A Method for Assessing Household Vulnerability to Flood at Regencial (Kabupaten) Level in Indonesia

Muriadi*, Andy Fefta WIjaya

Faculty of Administrative Science, Brawijaya University

Abstract

A simplified method for assessing household vulnerability to flood in regencial level in Indoneisa is proposed in this paper. Two components of assessment proces is discussed, namely: Mapping the floods and its hazards and investigation of vulnerable elements and aspects. It is argued that complex flood mapping can be simplified using historical information on past flooding to develop a relation between probability of occurrence versus magnitude, and investigation of vulnerable households and aspects of their lives which can be carried out by in-depth interview or any relevant qualitative approaches. Flood hazards map can drawn based on flood types, while four aspects of household dimension namely food, housing, livelihood and health are focused in the investigation.

Keywords: assessment, flood-hazards, Indonesia, vulnerability

INTRODUCTION

Within recent decades, damaging flood occurrence is increasing whole over the world, including most parts of Indonesia, which has many floodplain area. UN (Undated) stated that on a global basis, there is evidence that the number of people affected and economic damages resulting from flooding are on the rise at an alarming rate. Increasing climate warming and its variability is one of factors that contribute to increasing risk of flooding (Wetherald and Manabe, 2002). While, Kundzewicz et al (2007) mentioned that precipitation intensity, volume, timing, antecedent conditions of rivers and their drainage basins, as well as human encroachment into floodplains and lack of flood response plans increase the damage potential. On the other side, urbanization also exacerbates the size and frequency of floods and may in turn expose communities to increasing flood hazards (Konrad 2013). In many develepong countries, pursuing economic prosperity often much depends on the extraction of natural resources. Consequently, much of environmental problems accompanying resource depletion are exacerbated by development policy (Redclift 1991 p.20). Therefore, natural disasters including flood are not merely natural phenomena but a consequent of human activities. Whatsoever, people in floodplain area that originally take advantage from flooding, now are becoming vulnerable to the natural phenomena.

In such increasing magnitude and frequency of floods, assessing people vulnerability to flood is also increasingly important, whether as a part of risk management system, or for policy support requirements. The main purpose is to inform decision-makers or specific stakeholders about options for adapting to the impact of flooding hazards (Douben 2006). By studying vulnerability, it can also be recognized correct actions that can be taken to reduce vulnerability before the possible harm is realized (Balica 2007). A vulnerability analysis and assessment can also be used to identify the emergency responses that may be required, including the need for temporary shelters and evacuation requirements (UN undated). Therefore, IPCC (2012) in its summary for policy makers mentioned that disaster risk management and adaptation to climate change focus on reducing exposure and vulnerability and increasing resilience to the potential adverse impacts of climate extremes, even though risks cannot fully be eliminated. Generally speaking, without vulnerability assessment, it is hard to formulate appropriate policies for coping with hazardous events and improving resilience of element at risks.

THE COMPLEXITY OF ASSESSMENT OF VULNERABILITY TO FLOOD

There is a complexity in the process of vulnerability assessment. It comes from theoretical and practical complexities of the terms that have to be used. Flood for example can be defined as the inundation of a normally

* Corresponding Address:
Muriadi
Email : muriadi@yahoo.com
Alamat : Fakultas Ilmu Administrasi, Universitas Brawijaya, jl. Veteran, Malang

dry area caused by rising water in an existing waterway, such as a river, stream, or drainage ditch (NOAA 2010). While, flooding is a term to emphasize on the effects of flood as a distinct from the flood itself, and briefly can be define as overflowing by water of the normal confines of a stream or other body of water, or accumulation of water by drainage over areas that are not normally submerged (WMO 2011). Using of both terms in some extent is hardly distinguished.

