

# Evaluation of Participatory Mapping to Develop Parcel-Based Maps for Village-Based Land Registration Purpose

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## Abstract

*Validating land boundaries and their ownership status have become a huge task to be completed by local land offices in Indonesia. In order to accelerate the validation process, government-facilitated participatory mapping processes which have been endorsed by many local land offices. This study examines the applicability of participatory approaches in validating land boundaries for supporting land registration processes. Aerial photo-map was used as the base to plot land parcels, which later was used to produce a working map. Field surveys were conducted to verify land boundaries. The availability of participatory land parcel map was not only useful to accelerate land registration processes, but was also able to serve as a visual tool which helps anticipating boundary disputes and land development at village level. The results of the study shown that participatory map contributed in improving quality of land registration map but suffers level of detailing in respect to actual shape and area of land boundaries.*

## 1. Introduction

Parcel-based maps are useful for various spatial analysis purposes. Parcel-based map has detailed attributes which is used to support planning and supervision activities that involves the analysis of parcel-based GIS (Geographic Information System), such as: (a) land use monitoring (Bin et al., 2014), (b) land use and spatial planning (Drake, 1992, Lu, 2001 and Stone & Norman, 2006), (c) spatio-temporal modelling Land Information Systems (Heo, 2001), (d) land market monitoring, land banks and mortgage control (Hermosilla et al., 2012), and (e) environmental control. Since, the parcel-based map shows boundaries and all the information regarding the ownership status of the land parcel in great detail, so huge task of georeferencing of land certificates for validating the boundaries and ownership status fall on to the shoulders of Local Office (Kantor Pertanahan/Kantah) of National Land Agency (BPN). These tasks need to be done to support “one-stop shop principle” of land registration and cadastral services (Samborsky and Popiv, 2015), in Indonesia which is similar to “one map policy” (Peraturan Presiden No.9, 2016; Undang-undang No.4, 2011). The “one map policy” have a paradigm of “create once, use many” similar with the model of WORM “write once read many” (Narayanamurthy et al., 2015). The availability of parcel-based spatial data in Indonesia has not been fully completed. As per the data from Kementerian ATR/BPN (Ministry of Spatial Planning/National

Land Agency), the estimated number of land parcels registered in Indonesia are 44.5 million parcels (44.5%) of the total 100 million parcels (Ministry of Spatial Planning/National Land Agency, 2014). In order to accelerate the process of completing land parcel map through georeferencing and validation activities, government-facilitated participatory mapping processes have been adopted by many local land offices. However, data quality is still the main reason behind the uncertainty of cadastre authorities in various places to apply participatory-based cadastral data collection methods (Keenja et al., 2012). Esmaili et al., (2013) mentioned that it can be due to the heterogeneous sources of data as well as the inconsistency of participatory mapping contributors’ skills. Hence, data quality assurance needs to be conducted adopting the “Accurate, Assured, Authoritative” principle (Williamson et al., 2012).

Flanagin and Metzger (2008) highlighted the aspect of utilization of public participation in spatial data collection. Although, it has not been adapted much in the society mainly because of the difficulty in shifting the paradigm from old habits (authorities produce and define spatial data) to the new approach (participatory based). Therefore, GIS or spatial data generated from public participation should be validated by the relevant authorities. The use of participatory approach as a method of collecting spatial or land-related data needs to get a bigger role

without underestimating the aspect of data quality control. The data which were collected by the method of participatory approach is currently growing very rapidly and engaging communities across the world (Haklay et al., 2010). Walter and Ye (2004) stated that this approach is the most effective and efficient method in the execution of development projects.

