Implementable land use plan in Volcano Prone Area in Indonesia: Challenges and Opportunities

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Abstract
From the point of view of a land use planner, implementation of land use planning in volcano prone area may serve as one of the methods to reduce the impacts if a volcano erupts. Land use plan may include zoning regulations that limit the intensity of development while also take into consideration current development that takes place in volcano prone area. This paper aims to provide a possibility to incorporate of volcano hazard issues into land use planning. The case study focuses at the southern slope of Mt. Merapi. An observation to the two sub-districts (Pakem and Cangkringan) located on the slope of Mt. Merapi shows that many hamlets and villages reside at the hazard zones, including zone 3 as the most dangerous zone. To assess the socio-economic condition of the residents, a questionnaire survey was carried out to the residents living on 14 hamlets at the two sub-districts. The survey shows unique relationships between occupation of residents, location of the settlements and the hazard zone of the volcano. This finding suggests a dependency of the communities to the resources provided by the volcano. Therefore, in their point of view, the volcano is seen as the opportunity rather than a risk. Thus, applying a land use plan through exclusionary zoning to the communities living in this area will not work successfully. This paper systematically identifies the main challenges and suggests some possible opportunities to implement land use planning in reducing the volcano risks to the communities. The policy implications of these findings for local government in volcano hazard management are also discussed.

Keywords: hazard zone; land use plan; volcano; disaster risk reduction.

1. Introduction
Within the last five years (2004-2009), Indonesia has been hit by many natural catastrophic disasters (earthquakes, tsunamis, volcanic eruptions, floods, etc). The risks and losses due to these disasters have been huge, partly due to the disasters occur in inhabited places whether in urban or in rural areas. Some of these problems can be attributed to the development of the built environment at hazard prone areas (e.g. floodplains, lowland at coastal areas, close to volcano, earthquake faults, etc). While the benefit from constructing to the built environment at hazard prone areas maybe high, some the impacts (costs) that are ignored could be much higher and therefore the total value (benefit and cost) of the development could be negative (cost > benefit). To minimize this issue, land use plans are argued as one of the tools that can be effective in reducing this negative value (Brody, 2003a; Brody, 2003b; Burby, 1998; Burby and Dalton, 1994; Burby and French, 1981).

Located at the pacific ring of fire, Indonesia has more than 100 active volcanoes (SI-USGS, 2009). Most of the volcanoes are inhabited since they offer many sources of economy to the inhabitants (fertile land, cold climate, tourism). Despite the benefits, a volcano also poses risks to the inhabitants living nearby. In the volcanic crisis situation, the residents have to evacuate and leave their place in time (Perry and Godchaux, 2005) in order to minimize the risks for lives while still suffer losses to their belongings (damages to houses, crops, cattle, etc). The idea of
The dark red colour is the most dangerous zone or hazard zone 3, no permanent settlement is allowed. The pink colour is the hazard zone 2, settlements are allowed but the residents must evacuate during the high intensity of the volcano. Image courtesy of Volcanology Survey of Indonesia (2006)

Hazard zone 3 is located near the hazard source, and frequently affected by pyroclastic flows, lava flows, rock falls and ejected rock fragments (Hadisantono et al., 2002). According to the standard by Volcanological Survey of Indonesia, hazard zone 3 is applicable only for volcanoes which are very active and erupt frequently. Permanent settlement in hazard zone 3 is not allowed. Hazard zone 3 can be regarded as an exclusionary zones or controlled access area (Perry and Godchaux 2005). In contrast, in this area there have been more than a century people living, particularly in Turgo Hamlet where inhabitants have resided there since more than a century in order to get away from the tax imposed by the Dutch colonial (Schlehe, 1996).

Hazard zone 2 is classified into two groups, namely areas which are affected by mass flow (pyroclastic flows, lava flows and lahars) and ejected material (thick dry volcanic ash fall, volcanic bombs and other ejected rocks) (Hadisantono et al 2002). In the case of increasing activity of the volcano, people living in hazard zone 2 should prepare for the evacuation.

Hazard zone 1 is relatively safer than hazard zone 2 and zone 3. They are located far at down stream of the volcano but still have a possibility to be affected by secondary and primary
impacts of the volcano. However, the residents living along this area need to be aware of the possible damage posed by the volcanoes.

Similarly, the Sleman District Government also provides a land use plan as a way to manage the development and minimize the disaster risks. Figure 2 illustrates the overlay between the hazard zoning suggested by VSI and the land use plan proposed by Sleman District Government. The overlay can be seen from the red and dark red colors at the north part of the map.

![Figure 2 Map of Land Use Plan in Sleman District, Yogyakarta](source: www.kabsleman.go.id)

However, it is still questionable whether the policy of hazard zones works successfully or not. The following research questions can be proposed to analyze this policy. To what extent do the residents (living in the areas) understand that they area located at zone 2 and zone 3? How does the residents depend their living on the resources provided by the volcano? To what extent the current land use plan at Sleman District reflect the hazard zones proposed by Volcanology Survey of Indonesia?

