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REGULAR RESEARCH ARTICLE

Avoiding Mistakes in Drone Usage in Participatory Mapping: Methodological Considerations during the Pandemic

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ABSTRACT

Participatory mapping has continued to evolve with the onset of new methodologies and technology. Conventional methods for sketching have now expanded to incorporate the use of drone imagery and other sophisticated mapping approaches as a base map. However, the use of ultra-high resolution drone imagery does not mean that it will facilitate more participatory processes nor improve the quality of data and uses of information. Indeed, it has long been known that ultra-high spatial resolution can cause misinterpretation. During COVID-19, innovations are emerging to apply more remote technologies in participatory mapping. Mobility concerns, requirements, and preferences for physical distancing discourages active participation of local communities and are especially complex in contexts involving Indigenous People. This paper specifically explores the mistakes that can arise from over-reliance on employing drones as a tool in participatory mapping methods. This paper is based on a case study of participatory mapping conducted at 43 villages (around forest area) of Central Sulawesi Province and West Sulawesi Province. The participatory mapping was carried out by the Sulawesi Community Foundation (SCF) from 2019-2021. The result of the study found at least six signs of potentially negative outcomes from the use of ultra-high resolution drone imagery, starting from disorientation, misperception over the periods of drone acquisition, homogeneous land cover conditions, similar types of plants, numerous signs of nature, and labeling affixed on map. We also encourage the development of ultra-high-resolution drone imagery to take place under certain conditions and see its role as an interpretation dictionary or as a targeted tool in local contexts. In addition, we found that the level of active participation in participatory mapping during the Pandemic was higher than before the pandemic but requires some improvisations in meeting design.

KEYWORDS
Participatory mapping; Drones; Pandemic; Orthomosaic; Interpretation

1. INTRODUCTION

The COVID-19 pandemic is resulting in significant changes in rural development, influencing different facilitation techniques for practitioners to engage with local communities (Goswami et al., 2021; Haqiqi & Horeh, 2021; Iese et al., 2021; Middendorf et al., 2021). As a result, the field of mapping and GIS have been affected, resulting in various challenges and presenting new opportunities for innovation like to understanding the spatiotemporal dynamic of COVID-19 is essential for its mitigation (Franch-Pardo et al., 2020; Zhou et al., 2020). The strictness of COVID-19 protocols in Indonesia continues to be applied by the national government, all the way down through sub village governments, limiting social activities of rural communities (Rowan & Galanakis, 2020; Muhyiddin, 2020 Yanti et al., 2020).

The COVID-19 pandemic has become a catalyst for the use and advancement of technology faster, including the increasing use of drones (Abdel-Basset et al., 2021;

Brem et al., 2021). The skill of using drones for mapping before the pandemic was still limited to a few people / groups because training is still relatively expensive and learning media was difficult to access compared today. Especially in Indonesia, the pandemic resulted in a proliferation of online training including basic drone and drone mapping online, both in the form of free or low-cost training or workshops.

At the same time, drone technology is also increasingly being brought by academics and NGOs to villages and indigenous communities to carry out participatory mapping (Álvarez Larrain et al., 2021; Colloredo-Mansfeld et al., 2020; Paneque-Gálvez et al., 2014; Radjawali & Pye, 2017). This type of research, however, has not provided insights into how communities interpret the application of ultra-high resolution drone imagery. Whereas in the past conventional participatory mapping used basic sketch drawings with the aim of encouraging participation (Chambers, 2006), it has now evolved to ultra-high-resolution maps to increase precision. Nevertheless, little research has sought to examine the ways local knowledge interacts with and interprets the application of ultra-high resolution drone imagery. Furthermore, this research seeks to examine ways that communities and NGOs adapt to the use of drone imagery?

The Sulawesi Community Foundation (SCF) is an NGO that has implemented participatory mapping programs in West Sulawesi and Central Sulawesi Province since 2019. In West Sulawesi, supported by the KEHATI Foundation, SCF helped facilitate village land use planning (RTGLD) initiatives in 18 Villages and in Central Sulawesi, supported by the Forest Program III (FPIII), SCF conducted participatory land use planning (PLUP) efforts in 25 Villages. Both of these initiatives aimed to support improved management of natural resources in a sustainable manner based on community interests. These participatory mapping methodologies serve as a tool to empower local communities. They began implementation in 2019, before the pandemic, and continue implementation through 2022. The overall objectives of this paper aim to deepen and assist our understanding in participatory mapping methodologies, particularly in hopes of avoiding inappropriate uses or misinterpretations that might occur when ultra-high resolution drone imagery is applied in participatory mapping.