Along with the existing knowledge of GIS technology, the community-based approach has further added to the capability of GIS technology to support land management (Basiouka and Potsiou, 2014, Chapin et al., 2005 and Mohamed and Ventura, 2000). Aditya (2010) studied the use of participatory-based spatial data collection and compared various methods of participatory mapping (methods used: analogue map, web GIS and mobile GIS). This study highlighted the usefulness of community/ participatory-based mapping. Overall, the aim of participatory approach is to empower the community by providing assistance and support in the development activities (Orban, 2011). It aligns with one of the elements of Fit for Purpose Land Administration (FFP LA): "...public participation method in collecting and using the data to accommodate the interests of users" (Enemark et al., 2014). One of the advantages of community-based data collection is its efficiency which offers as an alternative to building a complete village parcel-based map. However, while the quality of the collected data is still questionable (Esmaili et al., 2013 and Keenja et al., 2012), it is still a promising alternative. The spatial data quality can be improved using the ISO codes. Some of the elements of good quality spatial data include completeness, legal consistency, and accuracy (ISO, 2013). Based on the description above, a critical study is required to evaluate both usefulness and the quality of the data generated from the participatory-based method (participatory maps) to support land registration activities.

## **2. Research Scope: Location and Data**

This research documents the implementation of participatory mapping in Dusun (sub-village) Daleman. Dusun Daleman is located in Desa (village) Girikerto, Kecamatan (sub-district) Turi, Kabupaten (Regency) Sleman, Province of DI (special region) of Yogyakarta, Indonesia. Location map of the study area is given in Figure 1. The data which were used for the study consist of land registration map (LR-map), participatory map (P-map), the map of systematic land registration activities (PTSL-map), and results of questionnaires

and interviews. Land-owners name mentioned in this paper have altered into pseudonyms, due to restriction and/or limited access of land-related data, especially in the "Daftar Nama" data or land-owners list (Peraturan Pemerintah No.24, 1997). In fact, instead of the land identification number (land-ID/NIB), we used temporal land-ID. The respondents of questionnaires and interviews are landowners, Pokmas, village officers and surveyors. The PTSL project conducted in early 2017 following the P-map project were done in 2015.

## **3. Method**

The participatory mapping activities were facilitated by Kantor Desa (village office) and endorsed by Kantor Pertanahan (local land office). The study aimed at checking result and the quality of map updating through participatory approaches. The elements of data quality employed were in accordance of ISO 1957:2013. These include: (a) data completeness, (b) legal consistency, (c) accuracy of geometries (shape and position). Fit for purpose approach was adopted in the context of land registration data maintenance and quality improvements by: (a) applying aerial imageries rather than surveying, (b) involving community in validating the maps as well as agreeing on the boundary marks, (c) updating cadaster data based upon validated maps (Bennett and Alemie, 2016). This study focuses on the implementation of some fit for purpose elements for improved and accelerated land registration. Questionnaires and interviews were conducted to provide qualitative reviews regarding the elements and context of the geospatial data quality analysis. The final stage of the research was data comparison between the results of government-facilitated participatory map (P-map) and the result of government land certification program (PTSL-map).

## **4. Implementation Method: Participatory Mapping in Dusun Daleman Desa Girikerto**

Participatory mapping activities were started by collecting data related to previous land registration process which has been done in the village. Data related to land registration include land registration map and land records from Kantor Pertanahan, as well as aerial photomap at the scale of 1:2.000 which was acquired in the year 2012. This orthorectified aerial photomap was used as the reference for the mapping process. Thus, the parcel boundaries in land registration map were plotted into the aerial photo map.