Another complexity comes from defining vulnerability it-self. The term is used in broad area with different meanings (Barroca et al. 2006, Ballica 2007, Ballica 2012). Turner et al (2003) define vulnerability as the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor. Simpler definition is proposed by IPCC (2012) which describes vulnerability as the propensity or predisposition to be adversely affected. Blaike et al (1994) stated that vulnerability means the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard. While, Balica (2007) defines vulnerability to flood as the extent to which a system is susceptible to floods due to exposure, a perturbation, in conjunction with its ability (or inability) to cope, recover, or basically adapt. Previously, United Nations (1982) have already expressed flood vulnerability as the degree of loss to a given element, or a set of such elements, at risk resulting from a flood of given magnitude andexpressed on a scale from 0 (no damage) to 1 (total damage).

Smit and Pilifosova (2003) formally express vulnerability in a formula as follow:

***Vist = f* (*Eist, Aist*)**

where

Vist : vulnerability of community *i* to stimulus *s* in time *t*

Eist : exposure of *i* to *s* in *t*

Aist : adaptive capacity of *i* to deal with *s* in time *t*

From above definitions, at least there area three components must be considered in any vulnerability analysis: exposure to hazards, susceptibility or sensitivity of elements at risks and adaptive or resilience capacity of the exposed elements.

Exposure is the probability of the element at risk to be present while the event occurs (EXCIMAP 2007). Susceptibility or sensitivity can be understood as the elements being exposed within a system, which influence the possibilities of being harmed in time of hazardous floods (Balica 2012). Resilience is capability of humans to endure hazardous effects of floods. Furthermore, Turner et al (2003) define hazard as threats to a system that comprised of perturbations and stress (and stressors), and the consequences they produce.

Generally, vulnerability can be divided into four different types that interconnected one another:

1. Physical vulnerability is how structures or built environment might impacted by hazards;
2. Social vulnerability is related to inability of population, whether in group or individual to withstand harms caused by hazardous events;
3. Economic vulnerability is how economic resources impacted by hazards;
4. And environmental vulnerability is how environmental health affected by hazards

Basically, approaches to vulnerability analysis can be divided into two types: quantitative approaches and qualitative approaches. Quantitative approaches try to measure the degree of harms caused by potential hazards to the exposed elements. In this approaches, thus vulnerability is a hypothetical and predictive term, which can only be proven by observing the impact of the event when, and if, it occurs (Blaike et al. 1994 p58). Flood Vulnerability Indices by Balica (2012) is one example to quantitative approaches in vulnerability analysis. In Qualitative Approaches, vulnerability is viewed as the quality of specific elements in coping with hazards. Therefore, in this approaches vulnerability is an evaluative and analytic term.

Further, vulnerability analysis always related to broader purpose, such as risk management or mitigation and prevention programs. In term of that, vulnerability analysis can also be viewed from two perspectives: structural and non-structural. Structural perspective focus on environment and physical aspects such as built structures, topography etc. Non-structural approaches emphasize on human behaviour including policy and administrative actions.

In Indonesia, assessment of vulnerability to flood is still lack of attention. Focus is still much weighted on structures and physical aspects. Analysis usually emphasized on detail of specific area such as nearby rivers or dams. The perspective of analysis is also merely on civil engineering or structural perspective. While for non-structural perspective, such as social and

human security aspects, is less emphasized. Therefore, it is important to establish a method of assessment for large area of flood prone which covers a regency.

Regency (Kabupaten) is a government level in Indonesia below province. It is characterized by rural area. Contrary to urbanized area of municapility (Pemerintahan Kota). A regency consists of several sub districts (Kecamatan). Furthermore, a sub districts coordinates several villages, the smallest autonomous government in the country.

A PROPOSED METHOD FOR THE ASSESSMENT OF VULNERABILITY TO FLOOD

Ideally comprehensive vulnerability analysis is that one which considers the totality of the system (Turner et al 2003). However, consider totality of the system is almost impossible to be achieved. It is related to the fact that components linked to vulnerability are broad. The most reasonable way is that at least a vulnerability analysis considers the population and structures at risk within the flood-prone area (UN undated).