In overall, this paper attempts to examine the hazard zone policy applied by Volcanology Survey of Indonesia and the land use plan applied by Sleman District. It takes into consideration the current practices by the local residents, to what extent the practices have followed the hazard zone policy and the land use plan.

2. Literature

The importance of land use plan in disaster risk reduction has been long proposed by urban and regional planners. Burby and French (1981) argue “the conventional ways of dealing with that problem” are to limit the hazard (e.g., flood control programs), limit buildings’ susceptibility to...
damage (e.g., wind, flood, and earthquake, building codes), and limit individuals' and communities' exposure to financial loss (e.g., insurance and disaster relief). Furthermore, they suggest that the impact of “limiting development” in areas at risk would minimize the potential for losses of lives and property in large hazardous events and may provide protection for sensitive environmental features. For her study in an earthquake prone area, Cartago City, Costarica, Montoya (2002) argues that hazard zoning is still an important approach to reduce the risks posed by natural disasters. Similarly, Brody (2003b) highlights the importance of land use plan to accommodate the issues of ecosystem management by taking it into the land use management.

Despite many literatures propose the importance of land use plan, however, the implementation of the hazard-zone based land use plan to reduce the risk remains low. Lavigne and Gunnel (2006) provided the examples from their observation to several volcanoes in Central Java, Indonesia. They further noted that the residents living at the slopes of the volcanoes cultivated tobaccos, potatoes and many agricultural plants despite the dangerous that might be posed by the volcanoes.

Nevertheless, there are some doubts on how land use plan can deal with the hazards that people are facing. Kelman and Mather (2008) noted, “avoiding the hazards”, such as through land use plan and hazard zoning implementation”, may not always work. In many cases, the impacts of the volcanic eruptions are not local and are sometimes global. Therefore, any place on the surrounding of the volcanoes can be affected and is not exclusive from the hazards that may occur. In the study at flood plain areas in the Philippines, Sagala et al (2007) also found that it is the residents themselves that ignore in implementing the land use plan. Despite flooded for two weeks in a year, the areas that they are living are close to the markets. Therefore they sacrifice the flood risks to other types of risks which are much higher for them (livelihood risks).

As argued above, land use plans offer several advantage to minimize the disaster risks that people are dealing with. However, when it comes to implementation, in hazard prone, it is challenged by many factors. Not only is it unable to fully provide an exclusive safe zone to the people, but also other types of risk also play role in the resident considerations. Thus, it is necessary to identify a land use plan that can be implementable to reduce disaster risks. This will be discussed in the following sections with the focus on land use plan and hazard zoning in Mt. Merapi, Yogyakarta.

3. Survey Methods
Located at the north of Yogyakarta City and the border of Yogyakarta and Central Java provinces, Mt. Merapi is one of the active volcanoes and has many inhabitants living at it’s surrounding. According to the recent records (Ratdomopurbo et al 2006), the return period of the volcanic eruption of Mt. Merapi is at least once within a decade. The last big eruptions occurred in 2006 and forced most of the inhabitants to evacuate further down slope to the evacuation shelters for about two months.

For this research, the study areas are selected at two sub-districts in Sleman District located at the southern slopes of Mt. Merapi: Pakem and Cangkringan sub-districts. Fourteen hamlets (small villages) at these two sub-districts are selected with the total number of respondents interviewed was 322 people. The respondents were selected randomly from the lists provided by each of head of small districts. The hazard zones (zone 2 and zone 3) from VSI were used as the basis to select the hamlets. 6 hamlets from zone 3 and 8 hamlets from zone 2 were selected to get similar distribution among zones.
As mentioned in the research questions at the introduction section, the survey assessed the following issues: socio-economic condition of the residents (source of livelihoods, income), perception of the volcanic hazards and understanding of the hazard zones proposed by the VSI. The survey was carried out for four weeks within January – February 2008 with the assistance of some volunteers from a local NGO. Further detailed of the questionnaire designs and methods can be referred to Sagala (2009).

4. Results and Discussions

From the observation, it is indicated that most residents surveyed in Pakem and Cangkringan sub-districts work as agriculture farmers, sand miners, and dairy farmers (see Figure 3 and Figure 4). These three types of occupations are related to the resources found at and provided by Merapi volcano. The fertile land and cool climate to raise the cattle are due to the high altitude while the abundance of sand materials is produced after an eruption. The high amount of sands and rocks produced after an eruption may provide a lot of opportunities for the residents. Not only they can build their own houses from the materials but also they can sell the materials to the city and earn money.

*Figure 3 Livelihood Sources in Mt. Merapi*

Both pictures above: The residents work as sand-miners and collect the sand and rocks to the trucks. Picture below: an old woman with came back from collecting grass to feed cattle.

