

Participatory three dimensional mapping for the preparation of landslide disaster risk reduction program

Eko Kusratmoko, Adi Wibowo, Sofyan Cholid, and Tjong Giok Pin

Citation: [AIP Conference Proceedings](#) **1857**, 110001 (2017); doi: 10.1063/1.4987120

View online: <http://dx.doi.org/10.1063/1.4987120>

View Table of Contents: <http://aip.scitation.org/toc/apc/1857/1>

Published by the [American Institute of Physics](#)

Participatory Three Dimensional Mapping for the Preparation of Landslide Disaster Risk Reduction Program.

Eko Kusratmoko^{1a)}, Adi Wibowo¹⁾, Sofyan Cholid²⁾, Tjong Giok Pin¹⁾

¹Department of Geography, Faculty of Mathematics and Science, Universitas Indonesia

² Department of Social Welfare, Faculty of Social and Political Science, Universitas Indonesia

^{a)} Corresponding author: eko.kusratmoko@ui.ac.id & kusrat.eko@gmail.com

Abstract. This paper presents the results of applications of participatory three dimensional mapping (P3DM) method for facilitating the people of Cibanteng' village to compile a landslide disaster risk reduction program. Physical factors, as high rainfall, topography, geology and land use, and coupled with the condition of demographic and social-economic factors, make up the Cibanteng region highly susceptible to landslides. During the years 2013-2014 has happened 2 times landslides which caused economic losses, as a result of damage to homes and farmland. Participatory mapping is one part of the activities of community-based disaster risk reduction (CBDRR), because of the involvement of local communities is a prerequisite for sustainable disaster risk reduction. In this activity, participatory mapping method are done in two ways, namely participatory two-dimensional mapping (P2DM) with a focus on mapping of disaster areas and participatory three-dimensional mapping (P3DM) with a focus on the entire territory of the village. Based on the results P3DM, the ability of the communities in understanding the village environment spatially well-tested and honed, so as to facilitate the preparation of the CBDRR programs. Furthermore, the P3DM method can be applied to another disaster areas, due to it becomes a medium of effective dialogue between all levels of involved communities.

INTRODUCTION

The success of sustainable disaster risk reduction and efficient must put the people that live in disaster-prone areas (local communities) as subjects who participated. [1]. The involvement of local communities is a prerequisite for sustainable disaster risk reduction. [1]. Local communities are those, both the main victims and those who were respond firstly when disaster strikes. They are people whose survival and well-being at stake. Community-based disaster risk reduction (CBDRR) encourage threatened community participation in the evaluation of risk (including hazard, vulnerability and capacity) as well as ways to reduce it. CBDRR should be able to empower communities by using self-development suit to their culture for solving crisis caused natural disasters. [1,2].

Participatory mapping is one part of CBDRR activities. Participatory Mapping Approach is a mapping method that put communities as mapping subject at their areas, also they performed as plan maker for developing their own region. [3]. Mapping products are not just has a cartographic meaning but reflect knowledge and social and agenda of the local community [4,5]. At present, the growing participation mapping such as based on geography information system (Participatory Geographic Information System or P-GIS) and participatory three-dimensional mapping (Participatory three-dimensional mapping) or P3DM. P-GIS has been applied widely in the last 20 years in many countries around the world, particularly in regional planning, land conflict resolution, environmental issues, and disaster risks reduction, both for people in rural and urban areas mainly [6.,7,8]. But compared to the others, the application of P3DM for CBDRR activities is still relatively limited. [1,8,9,10,11].

P3DM is essentially a three-dimensional model of the building that has a reference earth geographic scale and coated with a layer of thematic geographic information, such as land use, roads, rivers, and other important information (see Figure 1). This model is clearly visible and tangible, making it easier for everyone to understand, absorb and interpret geographic information. Three-dimensional model of raising awareness of local communities

will be its territory, provide stakeholders with a powerful media for land-use management and serves as a tool to organize effective community [6].