2. MATERIALS AND METHODS

2.1 Material

This research applied Ground Survey (Survey of Village Territory and land resource potential) through the application of GPS technologies and creation of an overall base map. Drone surveys and utilization data used a custom fixed wing (with 2 meter wingspan, 24Mp RGB sensor, 6s Li-Ion 15.000mah), a PC Core i9, Printer A4, Mission Planner, Agisoft Software and ArcMap Software. These hardware and software technologies were then used to guide and support focus group discussion (FGD) and other community meetings to meet broader objectives of community empowerment and improved natural resource management.

Drone acquisition data involved a total of 92 flying missions covering an area of ± 110,000 ha spread across 43 villages from 2019-2021. The sensor used is a Sony A5100 24MP RGB sensor, with flying heights ranging from 300-350 magl depending on topographic conditions. The front overlap was set at 80-90% and side overlap is at 70-75%. Apart from topographical factors and tree density, variables included flight altitude, image overlaps, flying directions, flying speed and solar elevation, all of which require careful consideration in order to produce the most suitable drone imagery (Dandois et al., 2015; Singh & Frazier, 2018; Tu et al., 2020). The result of th drone imagery were processed using agisoft software to produce orthomosaic data (González-García et al., 2020; Soohee & Chang-Ki, 2019; Urbanová et al., 2017). The result of data processing into orthomosaic included a spatial resolution ranging from 8-17 cm/pixel.

2.2 Methodological Approach

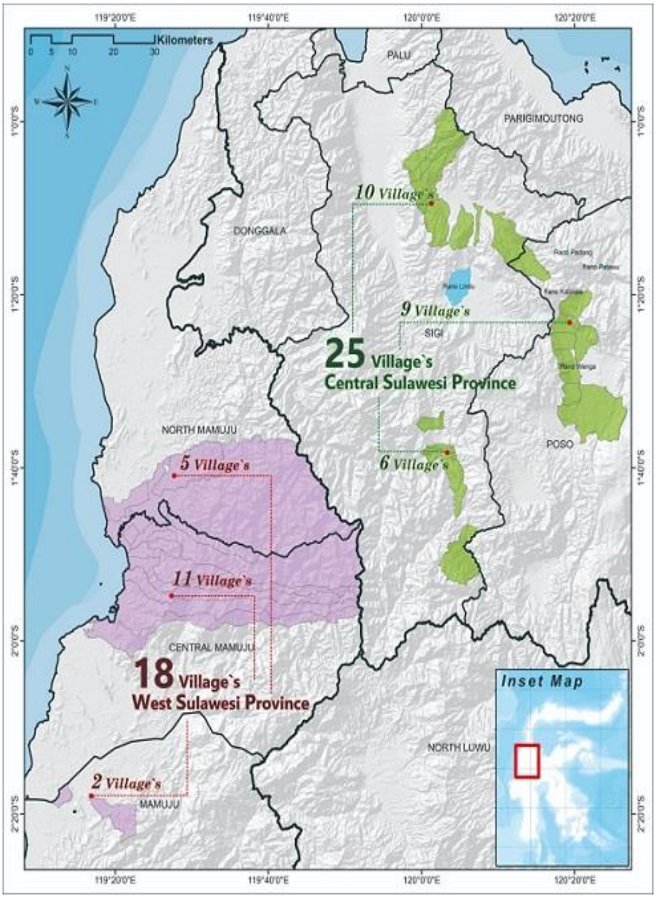

Figure 1. Map of participatory mapping conducted by SCF in Central Sulawesi and West Sulawesi Province in 2019-2021

Research locations were located in villages that carried out participatory mapping, whereby all of the selected villages are located in and around the forest area. This research was conducted by examining the participatory mapping methodology implemented by SCF in 2019-2021. Because, drones are used to produce high-resolution drone imagery, it can assist in identifying tree types or land use (Kotivuori et al., 2020; Orengo & Garcia-Molsosa, 2019; Schiefer et al., 2020). By using drones, the output from participatory mapping becomes more detailed, accurate, including higher acceptance of data and information from parties outside the community/village.

