, multi-disciplinarity of research and publications for high impacts journals. It is clear that some of the very limited Indonesian researchers from key universities doing disaster research such as the Bandung Institute of Technology (ITB), Indonesia Institute of Science (LIPI), the Gadjah Mada University (UGM) have been involved in international collaborations, and publications of high impacts journal (QS, 2016). There are only nine universities in Indonesia that are within the list of QS World University Rankings, with University of Indonesia tops the list (QS, 2016). Other universities in the islands of Sumatra, Sulawesi, and Kalimantan and other locations need to put disaster issues as part of their research agendas (OECD and ADB, 2015).

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There is a need for better target of scholars to do more collaboration for research and writing for high impact journals. This goes along with strengthening capacity of researchers and lecturers at the universities to write and publish for international journals. The ministry of Education has indeed conduct the scheme of training and giving incentives for lecturers that have published internationally (RISTEKDIKTI, 2016), however, an overall quality and quantity of papers by Indonesian researchers are still much less that those comparable universities in Malaysia or Singapore (RISTEKDIKTI, 2016).

There is abundance of materials within Indonesian repositories related to *bencana* (disaster in English), especially within the repositories with ITB, UGM, and Unive4rsity of Syiah Kuala in Aceh. These materials and research activities done within the universities needed to be reviewed and submitted for international journals in order to give a broader view on issues that have been discussed by scholars in Indonesia. The Indonesian Association of Disaster Experts was formed in 2014 and has meet annually to discuss their future research guidelines (IABI, 2016). One thing that should be in the agenda is to review current publications in Bahasa Indonesia and collaborations undertaken by Indonesian experts. This will enable better identification of research progress and hence research needs in the future.

485 The list from SCOPUS shows that there is still small numbers of female and of early career researchers.(SCOPUS, 2016b) The first stage is to have proper identification of researchers and make this available to public. The author cannot find





repository of researchers from the ministry of education website, let alone determining their progress, history of schooling and research systematically. There have been some concerns to strengthen the capacity of female researchers globally (Larivière et al., 2013), and also similarly in Indonesia. Early career researcher (ECR) is defined as those who are within 8 years after PhDs or within 6 years of trainings (AHRC, 2016). While globally there has been some systematic efforts to strengthen the capacity of ECR such as trough mentoring (Clarke, 2004;Kram and Isabella, 1985), there is no clear strategies for the Indonesian ERC done by the Indonesian governments. International journals (Elsevier, 2016) and international and other national research council's (RCUK, 2016) in have allocated resources and funding research specific for ECR.

- 495 There is increasing call for a more inter-disciplinarily collaborations so that complex problems on the social and environmental issues can be understood better and problems identifications can target those in needs better (Future Earth, 2016). Although we can see from the list that some of the most prominent authors are not only from universities but also from national level government agencies. The roles of private business and the communities at risk have rarely been part of the research and collaborations. It is also not clear how collaborations amongst scientists from social and physical scientist
- 500 have taken place in Indonesia. It is also not clear how or whether science (Wagner and Leydesdorff, 2005a), policy and industry (Lee, 1996) collaborations have taken place and be documented in these listed publications. These collaborations are important to face complexities of future problems (Leydesdorff and Wagner, 2008), and also to help achieve the outcomes of the Sustainable Development Goals (Nations, 2016)
- 505 In conclusion this study has been able to determine the progress in research related to natural hazards, risks, and risk deduction and climate change in Indonesia. It has also been able to examine the roles of Indonesian scientist in collaborations and towards high quality publications. The recommendations are outlined toward these two issues and it is the responsibility both by the Indonesian and international organizations that have and going to work in Indonesia to be able to meet the needs in order for Indonesia to better understood and manage its natural hazards and risks in the future.

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Figure 1 Risks map of Indonesia (OCHA-ROAP 2011) showing the Islands of Java and Sumatra as most at risks.







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Figure 2 Comparing between the impacts of geophysical and hydro-meteoro-klimatological disasters (modified from EMDAT, 2016)



Figure 3 Number of publications over the year (modified from SCOPUS, 2016b)

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Figure 4 Key topics in DRR group (Source; modified from SCOPUS results)











Figure 6 Organizations with highest number of publications (source: modified from SCOPUS results)