Cibanteng village, Sukaresmi District, Cianjur Regency is picked as case study in this activity, due to those area is one of regions categorized vulnerable to natural disasters. Physical factors of region (high rainfall, topography, geology and land use) and coupled with the condition of demographic factors, social and economic make this area extremely vulnerable to natural disasters, especially landslides and flooding[12]. During the period 2004-2012 this village was recorded as the village experienced frequent occurrence of landslides / soil movement. [13]. The Last occurrence landslides that happened at Cibanteng village occurred at May 15, 2013 and January 29, 2015. The landslides that happened in Cibanteng village at 15 May 2013 have damaged 57 houses and 17 of hectares agricultural land [14]. This paper describes the application of the three-dimensional participation in frame CBDRR at Cibanteng village, district of Sukaresmi, Regency of Cianjur, West Java Province.

METHODS

Study Area

Geographically Cibanteng village located in the northern part of the Cianjur regency with an area of 1331 ha. The village is located in the hilly area with altitude between 325 m asl to 926 m asl. Most of the area (about 43% of the village's area) located at altitude above > 500 m asl and the area with slope of 15-25% dominated by the proportion of about 60% (see Figure 1 and 2) Rice Field, mixed garden and non-irrigated field ("tegalan" in bahasa) are the type of land use which dominate in Cibanteng with area of 1125 ha (about 84%), while the remaining forest area recorded only 178 ha (13%).

The total population of Cibanteng village in 2014 recorded 5097 people, consisting of 2718 men and 2397 women, so the population density of Cibanteng village is 4 people per ha, with a number of households about 1516. Most of the population works in the agricultural sector.

Activity Phases

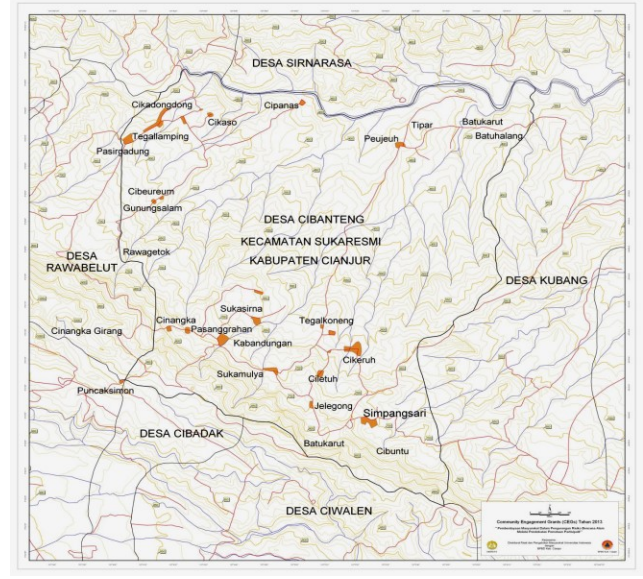
Participatory mapping three-dimensional (PP3D) carried out through the following steps:

Coordination: The research team has coordinated the Regional Disaster Management Agency (RDMA or BPBD in bahasa) of Cianjur Regency, as a local government agency that sets policy of disaster management, as well as the coordinator for implementation of disaster management. Results of the meeting with BPBD stated that village Cibanteng as the implementation place of participatory mapping activities. Furthermore, researcher and BPBD staffs conducted coordination with the Cibanteng village chief. Results of coordination, schedule of activities was determined and the Village Head Cibanteng set 20 community members involved in the activities, consisting of the chairman of Hamlet, Youth organizations, women's organizations and village officials.

Preparation : The team from the University of Indonesia prepared a three-dimensional map of Cibanteng' village based on framework of topographic map with scale of 1: 25.000 which was enlarged up to A0 size (the size of the horizontal scale of 1: 6500, and the vertical scale magnification of 1.5 times). The map created using thick cardboard with a 3 mm with basic plywood boards with a thickness of 1 cm. The presented information covered road networks, river, name of places, name of rivers, land use and disaster and disaster-prone areas. Information of land use were obtained by interpretation of Quick Bird imagery for 2012, while information of disaster areas were resulted from the activity of participatory mapping or P-GIS mapping.