The main stage of the participatory mapping methodology was undertaken by SCF, which included early community engagement, survey-mapping, data processing and land use planning (see figure 2). While in this study will focus on the stages of data processing in matching and scaling up data using orthomosaic data from drone

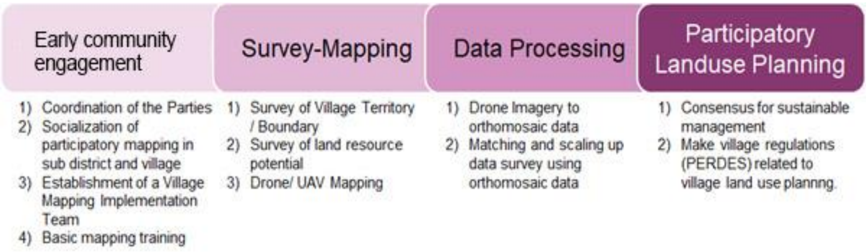

Figure 2. Step by step participatory mapping methodology to made village land use plans

The scope of this research is guided by insights from the FGD process of matching and scaling up data survey using orthomosaic data. At this stage, the facilitator conducted FGDs at the sub-village and village levels with the community to identify each piece of land in the village using a ultra-high resolution drone imagery (orthomosaic) printed at scale of 1:300. The FGDs helped to produce polygons for each piece of land in the village, including attribute data such as owner's name, land area, and type of plants. data and information from the results of the survey-mapping that had been carried out previously. Overall, 171 FGDs were conducted in these two provinces (see Table 1). The FGD aims to scale up data and identify each community land unit, so that each land can be recognized "by land by farmers". This paper will identify and analyze errors that occur repeatedly from the use of high-resolution imagery generated by drones and not the accuracy of the interpretation made by the community.

Table 1. Total of meeting/FGD was conduct on participatory mapping process

No.	Province	Total of Villages	Total of Meeting/FGD
1	Center Sulawesi	25	75
2	West Sulawesi	18	96
Total		43	171

3. FINDINGS

3.1. Improvement of Participatory Mapping Process

FGDs with an agenda of scaling up and identifying the land as a whole to obtain information on land units have been carried out in many ways (see Figure 3). Before entering the pandemic, we encountered some people who dominated meetings with more participants such as 30-40 people (see Figure 3 in box A). Although meeting design for discussion of mapping result for respective hamlets, conversations were still be dominated by a handful of people. Attracting fuller participation among those that lack of self-confidence and feelings of being intervened continues to be a challenge. This includes the lack of ability of the participants to see and explain their village/land from a map. Trying to explain on a map was very new to many people in the village, as just a handful of participants could easily contextualize the scale and locations on the map.

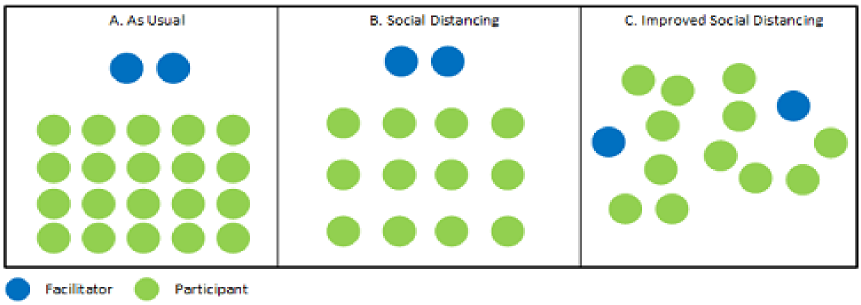

Figure 3. Several meetings/FGD model carried out during the participatory mapping process: (A) Normal conditions pre-pandemic, no improvisation, sometimes set up with U shape, class room, or auditorium settings; (B) With social distancing, participants reduce, and increase the distance between participants; (C) Improved social distancing, reduce participants, increase the distance, no formal time to join, no formal rule, random position, there is no opening and closing ceremonies.

The implementation of COVID-19 protocol forced meetings to be limited in number of participants, such are no more than 15 people (see Figure 3 in box B), or must be done virtually (Churiyah et al., 2020; Rowan & Galanakis, 2020). This is stated in the decrees of the national and provincial government which are sent down to the village level. Meanwhile, villages in Central Sulawesi and West Sulawesi are not sufficiently ready to hold virtual meetings, due to limited internet infrastructure, supporting equipment, and knowledge using software such as zoom, google meet, and skype.

