

PARTICIPATORY GIS TO VERIFY THE BOUNDARIES BETWEEN FOREST AREAS AND CUSTOMARY PEOPLE'S TERRITORIES (CASE STUDY: KASEPUHAN CIPTEGELAR, THE SUNDANESE CUSTOMARY PEOPLE)

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ABSTRACT: Both customary people and rain forest are important entities for Indonesia. Determining the boundaries of customary regions on the forest are serious issues for legal recognition as a customary law people/society. Bunch of indigenous/tribal/ethnic people widespread in Indonesia e.g. Sumatera (Suku Kubu/Suku Anak Dalam/Orang Rimba), Kalimantan/Borneo (Suku Dayak), Papua (Suku Asmat, Suku Dani), etc. Surprisingly, there were indigenous/tribal/ethnic people in Jawa which are conserving customary law e.g. Kasepuhan Baduy, Ciptagelar and many more. Some of them are lived in/near the forest. This research was carried out to test the cartometry method with participatory approach for the mapping of customary region which was located in/near the Indonesian national forest. We set Kasepuhan Ciptagelar (Sundanese customary people) as a sample. Research stages are data preparation (topographic dataset and satellite or aerial imageries), verification through direct discussion with customary people, interactive digitation on (digital) map, confirmation (iterative process), field survey, and map visualization. The boundaries of customary region were drawn well and detailed such as the kind of customary uses. We conclude that the method was robust and more efficient to get the whole picture of customary region as it offering effective method for transferring indigenous knowledge to the map. This method could be used as a verification tool too by government especially if the claim areas were overlap with national's forest map or other customary region.

1. INTRODUCTION

Comprehensive arrangements regarding the status of indigenous peoples are very important in the framework of managing forest areas in Indonesia because most of these groups are located close to forest areas. The link between indigenous peoples and forests also influences land systems which are more complex and require special attention from various parties (Agrawal, 2007). If the policy on land tenure security is not prepared seriously and comprehensively, it cause land conflicts and can further affect the availability of carbon stocks in Indonesia. Especially with the existence of regional autonomy, stakeholders become more complicated because it involves more parties to handle land ownership especially those in forest areas (Bakker & Moniaga, 2010). Globally, Indonesia is classified as poor in the management of land ownership rights, especially in forest areas, despite being a country with very high density of biomass that is still alive (Bruce, Wendland, & Naughton-Treves, 2010). One of the causes of carbon emissions is deforestation and forest degradation so estimations for the need to control the diversity of forest ecosystems need to be done as is done in Venezuela (Pacheco-Angulo, Vilanova, Aguado, Monjardin, & Martinez, 2017). The www.globalforestwatch.org is the sample of website that provides interactive information about deforestation. Many factors affect the reduction in the number of trees and forests, one of which is the largest in Indonesia is for production (commodity driven deforestation). This was demonstrated through comparison of multi temporal data from 2001 - 2015. (Global Forest Watch, 2016).

Recognition of a community group as a customary law community has become a special concern for the Indonesian government marked by the involvement of several parties in the government environment, namely the Ministry of Home Affairs, the Ministry of Agriculture, Spatial Planning and Land / Spatial Planning, the Ministry of Environment and Forestry, the Ministry of Social Affairs, and Local government. The intended involvement varies according to the respective duties, functions and authorities ranging from verification, validation, to determination.

Indonesia has many tribes scattered on each island. Tribal data in Indonesia is updated every census period which

was first produced through the Population Census (SP) of 1930 by the Dutch Government. In SP2010 data, 1,331 tribal categories were identified consisting of codes for tribal names, alias names, sub-tribe names (Badan Pusat Statistik, 2015). There are several classification differences between SP2000 and SP2010 results, for example the Javanese ethnic group in 2000 was only categorized as Javanese but in 2010 it consisted of Javanese, Samin, Tengger, Nagaringung and Nagaing (Ananta, Arifin, Hasbullah, Handayani, & Pramono, 2013). In 2013, according to the results of the Central Statistics Agency (BPS) and the Institute of Southeast Asian Studies (ISEAS) 633 major ethnic groups were identified from the tribal codes available in SP2010. For example in Jambi there are the Batin, Kerinci, Penghulu, Pewdah, Malay, Kubu and Bajau tribes. Then another example in East Kalimantan there are the Malays, Dayaks (Bukupai, Lawangan, Hamlet, Ngaju, and Maayan) and many others. It shows that the process of ethnic identification in Indonesia is a dynamic process (Dokhi et al., 2016).