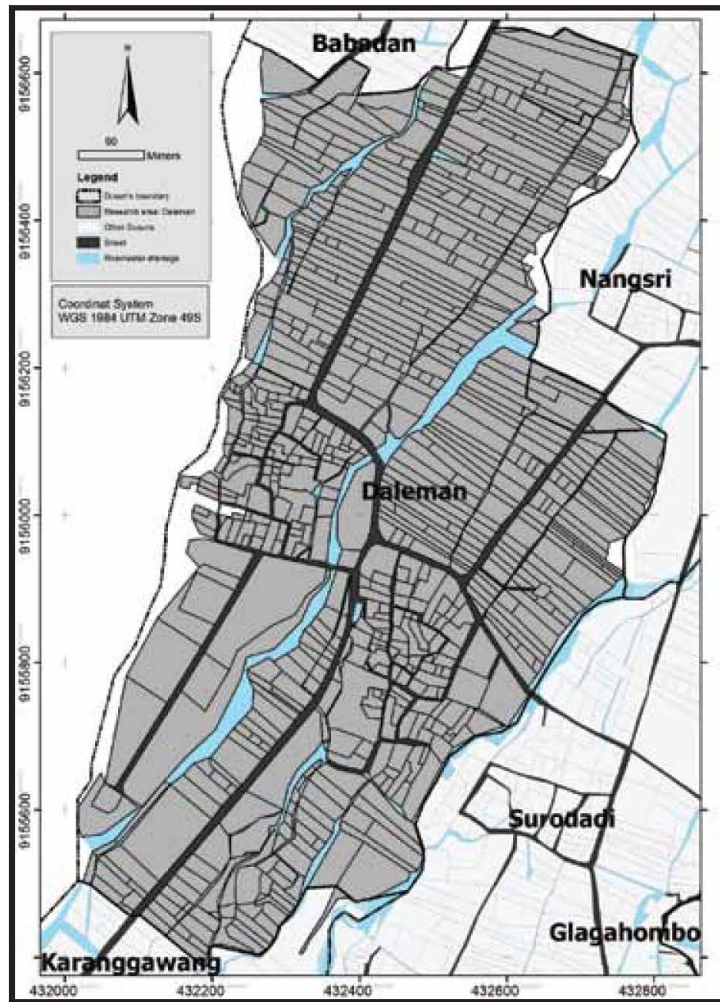


Figure 1: Research location: Dusun Daleman, Desa Girikerto, Kabupaten Sleman, Province of DI Yogyakarta

Table 1: Type of collected data abstracted from DI 201 (formulir number 201)

No	Data	Additional explanation
1	Land parcel: identifying number of parcel (NIB), address/location	NIB to be filled is temporary that need validation from the land office application
2	Subject of land registration (on behalf): name, date birth, address and occupation	Based on legal document, such as: ID card (KTP), family register card (KK), etc.
3	Land ownership evidence: land certificate issued by land office or other legal document	Number and type of land title or legal document of land parcel issued by local government.
4	Land parcel sketch	To be use for relative location identification
5	Neighborhood land owner or other	Name of neighborhood land owner or other circumstances such as: road, river, etc as the boundary of the land parcel.
6	Land Tax related document: C book number (letter C) or Land tax evidence number (SPPT PBB)	Number of village C book or Land tax object number (NOP)
7	Ownership history of land parcel	Land ownership history since year 1960 until present time.
8	Land use	Land use classification: non-farming (housing, school, religion site, etc) and farming (paddy field, vegetable, tobacco plantation, etc)
9	Building	Type of building: house, office, school, etc.
10	Land classification	Private, public (land for public activities, cemetery, school, public health centre, etc), customary land, nation land (TN), etc.
11	Land value	Land value is supply land price (commonly rupiahs per meter square).

Determination of the classification and registration of land parcel is delegated to the local community, but the government is in full control over the entire process. Meanwhile, information flow model refers to the following scheme: Government → Public and Government → Public → Government (Laarakker et al., 2014). This model involves information provided by the public or by the government in the first place. Then it is updated by the public or by the government and is used for decision making.

#### 4.1 Actors

The villagers involved in the participatory activities are landowners and Pokmas (community task force or community representative groups). Landowners determine the boundaries of their own parcels. Since landowners are determining their land parcel boundaries, the neighbourhood of the landowner has to approve it as well, the procedure known as “*contradictoir delimitatie*”. Pokmas plays roles in workshop sessions as participatory mapping participants in preparing field map. Pokmas also plays a key role in providing assistance when a measurement is conducted. Pokmas often act as a mediator between landowners/participants and facilitator. Pokmas ensures all the required documents of parcels are ready, such as ID card, family card, and land tax evidence. Pokmas also ensures the boundary markers are installed on the parcel boundaries.