Assessment of Vulnerabilities must always be related to a specified threat (or hazard), and the central questions are including which groups of people are vulnerable to what and why (IFRC, 1996). However, it is important to realize that vulnerability is not merely registered by exposure to hazards (perturbations and stresses), but also resides in the sensitivity and resilience of the system experiencing such hazards (Turner et al. 2003)

As vulnerability is not a stand-alone concept, the model of assessment should at least combine two steps namely:

1. Mapping the floods and its hazards
2. Investigation of vulnerable elements and aspects

Mapping the flood and its hazards

Flood maps are indispensable tools to provide information about hazards, vulnerabilities and risks, and to implement the necessary preventive and preparedness measures (EXCIMAP 2007). In a complex analysis, a lot of effort is needed to map a flood prone area which is important in vulnerability analysis. Bringing various environment systems into consideration requires enormous resources. Topography and structures are amongst complex systems that may affect the nature of flooding. However, all the complexities can be simplified. UN (undated) for example has explained a probability-based analysis wherein systematic records and historical information on past flooding are used to develop a relation of probability of occurrence versus magnitude. Simply, a flood map can be drawn from historical data on flooded villages or sub districts collected from government's records or any relevant sources including satellite images and media reports. Media is important as in many areas, data from government institutions may hardly accessed or lack of availability.

By using historical data, hazardous events and the impacts can be mapped in which areas can be grouped in ranks or classes. For instance, area with most often experience to flood can be categorized as highly potential flooded area. The rest can be grouped as medium and low potential. This grouping is important in policy prioritization and management purposes.

Flood hazards can be drawn as layers in a map in regard to flood characteristics. Alexander (1993 p.135) stated ten critical characteristics of floods that may influent the adaptation methods namely: depth, duration, area inundated, flow velocity, frequency and recurrence, lag time, seasonality, peak flow, shape of rising and recession limbs, and sediment load. The extent of hazards can be expressed in qualitative scale based on historical experience to the hazards. However, the simplest way to map flood hazards is by drawing it in flood types. Since, every type of flood has its own characteristics. The other way is to map the flood by type. It is easier because every type of flood has its own characteristics. It is also common that specific area experience certain type of flood only.

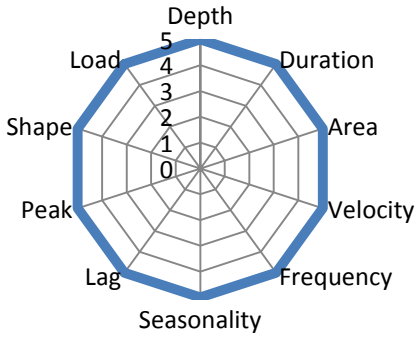

Figure 1: Extent of Flood Hazard by Flood Characteristics

World Meteorological Organization (WMO 2011) mentions ten types of flood that has its own characteristics, namely: flash flood, fluvial flood, urban flood, estuarine flood, single event flood, multi event flood, seasonal flood, coastal flood, snowmelt flood and ice- and debris- jam flood. Some of the mentioned types of flood are overlap each other in their characteristics. In Indonesia, some types of above-mentioned flood are not known. Therefore, to easily distinguish their characteristics and hazards for further analysis and assessment purposes, flood can be categorized into at least four main types: flash flood, riverine slow-onset flood (fluvial flood), urban flood and coastal flood.

Flash flood is one type than can be happened anywhere. It is also one of most dangerous types of floods. The prior characteristic is on the velocity or speed of water flow. Water in a higher place collected and gathering until suddenly flows in huge amount along flood way. It is how flash flood originally happened. It can be a natural caused flash flood and human-caused flash flood. Broken dam is one example of human-caused flash flood that extremely dangerous.

Riverine slow-onset flood commonly happened in large floodplain areas. It is also one of the most common types of floods. It can be happened when rainfall extensively pours large area. Water collects to small rivers and streams to gather to larger river. This causes gradual increase of river's surface. As a consequence, this type of flood can covers a very large area.

Another type of flood commonly found is urban flood. It is happened when rainfall water unable to flow smoothly because of lack of drainage system or hardly infiltrate soil because of extensive concrete-covered land. Urban flood much related to human activities rather than natural phenomena.