Figure 3 in box C involves meeting designed to use a certain time period, for example on a work day starting at 20.00-23.00 WITA, while on Saturdays or Sundays at 14.00-17.00 WITA. Participants can come and go home at any time during that time. An average 5-12 people would be present in the same room within a 30–60-minute period. Invited participants are still 30-40 people, but not all of them come and go home at the same time. In this setting people do not come in a hurry, and attendees tend to look very relaxed, dropping by wearing sarongs and informal clothes.

Interaction between communities is smoother this way because it is not in the form of formal meeting structures packed into auditorium style seating, with no official opening and closing the event, and the agenda is not strict or structured. Village heads and community leaders do not appear to be different in this process. In addition, the community feels more flexible because they can come at any time, within that timeframe, they don't have to come on time and go home according to the schedule like the meetings held before Covid19. This condition causes everyone who comes to talk or ask questions and no participant is dominant enough or controls the forum.

This is quite a contrast to the conditions before the pandemic and during the early period of the pandemic, where the design of the meeting had not been improvised (see Figure 3 in box A&B). The percentage of participants who expressed and conveyed their opinions was also less, it was clear domination and pressure on other participants. The burden one the facilitator tends put more effort so that more participants can speak instead of deepening what the participants have said. In the process of this meeting, it is very easy to identify village heads and community leaders, by looking at the clothes used, their sitting position, and dominated.

Even though there are clear benefits to the improvised in figure 3 in box C, there are also the drawback. One is that the participants cannot attend together to hear other perspectives that they might not get in smaller more casual settings. However, there is a sense that more participants get a fuller opportunity to participate, discussing where the lands located, telling stories about their groves, and sharing environmental conditions of the sub-village areas with less time constraints. People who come will also avoid feelings of intimidation or domination from other participants. The facilitators also showed quite a contrasting burden. On figure 3 in box A & B, two of the facilitators had difficulty attracting the participation of all participants in expressing their opinions. Meanwhile, figure 3 in box C allows the facilitator to have more control over the forum, guiding the facilitator's burden towards opportunities for exploring in greater depth what the participants were saying.

3.2. An Error Signal from using Drone Imagery

3.3.1 Disorientation

- **The projection on the wall:** The FGD which was held at the farmer's house in Tirtabuana Village led to intense discussions between the community and the facilitator. This began with the projector shining onto the wall of the house and displays the drone image in the GIS application.

Figure 4. North disorientation case between direction of projection and the real north

One of the participants, Mr. Komang asked the direction of north? The facilitator answered while pointing at the map (top side of the map). Mr. Komang then pointed to "my land is around here sir", but the facilitator wanted to clarify the location mark. Mr. Komang then doubted what he had described. "Again, which direction is north?" he asked while pointing at the door of the house "isn't that north?" Towards the back of the river, right?". The facilitator finally understood the confusion, by using the position of his house against natural signs such as the position of his house with the river behind the house. Suddenly, the FGD process became much smoother when the projector was aligned to follow the actual cardinal direction of the house.

- **Unfolded Map of drone image:** This condition tends to be the same as in the case of the projector on the wall, as it causes disorientation among participants. An orthomosaic map of A0 size has very detailed resolution and is spread out on the table during the FGD causing questions about scale and positioning. Tough discussions ensued because the position of community lands was quite difficult to recognize. The main obstacle was the position of the map whose northern direction did not match the north direction. The data must thus be rotated to equalize the north position according to the actual north position.

- **Misinterpretation directions:** In the convened meetings, the community generally only knows the four cardinal directions: North, East, South, West and does not have a vocabulary for cardinal directions like: Northeast, Southeast, Southwest, Northwest. When the community member that their garden was in the south, we learned after a detailed check it turned out that their garden was in the Southeast. In addition, the interpretation of this direction is often assumed by the community with a prefix (starting point / reference) from the house where they live to the object that is pointed to, not from the meeting place or the object pointed at. By looking at the high-resolution drone map, the finding of direction interpretation errors is more common than using his house or garden assets as a starting point/reference.