Natural Hazards and Earth System Sciences Discussions

1000 List of Tables

Table 1 Disaster impacts in Indonesia from 1900 - 2016 (E	EMDAT, 2016)
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Disaster type	Occurren ces	Total deaths	Number of People Affected	Number of People Injured	Number of People Homeless	Total Number of People affected	Total damage (´000 USD)
Earthquake	115	198,487	7401,192	171,429	1,556,548	9,129,169	11,695,926
Volcanic activity	56	18,310	1,294,297	3,731	23,500	1,321,528	530,390
Drought	10	9,340	4,804,220	0	0	4,804,220	160,200
Flood	172	6,555	9,445,598	255,197	183,295	9,884,090	6,422,047
Landslide	53	2,423	356,696	540	40,015	397,251	120,745
Mass movement (dry)	1	131	651	50	0	701	1,000
Storm	12	2,013	28,715	243	1,290	30,248	1,000
Wildfire	10	319	3,443,664	478	0	3,444,142	25,429,000
Total	429	237,578	26,775,033	431,668	1,804,648	29,011,349	44,360,308

Table 2 Analytical approach for the systematic review (Berrang-Ford et al., 2015)

Topics	Descriptions
Research questions and aim	Explicit
	Clear description
Data sources and document selection	Justification and description of sources
	Articulation of search term
	Description of inclusion and exclusion
	Documentation of literature included and excluded
Analysis and presentation of results	Description of method for analysis
	Critical appraisal of information quality

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Table 3 Classifications of findings based on topics of research

Major topics groups	Definitions (IPCC, 2012;UNISDR, 2009)
(1) hazard, risks,	Hazards: A dangerous phenomenon, substance, human activity or condition that may cause loss
disasters assessments	of life, injury or other health impacts, property damage, loss of livelihoods and services, social
(HRD)	and economic disruption, or environmental damage.
	Risks: The combination of the probability of an event and its negative consequences.
	Disaster: A serious disruption of the functioning of a community or a society involving
	widespread human, material, economic or environmental losses and impacts, which exceeds the
	ability of the affected community or society to cope using its own resources.
(2) disaster risk	The systematic process of using administrative directives, organizations, and operational skills
management or	and capacities to implement strategies, policies and improved coping capacities in order to
reduction (DRR)	lessen the adverse impacts of hazards and the possibility of disaster (UNISDR).
	The concept and practice of reducing disaster risks through systematic efforts to analyze and
	manage the causal factors of disasters, including through reduced exposure to hazards, lessened

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Major topics groups	Definitions (IPCC, 2012;UNISDR, 2009)
(3) climate change vulnerability, impacts and adaptation (CC)	 vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCCC). The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (UNISDR).

Table 4 Categorization of disaster groups included in this study (Source: EMDAT-CRED, 2016)

Disaster Group	Disaster Subgroup	Definition	Disaster Main Type	Disaster Sub-Sub-Type
Natural	Geophysical	A hazard originating from solid earth.	Earthquake	Ground shaking, tsunami
		This term is used interchangeably with the term geological hazard.	Mass Movement Volcanic activity	Ash fall, lahars, Pyroclastic flow, Lava flow
	Meteorological	A hazard caused by short-lived, micro- to meso-scale extreme weather and atmospheric conditions that last from	Extreme Temperature Fog	Cold wave, heat wave, severe winter conditions
		minutes to days.	Storm	Extra-tropical storm, Tropical storm, Convective Storm (Derecho, Hail, Lightning/thunderstorm, Rain, Tornado, Sand/dust storm, Winter storm/blizzard, Storm/surge, Wind)
	Hydrological	A hazard caused by the occurrence, Flood Coa movement, and distribution of surface Rive and subsurface freshwater and Flas saltwater Ice	Coastal flood Riverine flood Flash flood Ice jam flood	
			Landslide	Avalanche (snow, debris, mudflow, rockfall)
			Wave action	Rogue wave, seiche
	Climatological	A hazard caused by long-lived, meso-	Drought	
		to macro-scale atmospheric processes ranging from intra-seasonal to multi- decadal climate variability.	Glacial Lake Outburst Wildfire	





 Table 5 List of top ten authors with highest number of publications, and top ten Indonesian authors (SCOPUS, 2016b;Google, 2016b;Research Gate,

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 2016) NoP=Number of Publications (SCOPUS, 2016b), SC§ SCOPUS (publications, citations, h-index, most frequent collaborator), GS& Google Scholar

 profile (publications, citations, h-index, i10-index), RG% Research Gate profile (publications, citations, impact points)