The facilitator involved in this participatory activities support technical works on survey and mapping. Their role is to provide technical support to the participants/community (villagers) regarding the implemented cadastral mapping activities. It consists of filling out a form and parcel boundary delineation on a field map. The government representation involved in participatory activities are local authorities, local government, and land office. Local authorities are the officer of the village (head of village/Kades and his staff) and officer of sub-village (head of sub-village/Kadus and his staff) officers. Their roles are to provide accommodation for the facilitator and also to ensure the presence of participants (landowners). Local government involvement is done to make sure the activities carried out corresponds to the existing planning document and budgeting support (local government fund/APBD). Local land offices provide information regarding land registration procedures and legal aspects related to the land parcel certification. Regarding the legal aspects and sustainability of the land parcel certification procedure, BPN provides land registration form, known as the 201 form (DI.201).

The data entered in the DI.201 will be used for the next step in land registration procedure (see Table 1). Result of the mapping is to support the sustainability of the issuance of the land parcel certificate (for those who do not have land parcel certificate). BPN also provide survey officer, as quality control, in primary data collection activities (land parcel survey).

#### 4.2 Activities Flow

Prior to the participatory mapping, we did several preparations, including collection of supporting data, rectifications of aerial photo maps, land registration map, village parcel map, land and building tax map (PBB map). Land registration map and tax map were combined with village parcel map are overlaid on top of aerial photo map. Facilitators of the participatory mapping assisted participants to provide additional data or corrections to the draft map. Additional data and corrections were first drawn directly over the printed participatory map. Additional information includes correction on boundaries, shape and location of an individual land parcel and its corresponding owner. Further correction could be related to graphical representations of village boundaries, roads and important site/building (e.g. school, health center and village office). This process produced surveyor field maps. These maps as a guidance for surveyor team to follow up the earlier participatory mapping activities by measuring unregistered land parcels. The measurement results were then processed together with the supporting data to generate a new map containing corrected field data. This new map was then published to the public to obtain reconfirmation from communities. The result from reconfirmation activities was then further processed to generate participatory land registration map. Flowchart of participatory mapping activities is presented in Figure 2. While the situation in the participatory mapping activities are given in Figure 3.

#### 5. Result and Discussion

All land parcels in Dusun Daleman with their corresponding land-ID can be mapped successfully and presented into P-map (see Figure 4). The benefit of P-map as compared to the previous map is the correction of existing administrative boundary, both desa and dusun. The previous administrative boundary usually drawn on small-scale map, therefore, does not reflect the actual boundary depicted by land parcel. In this study area, boundary between Dusun Daleman and Dusun Nangsri, was redrawn (see Figure 5). Constraints regarding to this situation will be discussed in Section 5.4.