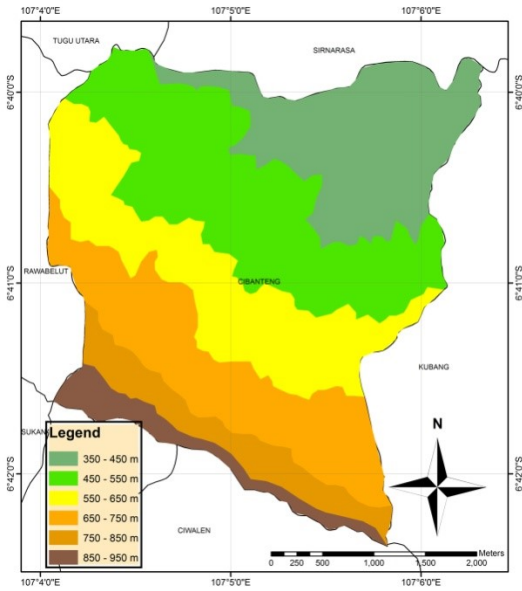


(a)

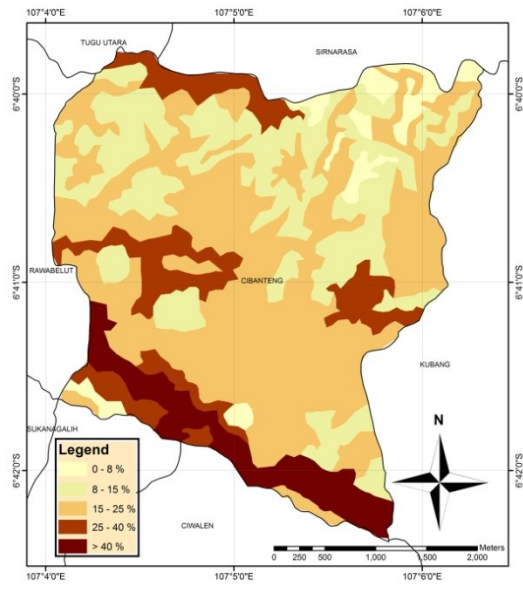


(b)

FIGURE 1 (a): Three Dimensional Map of Cibanteng Village. (b): Study Area, Cibanteng Village, Sukaresmi District, Cianjur Regency, West Java Province (Source : Topographical Map scale 1 : 25.000 Geospatial Information Agency).



(a)



(b)

FIGURE 2 : Elevation Map (a) and Slope Map (b) of Cibanteng Village, Sukaresmi District, Cianjur Regency, West Java (Source : processed from topography digital data scale 1:25.000, Geospatial Information Agency)

Focus group Discussion: 20 participants involved in the discussion group, composed of 10 men and 10 women, and 4 people as facilitators. Most participants (12 people) just graduated from elementary school, and partly graduated junior high school, and only 3 people who graduated high school.

Group discussions were held for 3 days and all participants were divided into two groups representing each organization. Subject of discussion includes 2 main material, namely first, to identify more closely the environment of the Cibanteng Village and second, to prepare of disaster risk reduction programs. The first material trying to express about a spatial knowledge of the participants, especially the knowledge of geographical names (the name of the hamlet, river names), knowledge of the characteristics of landslides and landslide-prone areas, and knowledge of the environment in which they live. While the second material tried to elaborate the ability of participants in preparing disaster risk reduction programs, particularly landslides.