Images courtesy of Saut Sagala (2008)

From the field survey, it was found that the average income of each household is around 100 USD / month. This amount of money is still found to be better than the income of the poor in the normal Indonesian cities. In term of economic condition, thus, the residents living at the slopes of Mt. Merapi have adequate sources of income. This finding suggests that the residents of Mt. Merapi are encouraged to stay at their areas since a lot of economic opportunities are available in their area.
Figure 4 Percentage of Occupation of respondents in Mt. Merapi

Note a respondent may have more than one type of occupation and therefore the total number respondents who have occupation are more than 100 percent. Source: field survey (2008)

If Figure 4 is analyzed with respects to the hazard zones, it will result Figure 5 that explains the distribution of the occupation on the basis of zones. It is still found in Figure 5 that in both zones, agriculture farmers, sand miners, and dairy farmers are the main occupations. However, the percentage distribution of the occupation slightly changes as compared to those of Figure 4. Zone 2 is more dominated by agriculture farming activities while zone 3 is more dominated by dairy farming and sand mining activities.
Furthermore, figure 5 suggests that the respondents live much closer to the volcano (zone 3) and depend much on their sources of livelihood from the volcano: sand mining and dairy farming. Therefore, when they were asked to move permanently by the local government, they were reluctant to do so. As this was also noted after an eruption in 1994 where many people from Turgo hamlet were relocated to Sudimoro, a hamlet located 8 km down of Turgo, most of the respondents returned to their origin despite the settlements provided by the government. The failure of this government program, identified by Dove (2008), is due to its inability to identify and accommodate the sources of livelihood of the residents into the government’s program. This finding further suggests that the risks posed by the volcanoes are perceived lower than other types of risk that people face. It can be inferred also that the respondents see the living on the slopes of the volcanoes provide higher benefits than the costs that they have to deal.

From the questionnaire survey on the residents’ perception of the volcanic hazards it was found that most of them understand that they live at volcanic prone areas (77%). However, when they were asked in detailed on what types of hazards that could affect them, most of them could not provide a clear answer. This could be due to their lack of knowledge on the volcano hazard phenomena and how they can be affected by the hazards as also noted by Lavigne et al (2008). The residents also did not understand whether they live in hazard zone 2 and zone 3 though the implication and the risks of living in each zone are different (see introduction). Therefore, the aim of the VSI and Sleman District to provide the information (maps) to the residents is yet to be improved.
On the other hand, despite the reluctance of the respondents to follow the suggestion of land use plan and hazard zones provided by Sleman District Government and Volcanology Survey of Indonesia, the disaster risks should still be reduced. Therefore it is important to identify other ways to deal with this problem.

5. Conclusion: Challenges and Opportunities
This paper examines the importance of hazard zones and “limited zones” in land use plan to reduce the risks that people will face if there is an eruption. In a volcano prone area, it is true that a hazard zone is required to limit the dangerous zones and reduce the risks to the residents. However, the implementation of land use plan to reduce the risks is still low. This paper identifies the challenges and the opportunities as follows.

The challenges to implement a land use plan to reduce the risks can be due to the low level of acceptance and understanding by the residents to the land use plan provided by the government. Low level of acceptance occurs because the residents’ interests are not fully covered by the land use plan. For example, when the current area that they live is assigned one-sidedly by the government as a limited area, they do not have other option but to ignore. Low level of understanding is because the respondents do not clearly comprehend the dangerous posed by the governments. In more practical views, the residents see the socio and economic reasons are more important than the disaster risks that may only occur once in a while. As the examples from the case study infer, the residents who are dependent to the volcano, will be hesitant to leave their place and their belongings.

Nevertheless, there are some opportunities that can be done to improve the implementation of land use plan. First and foremost, it should be understood clearly what risks that the residents deal with. The risk is not only in the form of volcanic risks, but also other risks. People may be safe from the volcanic risks but could be at risk of losing their sources of income if they are relocated or removed from their current area. Therefore, other approach that could be introduced is to integrate the land use plan with other types of plan that aims to reduce the risks. This could be done by integrating the land use plan with a more detailed emergency and evacuation plan.

Other opportunity is to involve the stakeholders in assessing the current land use plan. When one party does not agree and see the importance of the land use plan, it is important to clearly address the problem. For example, if the residents see that they do not need to move, they will not follow the land use plan. To deal with this, there should be a further commitment between the government and the residents. This can be addressed by calculating the benefits and costs of each activity. For example, if the residents need to move and they have to face a certain amount of cost, does the government have the capacity to compensate or not? If not, then other way should be found to deal with this issue.

The main issue is to find the solution that can be able to optimize the value of sustainable development at disaster prone area. Therefore, it is important to integrate the land use plan that is able to accommodate the development, with other emergency plan that is able to prepare in reducing the risks.

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