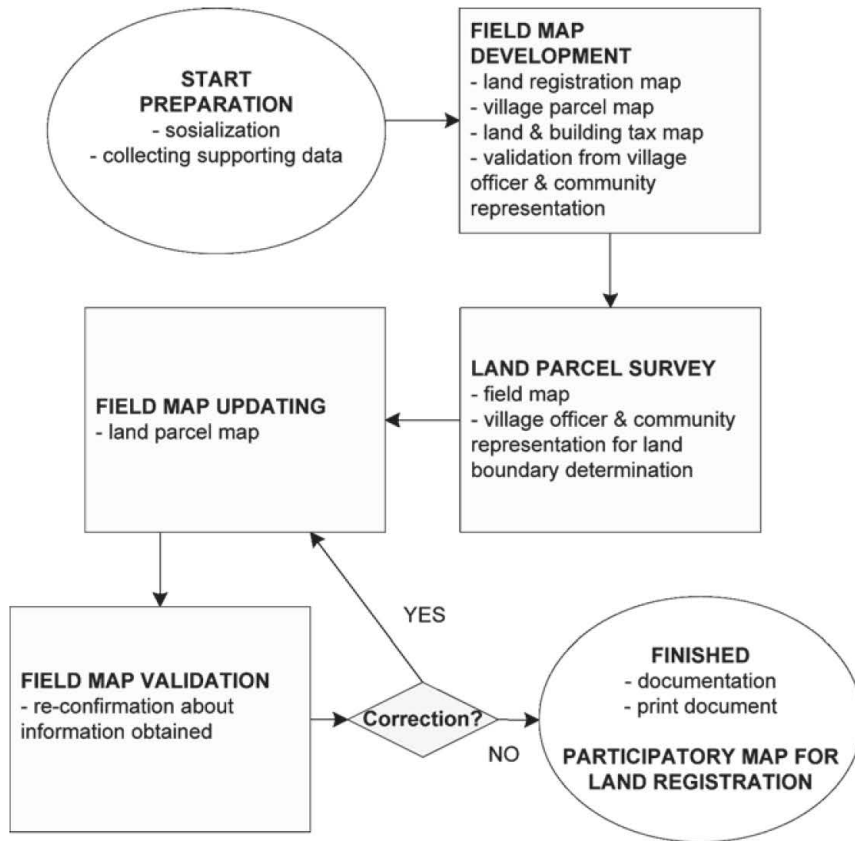


Figure 2: Participatory mapping flowchart



Figure 3: Participatory mapping activities: (1) deliberation & preparation, (2) defining relative location of flying parcels, (3) editing administration boundaries

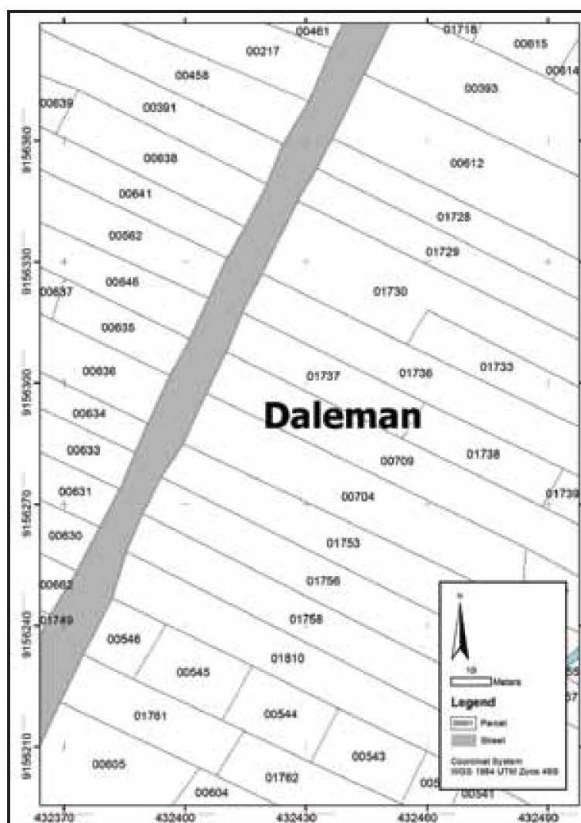


Figure 4: The results of cadastral participatory mapping (P-map)