Coastal flood is the increase of sea water level exceeding its normality. It can be happened due to storm or earth gravity. As its name, coastal flood is happened in coastal area. Tsunami can be also categorized as coastal flood as it happens in coastal area. Tsunami usually comes following earthquake under sea floor. One single tsunami can cause a very devastative disaster.

Investigation of vulnerable households and aspects of their lives

One of the purposes of flood mapping in the assessment process is to identify area under scrutiny. After mapping process end, the next step is investigation to know vulnerable people is carried out. The aim is to understand how flood hazard impacts people. It is focused on knowing who is vulnerable to flood, where the people live and in what aspects are they more vulnerable. It can be done mainly but not limited by in-depth interview.

Vulnerability is closely related to exposure to hazard. Those who have no possibility to be exposed to certain hazard would not be directly vulnerable. Therefore, vulnerability analysis should first identify who have probability to be exposed to hazards. This can be explained by mapping flood prone area. People who live in flood prone area basically are they who potentially vulnerable to flood. However, vulnerability is not merely about exposure to hazard. Therefore, Investigating characteristics of exposed population also must be done. Those who have more propensities to be adversely affected by flood hazard are those vulnerable. For example, damage of certain crops will directly influence those population groups that rely their livelihood on the crops types.

In particular population, there might be certain groups exposed to the same hazard but has different vulnerability. People under poverty might be differently vulnerable to flood with those middle-income families, very young children might be more vulnerable than adults, female might also more vulnerable than male.

To know who and where do vulnerable people live, in-depth interviews are carried out to investigate how particular groups (elements) are vulnerable to flood. Result of the investigation can be used to identify groups of population that should be paid attention in the policy making. Knowing who and where, is not enough without understanding of in what aspects do they vulnerable. Therefore, in the vulnerability assessment, at least four aspects of household should be investigated, namely: food, housing, livelihood and health. Other aspects can be added depends on policy requirements. However, the four aspects are central question and represent afore-mentioned four types of vulnerability.

Food insecurity is common happening during flood. It is one of the most important indicators to determine household vulnerability to disaster. Some important indicators in this aspect include percentage of households dependent on family farm for food, percentage of households that do not save food, and percentage of household that do not save seed (Hahn, Riederer and Foster

2009). Qualitatively, the questions in the investigation of food vulnerability to flood are focused on dietary during and soon after the flood. A certain group of household may be impacted more than others. The impact is both in terms of adequacy and quality of the food.

The other question is on how household get food supply. This question is aimed to know source of food supply of people. They who get supply from their normal sources are more resilience. People who rely on their own stocks are also resilience. However, those who rely on aid, help or owe to other people are vulnerable.

Housing is another aspect that should be investigated in the vulnerability assessment. Investigation is focused on whether how houses can be used as shelter during flood. House that cannot be used as save shelter during flood is vulnerable. Shelter means not only for human but also to properties such as furniture and appliances. The probability of the house to be damaged by flooding is also taken into account.

Livelihood vulnerability to flood can be investigated by looking on how livelihood is potentially disrupted. Disruption of livelihood means disruption to the source of income. Civil servants for example may not able to do their occupation during flood, but it does not mean they will lose their income. The other condition may be different for farmers or fishermen. Family whose sources of income potentially adversely affected are vulnerable.

Period of livelihood disruption may far beyond the period of flood occurrence. Farmer family for example may experience longer period of livelihood disruption due to damage of their crops. Since, it is required longer time to re-cultivate their land. This reality should be investigated to give a brief picture of livelihood vulnerability to flood.

A more quantitative approach can also be used in the livelihood vulnerability assessment. At least there are three indicators can be assessed: percentage of households with family member working in a different community, percentage of households dependent solely on agriculture as source of income, and average agricultural livelihood diversification (Hahn, Riederer and Foster 2009).

While, for health component, some indicators can be used to assess the vulnerability including: family members with illness, exposure to contagious diseases, and accessibility to health centres and facilities.

CONCLUSION

Increasing occurrence of damaging flood in the world including Indonesia requires a development of methods for assessing vulnerability to flood. The perspective of analysis should combine structural and non-structural approaches. In Indonesia, household vulnerability to flood can be assessed in regencial (Kabupaten) level using a simplified method.