3.3.2 Misperception of acquisition period

The ultra-high resolution of the drone imagery makes some of the vegetation easily recognizable by the community. However, the FGDs can be challenging to create tensions if the vegetation depicted in the drone imagery and community information is different. This problem can occur due to data acquisition period, it turns out that the community thinks the drone photo displayed is a real time photo, or that it reflects recent conditions. For example, 3 days ago the palm oil land became empty land, so they are looking for or will only recognize the land through signs that the oil palm has been cut (empty land). However, the drone photo was obtained 1 month ago and still depicts palm oil grove. Similar cases like this are also often found in several types of seasonal crops that undergo rapid cultivation changes. From the drone photo it is clear that corn plants are visible, but the community member might explain "not this one, my garden is sweet potato not corn". After investigating more deeply, the community just remembered that planting sweet potatoes 3-4 weeks ago was indeed corn when the drone imagery was taken.

3.3.3 Homogeneous land cover

Land stretches that have homogeneous vegetation cover, such as: 1) Oil palm; 2) Cocoa; 3) The Bamboo is clear enough to be identifiable through drone imagery. But in this context, participatory mapping is also aimed at identify parcel of land, so the homogeneous land cover can present other delineation challenges. This process will be more difficult if the plants are relatively the same age. The potential for error is very large and often occurs when a parcel of land that what want to identify first is in the middle of the stretch. The design of the FGD settings as described above, allowing participants to come and go can therefore present a key factor in amplifying potential misunderstanding, especially when some land cultivators are present and others are not.

3.3.4 Similar types of plants

There are four cases that we found happened repeatedly, especially when the community identified plants from reading high-resolution drone images. This happens because of the similarity in appearance when viewing images displayed in Figures 6-8. Although Interpretation can be done using the spectral index method through GIS applications, the method that can be applied or remembered by the community in interpreting is to build shared knowledge and experience regarding differences in color, shape, hue, and size.

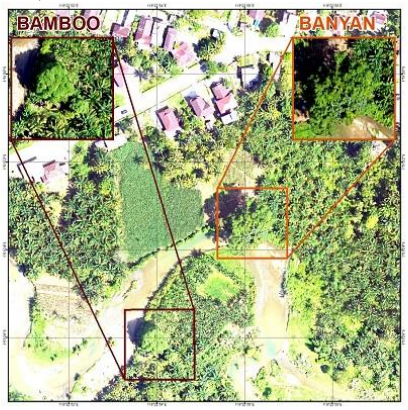

Figure 5. Case 1 for Similar types of Plants: Bamboo and Banyan

Figure 6. Case 2 for Similar types of Plants: Patchouli and Pepper

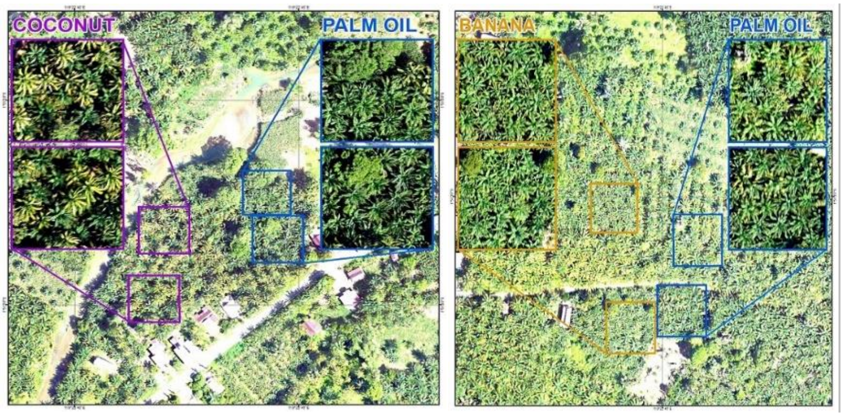

Figure 7. Case 3 for Similar types of Plants: Coconut, Palm Oil, and Banana

3.3.5 Numerous of nature

1) Dead River is term in local language but common terms are former river, means the bends in an abandoned river that are no longer connected to river flows (Citterio & Piégay, 2009; Rostan et al., 1997; Wotherspoon et al., 2012). For example, statements like "My corn garden is here sir, beside a dead river" are examples of common cases. Communities use specific natural markers or local knowledge to identify their land. We only found cases of dead rivers in West Sulawesi (nine villages) and not in Central Sulawesi. The challenge, there are quite a lot of dead rivers, found 4-5 dead rivers in one village in West Sulawesi (see Figure 9). **2) Hill/Top Mountain;** Unlike the case elsewhere in Indonesia (Java, Kalimantan, and other sites with mapping initiatives) the Provinces of West Sulawesi and Central Sulawesi have mountain ranges that stretch from south to north (Brambach et al., 2017; van Leeuwen et al., 2010), with predominance of steep areas and a lot of hilly regions. This topographical condition is also used by the community to identify land.