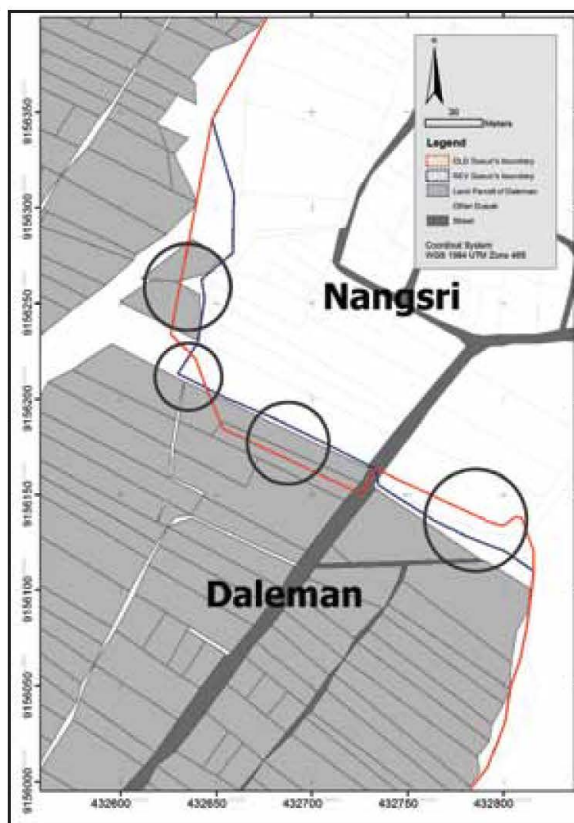


Figure 5: Daleman-Nangsri administrative border: after and before P-map project

Table 2: Land parcels completeness in Dusun Daleman

Total land parcels exist	Type of data exist					
	Sketch map (GU)		Survey doc (SU)		Land book (BT)	
733	79	10.8%	224	30.6%	212	28.9%

Table 3: Land parcel map, before & after P-map

Total land parcels exist	Registered (before 2015)		Land parcel map (P-map) (2015)		Registering via PTSL (2017)	
	Sum	%	Sum	%	Sum	%
733	240	32,74	733	100	300	61

### 5.1 Completeness

Dusun Daleman has in total of 733 units of land parcels (Aditya et al., 2015). Before the P-map project, only 30.6% (224 land parcels) has been registered, from which only 28.9% (212 land parcels) have letter of measurement (SU), and 10.8% of the total (79 land parcels) have GUs (see Table 2). Completeness aspect also can be seen in Table 3. Before P-map have been done, there were only 240 land parcels mapped from 733 land parcels. P-map project was completed the rest of 493 land parcels.

### 5.2 Legal Consistency

Land owner's name becomes very important for land registration regarding its legal certainty. According to PTSL-map, some differences were found in the land parcel owner's name. The differences can be either totally different person or misspelled name of same person (or typing error). For example, the record of Raden Ahmad (pseudonym) becomes Ahmad (see Table 4) represents error due to misspelling in previous cadastral process. Another case can be simply error of identifying landowners correctly.

Table 4: Legal consistency of land parcels in Dusun Daleman (land owner's name comparison between P-map and PTSL map)

No	Land ID (temporer)	Land Owner's Name (P-map)	Land Owner's Name (PTSL-map)	Name change
1	03636	Mariyem	Anton	Yes, totally
2	03642	Supartini	Partinah	Yes, fonts
3	03648	Narno	Narno	No
4	03840	Raden Ahmad	Ahmad	Yes, fonts
5	03872	Marno	Marno	No
6	03885	Darno	Darno	No
7	03939	Darni	Darni	No
8	03945	Nono	Nono	No
9	03964	Isah	Isah	No
10	03995	Bali	Bali	No
11	04000	Partono	Partana	Yes, fonts
12	04123	Makyah	Makyah	No

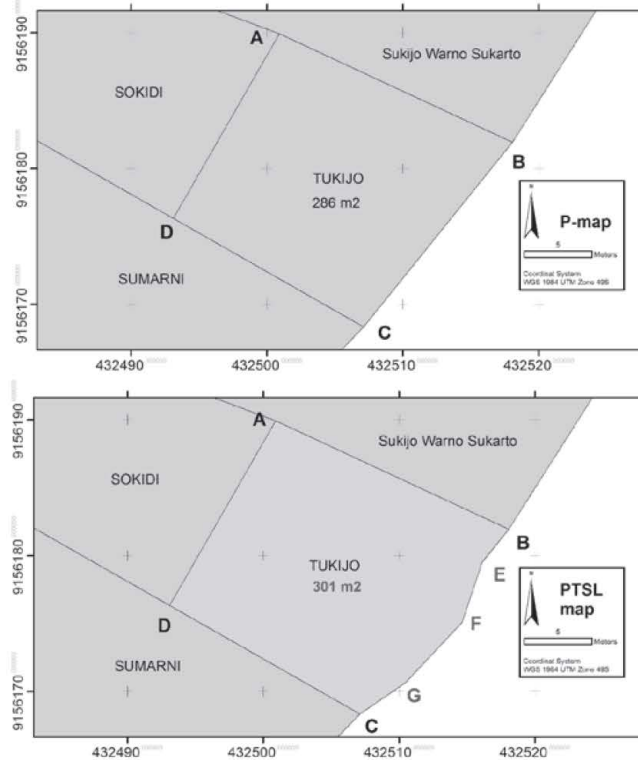


Figure 6: Geometry comparison of land parcel on P-map (boundary points are: A, B, C and D) and on PTSL map (there are additional 3 points: E, F and G)