Simplified method for assessing household vulnerability to flood can be done through two approaches: mapping the flood and its hazards which can be achieved by using historical information on past flooding to develop a relation between probability of occurrence versus magnitude, and investigation of vulnerable households and aspects of their lives which can be carried out by in-depth interview or any relevant qualitative approaches. This simplified method is not a fixed process for all area. Adaptation and modification might be required in the application. Specificity and uniqueness of an area should be taken into account to achieve a better assessment results.

REFERENCES

Alexander, David. 1993. Natural Disasters. UCL Press Limited. University College London. UK

Balica, Stefania Florina. 2007. Development and application of flood vulnerability indices for various spatial scales. Unesco-IHE. Delft.

Barroca, B.,Bernardara, P.,Mouchel, J. M., and Hubert, G. 2006. Indicators for identification of urban flooding vulnerability. Nat. Hazards Earth Syst. Sci., 6, 553–56. Copernicus GmbH)

Blaike, Piers., Cannon, Terry., Davis, Ian., and Wisner Ben. 1994. At Risk; Natural Hazards, People's Vulnerability, and Disaster. Routledge. London and New York.

Douben, N. 2006. Flood Management, UNESCO-IHE, Lecture Notes. In Balica (2007) Development and application of flood vulnerability indices for various spatial scales. Unesco-IHE. Delft

EXCIMAP/ European Exchange Circle on Flood Mapping. 2007. Handbook on Good Practices in Flood Mapping in Europe. EXCIMAP. EU.

Hahn, Micah B., Riederer, Anne M., and Foster, Stanley O. 2009. Livelihood Vulnerability Index: A pragmatic approach to assessing risks from climate variability and change—A case study in Mozambique. Global Environmental Change 19:74-88. Elsevier ltd.

IFRC/ International Federation of Red Cross and red crescent societies. 1996. Vulnerability and

Capacity Assessment, International Federation of Red Cross and red crescent societies.

IPCC/Interngovernmental Panel on Climate Change. 2012. Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.). A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1-19.

Konrad, Christopher P. 2013. Effects of Urban Development on floods.US Geological Survey.Fact Sheet 076-03.Pdf.

Kundzewicz, Z.W., L.J. Mata, N.W. Arnell, P. Döll, P. Kabat, B. Jiménez, K.A. Miller, T. Oki, Z. Sen and I.A. Shiklomanov. 2007: Freshwater resources and their management. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 173-210.

NOAA/the National Oceanic and Atmospheric Administration . 2010. Definitions of flood and flash flood. Retrieved from http:// www.srh.noaa.gov/mrx/hydro/flooddef.php. on 6/8/2013 at 12:10

Redclift, Michael. 1991. Development and the environmental crisis: Red or Green Alternatives?.Routledge. New York. USA

Turner, BL., Roger E. Kasperson, Pamela A. Matson, James J. McCarthy, Robert W. Corell, Lindsey Christensen, Noelle Eckley, Jeanne X. Kasperson, Amy Luers, Marybeth L. Martello, Colin Polsky, Alexander Pulsipher, and Andrew Schiller. 2003. A framework for vulnerability analysis in sustainability science. PNAS: 100; 14. Retrieved from: www.pnas.org_cgi_doi_10. 1073_pnas.1231335100

UN/United Nations (undated) Guidelines for Reducing Flood Losses.United Nations. Retrieved from http://www.unisdr.org/ files/558_7639.pdf on 6/9/2013 at 13.25

UN/United Nations. 1982. Proceedings of the seminars on flood vulnerability analysis and on the principles of floodplain management for flood loss prevention, September, Bangkok

Wetherald, R.T. and Manabe, S. 2002. Simulation of hydrologic changes associated with global warming. J. Geophys. Res.,107 (D19), 4379, doi:10.1029/ 2001JD001195.

WMO/World Meteorological Organization. 2011. Manual on Flood Forecasting and Warning. WMO No. 1072. Geneva. Switzerland.