Figure 8. Dead River in the one village

3.3.6 The label previously affixed to drone image

In scaling up and identifying each community land unit, the facilitator gives a sign/label on the map from the drone image. The sign is affixed using a 50x15mm sticky note to recognize or remind what some people had said earlier. The sticky notes are written with land descriptions such as "Mr. Sugianto's cocoa patch" and "Mr. Sarmin's garden". The signs then turn out to be quite significant in influencing the people who came afterwards, like reading sticky notes instead of reading or understanding the position on the map. The impact is, if from the beginning there are many mistakes in interpretation, the more time goes by, the more errors will be found. "My garden is next to Mr Aco's garden" but after studying it with other garden neighbors, he did not recognize the name. As it turned out, the discrepancy lay on the label of Mr Aco's garden which was put on first.

Figure 9. People identified the land with map has the label

3.3. How to Avoid the potential mistake

The case of Direction Disorientation can be handled by turning the north of the map or the projector to the north that is actually understood by the community. Relating to Misperception of Acquisition Periods, will be easier if the meeting design is carried out as pre-pandemic periods (coming and going home according to the time of invitation). This is because the delivery of information related to the acquisition time of the drone results can be done only at the beginning of the meeting. To deal with this problem with a modified meeting design (figure 3 in box C), facilitator can provide information / instructions written on flipchart paper and affixed to a strategic location at the meeting place such as near the entrance. For example, a sign can be placed at that location to reaffirm "This drone map was taken 1 month ago, what was in your garden 1 month ago ??". This will reduce repetitive delivery of information related to the timing of taking drone photos by the facilitator, to participants who come and go.

Homogeneous land cover, is the most difficult thing to avoid or handle. It is difficult to avoid this because the potential to occur in many places is enormous (see figure 11). Meanwhile, it is difficult to address or unpack because it requires prerequisites to make process easier. The surrounding land must be known first, while the surrounding land also needs to be recognized. The first thing we did was collectively identify land that is close to public / social facilities on the drone image map. This is analogous to the placement of tie points in the mapping process in general. This identification process takes place gradually starting from the tie point and continues to widen. If confusion is found by the community, the land recognition process will be withdrawn and if needed, it will return to the initial tie point. Each map printed on paper size A0 with a scale of 1: 3,000 covers each area of ± 800 ha at least one tie point. The more tie points on the map the more it will help the community in this process.

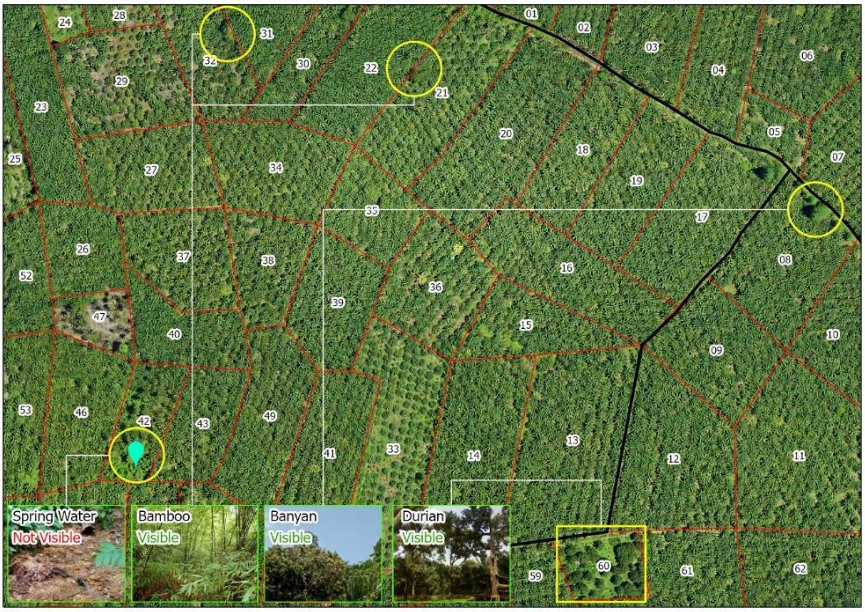

Figure 10. A map that has visible and invisible marking from ultra-high resolution drone imagery used to identify surrounding lands