RESULT AND DISCUSSION

Results of Participatory Three-Dimensional Mapping (P3DM)

Group discussion is done interactively and it was begun by measuring knowledge of local communities about their neighborhood specifically and Cibanteng village generally. Each participants is given time to observe 3-dimensional model of the map Cibanteng village and gave his opinion that related to physical environment of his village. Results of the discussion guided by team facilitator of UI can be described as follows (see also Figure 3):

1. Geography names which were written based on RBI map scale 1:25.000, such as name of villages, name of rivers, can be corrected about writing mistake and also participant could create for those have not got name
2. Administrative boundaries of Cibanteng village can be corrected directly by the participants.
3. Participants could find out the physical environment at his closest environment well, particularly in relation to vulnerable or not their place of residence against the landslide hazard. Using a push-pins (points), yarn (lines), and paint (polygons). participants could mark the disaster-prone areas and safe areas from disaster.
4. In general, participants have already known about impact of tree logging and farming in areas with steep slopes.



FIGURE 3. The atmosphere of the group discussion application of participatory three-dimensional mapping for arranging the disaster risk reduction program, Cibanteng Village, Sukaresmi District, Cianjur Regency.

On second and third days, participants were invited to participate in arranging reduction program of disaster risk in Cibanteng village and presented its results. Preliminary results of group discussion, participants could compose the programs of disaster risk reduction. The program can be classified into three main programs namely, programs of environmental management, programs of preparedness capacity building and disaster response capacity and program of socialization about disaster especially landslide.

In the environmental management program, participants believe the importance of tree planting activities in areas of steep slopes and the former landslides. They suggested that trees planted are valuable trees, such as mangosteen tree, clove and nutmeg. The trees have a high economic value and long-lived. Other activities they are proposing was making village regulations on the prohibition of cutting down trees in areas prone to landslides.

Program for Capacity building and disaster response preparedness. In this case, participants have not been able to arrange any activity. They need to coordinate with the BPBD of the Cianjur regency to arrange activities that can be organized.

Socialization program on disasters, especially landslides, participants noted the importance of the role of mothers and children. For that the proposed activities are to enable the role of women's group in the socialization of disaster for women, and activating the role of religious education, particularly the teaching activities at the mosque, for children and teenagers. All of the programs and activities that have been prepared would be finalized in the group discussions are larger and involve all existing stakeholders.

P3DM for Arranging the CBDRR Program: Challenges and Opportunities

Referring to the indicators presented by McCall and Pinang [7] the success of P3DM activities that conducted in Cibanteng village can be described as follows:

1. Legitimacy and participation of communities: This is based, that the determination of the participants P3DM were set by the village chief. It was still possible because of political factors, because the selection of village chief through direct elections recently held in the village of Cibanteng. Whether participants in the activities of PP3D really represent the whole communities, it needs to be tested further in the next activity
2. Empowerment: P3DM particularly provides an opportunity for all stakeholders to address issues associated with disaster risk around the same table at the same time, thus facilitating a fair and power-balanced dialogue amongst the members of upper and lower as well as outside stakeholders such as scientists, NGOs and government agencies. In the particular context of DRR, P3DM further provides a tangible view of vulnerabilities and capacities. Bringing these two concepts into discussions with local communities is often tricky. Vulnerability and capacity are abstract concepts, even when disasters have previously occurred in the area. One of the contributions of P3DM for DRR is therefore to render these concepts tangible and to lay the foundations for assessing disaster risk [8].
3. Transfer Process of Disaster and Mapping knowledge: At activity of PP3D, the spatial knowledge of local communities could be seen through their capabilities for correcting mistakes of place's name, village administrative boundaries, showing locations where prone areas to landslides and delineating its areas and their ability down the locations they considered hazardous in case of heavy rain. The spatial knowledge of male group were more comprehensive (covering the whole village) than female group who were more familiar with its neighborhood.

CONCLUSION

the results of participatory three-dimensional mapping (P3DM) showed the ability of communities to understand their village environment spatially well-tested and honed, so as to facilitate the preparation and implementation of CBDRR program. P3DM particularly provides an opportunity for all stakeholders to address issues associated with disaster risk around the same table at the same time, thus facilitating a fair and balanced dialogue. Further the P3DM method can be applied to the other hazard prone areas, because this method is as a means space effective dialogue between all levels of society are involved.