**5.3 Accuracy of Geometries (Shape and Area)**

There were some corrections for P-map. As the PTSL-map was gathered from field survey, it was assumed that the map should be used as a reference. One typical correction to P-map is that the land boundaries discussed and agreed by community groups and landowners are different with the ones measured in PTSL Map. The correction gives a different shape of the land parcel. For example, parcel belonging to Mr Tukijo (pseudonym), has 4 (four) points of boundary mark (A, B, C and D) on

P-map (see Figure 6). The points became 7 (seven) in PTSL-map (A, B, C, D, E, F and G).

As land parcel's shape changes, so did the areas, as is shown in Table 5. We selected 10 random parcels (pseudo land ID) in the study area and compared the area of parcels mapped through P-map and the area of parcels from PTSL-map. The differences in the areas between the two vary from very small to relatively large. Record number 1 shows that the difference is relatively small (5 m<sup>2</sup>). On the other hand, land parcel number 9 shows that

the difference is significantly huge (31 m<sup>2</sup>). As per the interview these circumstances happened due to the inconsistency in determining land parcel boundaries (represented by land boundary markers). Landowners and their corresponding neighbours tend to put more detailed boundary markers on their adjacent land when a land survey activity is to be conducted on their land. Villagers represented by respondents of interview mentioned that they had more trust with the project executed by government that required the presence of land office surveyor on the field. It was not about technical competence, but more about presence of authority of land office surveyor.

#### 5.4 Constraints of Participatory Mapping

The P-map effectively validates the ownership status, the shape and boundary of each single parcel map in the study area. Participatory approach gets benefited from high resolution of aerial imageries, contributing significantly to quality improvements of cadastre data. The P-map project can be done in an effective and efficient way to the objectives for data maintenance and quality improvements can be done, however some constraints were still to be overcome.

As there were differences between government-facilitated participatory mapping result (P-map) and government mapping project (PTSL-map) on land registration, the questionnaire and interview were conducted to investigate the causes. Participants of this evaluation consisted of landowners and Pokmas (64 villagers and Pokmas), village officers (13 sub-village officer and 3 village officers), and facilitator (18 surveyors). Based on the result of the questionnaires and interviews, it can be categorized that there are four typical constraints in participatory

mapping activities, i.e. natural, technical, non-technical and socio-culture. Natural constraints consists of: (a) vegetation: dense vegetation obstructed GPS signal, (b) location difficult to reach, and (c) weather (dense cloud, heavy rain) (d) difficult to install boundary marks due to difficult field conditions (steep, too dense, hard to reach). Technical constraints consists of: (a) complexity of land parcels' shape so that measurement takes more time and effort, (b) boundary marks are not visible or difficult to identify, (c) initialization setting GPS can be time consuming (it must be re-retrieve the coordinates of control points due to damage or accidentally moved), and (d) lack of the number of measuring instrument (GPS). Non-technical constraints, consists of: (a) land parcel boundary disputes, (b) limited time so socialization is less effective and activities done in a rush situation, (c) occasionally, the boundary marks have not been installed yet. Socio-culture constraints, consists of: (a) landowners not quite cooperative on determining boundaries, (b) landowners are absence because they live outside the village area, (c) stimulation factor, it is need to convince people to participate, (d) limited Pokmas knowledge, and (e) sometimes coordination of Pokmas is not always running well.