Apart from this, to address COVID-19 appropriate FGD designs, it can be arranged overtime requirements for attendance, setting periods for those with a certain distance of lands from the main road. For example, people who are only between 1-100 meters from the main road can arrive at the beginning or at different days with a distance that is further from the main road.

Similar types of plants; there is no shortcut or tricks that we have come up with to make it easier or avoid this happening. The only way is to build habits and share knowledge about interpretation in identifying vegetation (see table 2). This knowledge was built on from a potential survey conducted previously by the village mapping team. The team has picked up points using GPS and recorded plant species / land cover in many different areas. The data and information will then become material for discussion to become shared knowledge. Some questions that can be of little help such as plant age, as this implies different hues of the same plant species.

Table 2. Interpretive knowledge built with the community during the FGD process

CASE	Shape	Size	Color	Hue
Bamboo vs Banyan	Bamboo has a canopy in the form of a proportional circle and there are several small bamboo trees (canopy) around it. While Banyan has a random canopy shape.	Bamboo has small and dense leaves, while Banyan has larger leaves.	Bamboo looks bright green compared with Banyan	Bamboo has a softer crown, while banyan has larger leaves so it looks rough.

CASE	Shape	Size	Color	Hue
Palm oil vs banana vs coconut	Palm oil has a large leaf base and stem, compared to banana and the smallest is coconut	Palm oil has the widest tree size, followed by banana and coconut	Palm oil has a darker green color than banana and coconut. Coconut also tends to be yellowish	Palm oil looks rough around the leaves, in contrast to banana and coconut it looks thinner/smoother.
Patchouli vs Pepper	Pepper has a more regular cropping pattern while Patchouli appears to have a random distribution.	Pepper has a smaller size than Patchouli	Patchouli is brownish green while Pepper is yellowish green	Paper looks brighter when compared to Patchouli

Note: comparisons obtained with the ratio of each mature plant

Numerous signs of Nature; requires triangulation with other object to validate that it is a sign of the specific naturel feature of interest. This can be done by comparing the distance and / or direction of several natural signs (dead rivers, hills, and a big tree) with public facilities that are more easily recognizable. After the natural signs have cleared up, the next step is to validate whether the names of the closest land owners who have been previously identified are compatible.

The label previously affixed to drone image; This presents a difficulty level related to the homogeneous land cover case. On printed maps, we reduced, and in some case no longer attached labels. At the beginning of the meeting the labels were affixed only to the vicinity of public facilities and natural signs were very clearly recognizable. If the participants who come have land in a location that cannot be validated, such as in the middle of a cocoa plantation, the surroundings are not yet known. We first note only the labels using the vector data format that ArcMap provides. After enough information about the surrounding fields is known and the information that was stored is validated by itself, then we label it on the map that has been printed. It is important to do this in stages to help other participants who might arrive at a later time.

From our experiences of FGDs in 43 villages, each case was mapped based on the frequency of occurrence, the difficulty of overcoming it during the process, and the impact caused (see table 3). The table illustrates that “similar types of plants” did not occur in Central Sulawesi, which is a region strongly influenced by land use patterns, which were reflected on the areas of the map. As for the "disorientation and affixed label" condition, the frequency of occurrence when compared between provinces is the same. However, other potential errors are more common in West Sulawesi Province. The "Overall" column is a comparison of the intensity of the occurrence between the six potential signs of error, "similar types of plant and numerous natural signs" are the most frequent.

Table 3. Facilitator response to community process of interpreting ultra-high resolution drone imagery.