ACKNOWLEDGMENTS

The team of authors would like to thank the University of Indonesia through DRPM that has facilitated these activities through the Grant Program of CEGs (Community Engagement Grands) University of Indonesia for the 2013 and 2014 batches 2. Thank you, we would like to RDMBPBD, Cianjur Regency and head of Cibanteng village for support and assistance facilities so that these activities can be run well.

REFERENCES

1. Gaillard, J-C & E. A. Maceda (2009) Participatory three dimensional mapping for disaster risk reduction. In *Participatory Learning and Action* 60 (Edt. H. Ashley, N. Kenton, and A. Milligan). IIED.
2. Cadag, J. R. D. & J-C. Gaillard (2012) Integrating knowledge and actions in disaster risk reduction: the contribution of participatory mapping. *Area* 44(1), 100-109.
3. Hidayat, R. Wisnu Adhi & Dianto Bachriadi (ed.) (2005): *Mengenalkan Pemetaan Partisipatif*. Seri Panduan Pemetaan Partisipatif. Jaringan Kerja Pemetaan Partisipatif (JKPP). Bandung.
4. Corbett, J. M. And Keller, C. P., (2005), 'Empowerment' and 'Participatory Geographic Information' and 'Multimedia' Systems: Observations from Two Communities in Indonesia. *Information Technologies and International Development*, 2(2): 25:44.
5. Di Geissa, Stefano (2008) Participatory mapping as a tool for empowerment. International Land Coalition. Italy, 45 pp
6. Rambaldi, Giacomo; and Jasmin Callosa-Tarr (2002) *Participatory 3-Dimensional Modelling: Guiding Principles and Applications*. Los Banos: ASEAN Regional Centre for Biodiversity Conservation (ARCBC).
7. Sujatmiko (1972) *Peta Geologi Lembar Cianjur, Jawa*, skala 1:100.000. Direktorat Geologi, Bandung.
7. McCall, M. K & P. A. Minang (2005) Assessing participatory GIS for community-based natural resources management: claiming community forests in Cameroon. *The Geographical Journal*, Vol. 171, No. 4, pp. 340-356.
8. Gaillard, J-C, C. Monteil, A. Perrilat-Collomb, S. Chaudhary, M. Chaudary, O. Chaudary, F. Giazzi, and J. R. D. Cadag (2013) Participatory 3-dimension mapping: a tool for encouraging multi-caste collaboration to climate change adaptation and disaster risk reduction. *Applied Geography* 45, 158-166.
9. Maceda, E. A., J. C. Gaillard, E. Stasiak, V. Le Masson, & I. le Berrethe (2009) Experimental Use Of Participatory 3-Dimensional Models In Island Community-Based Disaster Risk Management. *International journal of Research into Island Cultures*, Vol. 3 Number 1.
10. Bobb-Prescott, N. 2014. Case study on the use of participatory three dimensional modelling to facilitate effective contribution of civil society in the Caribbean islands in planning for action on climate change. CANARI Technical Report 401, Laventille.
11. Kienberger, S. (2014) Participatory mapping of flood hazard risk in Munamicua, District of Búzi, Mozambique, *Journal of Maps*, 10:2, 269-275, DOI: 10.1080/ 17445647.2014.891265.
12. Arifin, Z (2010): *Pola Spasial Kerentanan Bencana Alam (Studi Kasus Kabupaten Cianjur)*. Tesis Magister Geografi, Universitas Indonesia. Depok.
13. Badan Penanggulangan Bencana Daerah (BPBD) Kabupaten Cianjur (2012) *Laporan Tahunan*, Cianjur.
14. Kusratmoko, Eko, Tjong Giok Pin & Sofyan Cholid (2013) *Pemberdayaan Masyarakat Dalam Pengurangan Risiko Bencana Alam Melalui Pendekatan Pemetaan Partisipatif*. Laporan Akhir Hibah CEG's UI.