Author	Organizati on / Country	NoP	SC §	GS &	RG %	Other profile	Indonesian Author	Org aniz atio n	NoP	SC §	GS &	RG%	Other profile
Lavigne, Frank	France / Université Paris 1 Panthéon Sorbonne	28	62, 1152, 19, more than 150,	124, 164 8, 21, 34	153, 1,43 0, 162. 61		Surono	PV MB G	18	27, 348, 12, 125, Hendrast o M			https://en.w ikipedia.or g/wiki/Suro no_(volcan ologist)
Surono	Indonesia / PVMBG (Volcanolo gy Survey Indonesia)	18	27, 348, 12, 125,			https://en. wikipedia. org/wiki/S urono_(vo lcanologis t)	Abidin, H.Z.	ITB	16	53, 493, 11, 121, Andreas H		119,77 3,99.2 1	http://www .fitb.itb.ac.i d/en/hasan uddin.abidi n/
Abidin, Hasanud din Zainal	Indonesia / Institute Teknologi Bandung (ITB)	16	53, 493, 11, 121, Andreas H	172, 151 3, 19, 35	119, 773, 99.2 1	http://ww w.fitb.itb. ac.id/en/h asanuddin. abidin/	Natawidjaja, D.H.	LIPI	11	42, 1913, 21, 123, Sieh KE	147, 296 4, 25, 33	123, 2788, 376.31	
Thouret, Jean- Claude	France / Laboratory Magmas er Volcanis	16	114, 1147, 20, More than 150,Gourga ud, A			http://pen dientedem igracion.u cm.es/info /agr/partic ip/cv/thou ret.html#	Marfai, M.A.	UG M	11	19, 183, 8, 36, King, Lorenz	79, 517, 12, 14		http://arism arfai.staff.u gm.ac.id/m ain/?page_i d=44
Gertisser , Ralf	United Kingdom / Keele University	15	42,684,468, 14,aboce15 0,Charbonni er SJ	86,1 009, 19, 29	87 803 132, 51	https://ww w.keele.ac .uk/gge/pe ople/ralfg ertisser/	Hendrasto M	PV MB G	10	16, 92, 4, Surono			-

Natural Hazards and Earth System Sciences



Author	Organizati on / Country	NoP	SC §	GS &	RG %	Other profile	Indonesian Author	Org aniz atio n	NoP	SC §	GS &	RG%	Other profile
Voight, Barry	USA / Pennsylvan ia State University	14		313, 818 5,53 ,128	250 5,30 7 570. 75		Andreas, H.	ITB	10	20, 123, 6, 46, Abidin, H Z			
Sieh, Kerry.	Singapore / Earth Observator y of Singapore	13	120, 5752, 43, more than150, Natawidjaja , DH			http://ww w.earthob servatory. sg/people/ kerry-sieh	Ratdomopur bo, A.	NTU	8	17, 441, 10, 59, Lühr, B G			
Natawidj aja, Danny Hilman	Indonesia / LIPI	11	42, 1913, 21,123, Sieh KE	147, 296 4, 25, 33	123, 278 8, 376. 31		Muhari, A.	MA AF	8	15, 112, 6, 53, Imamura, F	49,5 22,1 2,12	36, 217, 23.05	
Marfai, Muham mad Aris	Indonesia / UGM	11	19, 183, 8, 36, King, L	79, 517, 12, 14		http://aris marfai.staf f.ugm.ac.i d/main/?p age_id=44	Sumarti, Sri.	UG M	8	14, 367, 13, 84, Surono			
Hendrast o, Muham mad	Indonesia / PVMBG (Volcanolo gy Survey Indonesia)	10	16, 92, 4, 59, Surono	NA			Suwargadi, BW	LIPI	7	31, 1102, 17, 103, Natawidj aja, DH	97, 158 5, 20, 24		





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Table 6 List of most submitted journals (source: modified from SCOPUS results)

1	0	1	5
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Publications	Number of	IF / SJR		Category	7
	papers		HRD	DRR	CC
Journal of Volcanology and Geothermal Research	75	2.543	Х		
Natural Hazards	39	1.719	х	х	
Natural Hazards and Earth System Science	27	1.735	х	х	
Bulletin of Volcanology	22	2.519	Х		
Geophysical Research Letters	17	4.196	х		
Earth and Planetary Science Letters	16	4.734	х		
Pure and Applied Geophysics	15	1.618	х		
Nature	14	41.456	х		Х
Journal of Disaster Research	14	SJR 0.18		х	
Journal of Geophysical Research: Solid Earth	12	3.426	Х		
International Journal of Disaster Risk Reduction	12	SJR 0.510		Х	Х
Bulletin of the International Institute of Seismology and Earthquake Engineering	12	SJR 0.12	Х		
Geomorphology	11	2.785	Х		
Disasters	10	0.742			
International Journal of Remote Sensing	9	1.652	Х		
Bulletin of the Seismological Society of America	7	2.322	х		

Table 7 Total numbers of papers, citations and citation average (source: modified from SCOPUS results)

Main research topics	Numbers of papers	Numbers of citations	Citation average
Hazards, risks, disasters	412	3386	8.22
(HRD)			
Disaster risk reduction	177	668	3.77
(DRR)			
Climate change (CC)	154	1237	8.03
Total	744	5291	-