No	Potential mistake from using ultra-high drone imagery in community level	Frequency of occurrence			Difficulty level overcome	Impact on other data
		West Sulawesi	Central Sulawesi	Overall		
1	Disorientation	neutral	neutral	low	easy	low
2	Misperception acquisition	often	rare	medium	easy	low
3	Homogenous land cover	often	rare	medium	moderate	high
4	Similar types of plant	often	N/A	high	hard	high
5	Numerous signs of nature	often	rare	high	moderate	neutral
6	Affixed Label	neutral	neutral	low	moderate	neutral

In addition, the facilitators also considered the process related to "similar types of plant," which was the most challenging element to address, because the community needs time to practice and remember the differences in each type of plant from recognizing hues on ultra-high resolution drone imagery. As listed in the impact column, "similar types of plants and homogenous land cover" has a large influence on other lands. If one identifies land ownership incorrectly, then the land identification after that will also be wrong.

4. DISCUSSION

Although using high-resolution maps generated from drones can provide new possibilities in mapping and engaging with communities (Kotivuori et al., 2020; Orengo & Garcia-Molsosa, 2019; Schiefer et al., 2020), it does not necessarily strengthen the participatory mapping process, especially when viewed from the output or the validity of the data. This illustrates that mapping using technology is not easy to do (Sidiq, 2021). Special techniques or methods are needed so that they can be used optimally and avoid potential mistake that may occur if drone imagery is used at the community level. Several papers related to the use of high-resolution imagery from drones at the community level, have not explored these facilitator-community dynamics, or have not yet to articulate how the opportunities for errors may occur. This research was intended to deepen such insights in relation to cases described by Radjawali (2017) at Indonesia, Colloredo-Mansfeld (2020) at Galapagos, Larrain (2020) at Argentina, Paneque-Galvez (2017) at Peru, Gunaya dan Panama. For example, the use of drones is believed to strengthen the recognition of indigenous peoples on land claims as counter mapping in Kalimantan. The uses of drones by indigenous people to carry out territorial mapping and monitoring in strengthening and protecting indigenous people's territories in South America. From all signals of potential mistake, we realize that we will continue to develop the process going forward, and is not limited to differences in geographical conditions, culture, education, and land cover.

Seeing the development and penetration of technology previously mentioned, further research is needed. As participatory mapping continues to generate broader interest and innovate new technological and participatory applications, researchers and practitioners need to build dictionaries/tools for interpreting local/community knowledge relative to the use of ultra-high resolution drone imagery. This will greatly help academics, NGOs or policy makers because it will increase the accuracy of the data produced and improve the ethics for how it is applied. In parallel, it also makes it easier for the community to explorer their knowledge on drone imagery. Because, this is considered a new thing and community really interest to see the land on the map and explain what is around it. In the future, this research can be developed into a participatory mapping module or guide that use ultra-high resolution drone imagery based on the similarity of geographical conditions or local knowledge of the community.

The author also believes the COVID-19 Pandemic situation offered both technological innovation but also practical ones around simple issues such as how to structure and convene meetings. This includes limiting the number of meeting participants, regulating the timing, guiding community engagement for greater depth of understanding, and overall improving key aspects of the participatory process. This of course has implications for the budget and time, and the positive outcomes is that the Covid 19 pandemic will force more parties to explore new ways of fulfilling mutual interests. In this context, the authors also have not seen the correlation between pandemic conditions and the level of women's participation. Women's involvement and participation is highly dependent on the design and facilitation process, which is an area that should be explored further going forward One limiting factor in our research site for gender representation is still related to "culture", especially in Sulawesi, whereby male family members that's choose to attend, also tend to claim representation over their household.

5. CONCLUSIONS

From 2019 to 2021, we convened hundreds of meetings/FGDs on participatory mapping processes in Central and West Sulawesi. We noted changing situations before and during the pandemic. We found at least six potential signals of interpretation error when using high-resolution imagery from drones at one stage of the participatory mapping process. This includes disorientation, misperception of acquisition period, homogeneous land cover conditions, similar types of plants, numerous similarities of natural signs, and challenges of affixing labels to drone image map. The findings were geographically distinct in some cases but distributions of occurrence were drawn from across the data collection sites in forty-three villages in across the two provinces.

The impact of the COVID-19 pandemic has resulted in social restrictions which including changing requirements and practices for convening meetings at the village or community level. This actually has a positive impact on the participatory mapping methodology processes in some ways, especially on the meeting/FGD process for data collection. Some improvisations on the format and design of the meeting must be carefully considered. These include less formal meeting times, agenda, design. This is evident from the number of people who are willing to participate and express their opinions freely and with greater depth to distinguish from ordinary people.

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