The most difficult part of land registration mapping was the process of determination of land parcel boundaries. In some cases, as explained in Section 5.3, lack of consistency in determining the land parcel boundaries happened, even though the same method of survey applied by various surveyor. It was lack of consistency of determining border/boundary by land-owners and (sometimes) its neighbors, rather than surveyor's error.

Table 5: Land parcels area comparison between P-map and PTSL map in Dusun Daleman

No	Land ID (temporary)	P-map (m2)	PTSL-map (m2)	Areas difference
1	03636	347	342	5
2	03642	357	358	-1
3	03648	397	388	9
4	03840	180	180	0
5	03872	116	90	26
6	03885	280	250	30
7	03939	241	241	0
8	03945	410	440	-30
9	03964	14	45	-31
10	03995	128	95	33
11	04000	711	711	0
12	04123	138	138	0



### 5.5 Participants Opinion about Participatory Mapping

Practically, participants do not quite care either about numbers or degree of accuracy and sophisticated RMSE measures. Their parameter of qualified data is about how the data collected met their goal: their land parcel validated and certificated. This sub-section summarizes results of interview after P-map and PTSL project accomplished. Respondents consist of 30 participants who were participant/land-owners in PTSL project. Their age ranges between 31 to 70 years. They live in Dusun Daleman and also other dusun surrounding (various areas of Desa Girikerto). The majority (28 people) work as farmer.

Participatory mapping was very beneficial in supporting land registration activities (land registration and/or PTSL). The P-map was used as field map by local village and local land office and hence was very useful. The map can accelerate the identification of unregistered land parcels in PTSL activities. The identification and confirmation process in PTSL can be very fast due to the availability of P-map. Participants were excited about the results of P-map because they hope to obtain land certificate for their registered land. P-map offers other benefits in addition to support PTSL process. P-map can identify potential disputes from the outset, therefore local village officers and community groups can anticipate, or even resolve, the disputes as soon as possible (in some cases boundary disputes did occur but can be resolved before the field survey was conducted in 2017. The inventory project on land use was also done and documented (which land is for farming, so its need fertilizer distribution). Finally, tentative locations for land development have also been identified by local office.

Major complaints mainly are on the differences on area of their land parcel. More detailed boundary markers were put by the community task force, resulting in more detailed measurement of land parcels. The land surveyor officer from BPN was considered more convincing, and therefore the information from the landowners and neighbors were more detailed.

### 6. Conclusion

Ortho-rectified aerial photo map that was used as a base reference of registered parcel mapping in the study contributes significantly to help actors in participatory map producing the validated parcel map. The validated participatory map depicts registered and unregistered land parcels that were very useful for deploying as the basis for running certification program (PTSL).

Participatory mapping provides an increased accuracy of supporting information for land registration. Also, community participation (landowners and neighbors) increases the efficiency in terms of cost and time. Community-based activities before the land measurement can reduce potential boundary disputes due to the negotiation undertaken in the early stages and mapping phase. The quality of the parcel map boundaries and their corresponding status is considered sufficient and necessary by local land office and local village officers for supporting land registration process. When compared with the map resulted from field survey in government certification program, the participatory map still suffers from many errors that need to be cross-validated. Differences in terms of area and shapes can be found in the same individual land parcels. Landowners name mostly with no differences but some misspelling name can still be found. The accuracy of the land measurement results a dilemma in the community. The demands for accuracy lead to excessive expectations, while on the other hand, there are inconsistencies on the field, especially in the stage of determining boundaries of land parcels by the landowner and their neighborhood that lead to different shapes and different areas measurement compared to the ones derived from participatory map.

Although the participatory approach in land parcel mapping gives a new hope for accelerating the completion of parcel mapping of non-forested land, the geospatial data quality from government-facilitated participatory mapping processes of the study area is compared with the newest result from field survey of government certification program. The geospatial data quality of participatory map suffers level of detail in terms of land boundary determination that poses differences in aspects of shape and area and landowners name. The results of the study concluded that participatory mapping processes contributes significantly in preparing a good quality of land registration map but suffers level of detail boundary determination that hinder actual shape and area representation of land boundaries.

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