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	H	3.1 57	4.1 96	5.5 24
	Indonesia n author(s)	Aldrian E., Dwi Susanto R.	Susanto R.D.,	Amien I., Rejekining rum P., Pramudia A., Susanti E.
	Authors	Aldrian E., Dwi Susanto R.	Susanto R.D., Gordon A.L., Zheng Q.	Amien I., Rejekining rum P., Pramudia A., Susanti E.
	No of citatio ns	282	137	46
onesia	Journal Name	Internatio nal Journal of Climatol ogy	Geophysi cal Research Letters	Water, Air, and Soil Pollution
by Ind	Ye ar	3 200	1	66 6
First authored	Title	Identification of three dominant rainfall regions within Indonesia and their relationship to sea surface temperature	Upwelling along the coasts of Java and Sumatra and its relation to ENSO	Effects of interannual climate variability and climate change on rice yield in Java, Indonesia
	H	41.4 56	41.4 56	41.4 56
	Indonesia n author(s)	Adi Jaya and Suwido Limin (Universit y of Palangkar aya, Kalimanta n)	1	1
	All Authors	Page S.E., Siegert F., Rieley J.O., Boehm HD.V., Jaya A., Limin S.	Siegert F., Ruecker G., Hinrichs A., A.A.	Ishii M., Shearer P.M., Houston J.E.
	No. of citatio ns	1156	473	355
	Journal	Nature	Nature	Nature
Overall	Ye ar	200	1	5 500
Authored (Title	The amount of carbon released from peat and forest fires in Indonesi a during 1997	Increase d damage from forests during droughts caused by El Niño	Extent, duration and speed of the 2004 Sumatra- Andama n earthqua ke by the by the Hi-Net array

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- dar h h atra- iqua	66	Nature	326	Subarya, Chlieh, Prawirodir djo, Avouac, Bock, Sieh, Meltzner, Natawidjaj a, McCaffrey	Subarya, Prawirodir djo, Natawidjaj a,	41.4 56	A detailed tephrostratigr aphic framework at Merapi Volcano, Central Java, Indonesia: Implications for eruption predictions and hazard assessment	0 00	Journal of Volcanol ogy and Geother mal Research	67	Andreastut i S.D., Alloway B.V., Smith I.E.M.	Andreastut i S.D.,	43
anic er erat atio ving r- tion	199 2	Nature	307	Rampino M.R., Self S.		41.4 56	Land subsidence of Jakarta (Indonesia) and its relation with urban development	1	Natural Hazards	49	Abidin H.Z., Andreas H., Gumilar I., Fukuda Y., Pohan Y.E, Deguchi T.	Abidin H.Z., Andreas H., Pohan Y.E.,	1.7
of of atra ilt, nesi	0 0	Journal of Geophysi cal Research: Solid Earth	281	Sieh, Natawidjaj a	Danny Natawidjaj a	3.42 6	Building resilience to natural hazards in Indonesia: Progress and challenges in implementing the Hyogo Framework for Action	2 201	Natural Hazards	30	Djalante R., Thomalla F., Sinapoy M.S., M.	Djalante R., Sinapoy M.S.,	1.7
iiona erslip wing 005	200 6	Science	246	Hsu YJ., Simons M., Avouac J P.,	Natawidjaj a D., Prawirodir djo L	33.6 1	The role of fire in changing land use and livelihoods in	200 4	Ecology and Society	29	Suyanto S., Applegate G., Permana	Suyanto S., Permana R.P., Khususiya	3.3

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	ndonesia IF t uthor(s)	N., curniawan	Auhari A., 1.7 35	
	Authors In n au	R.P., h Khususiya K h N., I. Kurniawan I.	Muhari A., M Imamura F., Koshimura S., Post J.	
	No of citatio ns		27	
lonesia	Journal Name		Natural Hazards System Science	
l by Ind	Ye ar		11	
First authored	Title	Riau-Sumatra	Examination of three practical run- up models for assessing tsunami impat on highly populated areas	
	IF		33.6	
	Indonesia n author(s)	(LIPI)	Natawidjaj a D., Suwargadi B Hananto N., Suprihanto I., Prayudi D., (LIPI) (LIPI)	
	All Authors	Galeteka J., Sieh K., Chlieh M., Natawidjaj a D., Prawirodir djo L., Bock Y.	Briggs R.W., Sieh K., Meltzner A.J., Natawidjaj a D., Galetzka J., Suwargadi B., Hsu YJ., Simons M., Hananto N., Suprihanto I., Prayudi D., Prawirodir djo L., Bock Y.	
	No. of citatio ns		211	
	Journal		Science	
Overall	Ye ar		66	
Authored (Title	Simeulue earthqua ke, Sumatra	Deformat ion and slip along the Sunda megathr ust in the great 2005 Nias- carthqua ke	

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All Authors		K., Fang P., Li Z., Galetzka J., Cenrich J., Chlich M., Natawidjaj a D.H., Bock Y., Fielding E.J., Ji C., Helmberg er D.V.
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