Forest areas, private forests, customary lands, customary territories, customary forests, and customary villages are various terms that relate to a certain geographical area (object) and certain indigenous peoples (subjects). The mainland of Kalimantan (known as Borneo) is a good example in terms of forest area management and its various interventions because it deals with economic, social and environmental aspects of both Indonesia and Malaysia. The mainland of Kalimantan is one of the biggest producers of oil palm and timber. These conditions are related to important issues including customary land ownership, borders, conflict resolution between stakeholders, and the division of the role of non-governmental organizations (NGOs) in the context of liaison between the community and the state (Cooke, 2006b). Land and natural resource conflicts in Indonesia usually arise when there are overlapping interests such as community groups, the state and certain groups (private), for example conflicts in wood-producing forest areas that collide with 3 (three) interests, namely conservation (state), customary rights (indigenous peoples), and (private) production (Deddy, 2006)(Ruwiastuti, 1997). The problems in Kalimantan (Borneo) are a complete case example of conflicts over customary land in forest areas and have been described comprehensively by (Cooke, 2006a).

The problems that exist in Indonesia include the complexity between the status of the area, land ownership, and administrative areas related to the boundaries of the rights of a group of people who live on a certain land. Some examples of cases of legal recognition of an adat group at the local level are clearly presented by (Bakker & Moniaga, 2010). For example the success of obtaining legal protection as an indigenous community obtained by the Orang Rimba (also known as Kubu), a group of indigenous peoples who depend on the Bukit Duabelas forest, Jambi Province, Sumatra. The recognition of the Jungle People was through a lengthy negotiation process with the Ministry of Forestry as a representative of the Central Government (from the start of the proposal in 1984 and determined in 2000) (Bakker & Moniaga, 2010). Another example is through decentralization authority by the regional government, there are 2 (two) customary territories which are recognized as customary villages through recognition of their customary rights, namely Kanekes (Baduy), Lebak, Banten Province and in Lundayeh (Dayak), Nunukan, North Kalimantan (previously still East Kalimantan). The last example is through extra-legal arrangements involving many institutions such as the Ministry of Forestry, the Ministry of Home Affairs, and others relating to the complexity of customary claims of the Katu community group, Lore Lindu National Park, Central Sulawesi (Bakker & Moniaga, 2010).

One of the steps that needs to be taken to minimize conflicts between indigenous peoples, the government and other parties that have an interest is to identify through the mapping method because this identification is the first step to seek certainty about the status of indigenous peoples and their territories which has implications for land and resource management rights. natural power (Deddy, 2006). Most of the mapping process is done bottom-up through a participatory approach. The mapping was carried out both by research institutes, non-governmental organizations (NGOs) together with the community known as community mapping (Deddy, 2006). The participatory approach has long been applied to the village planning process and then also applied to participatory mapping. Participatory Rural Appraisal (PRA) is a term that is very often found in research and regional planning work with a bottom-up paradigm. PRA was developed after the Rapid Rural Appraisal (RRA) which has different goals between the two. PRA is more about empowering local people. The study of the differences between PRA and RRAS was carried out comprehensively by (Chambers, 1994a)(Chambers, 1994b). But in essence the two approaches have become one of the historic parts of the development of participatory mapping. The number of community mapping in Indonesia increased in the period 1994-1999 with various objectives grouped as follows: 1) for the management of protected areas, 2) for research purposes, and 3) for the recognition of customary rights (Deddy, 2006).

Participatory GIS (PGIS) is the application of collaborative social science, natural sciences and technological developments where local knowledge is collected by utilizing GIS as a tool in decision making from interpretation to analysis. The main keyword of PGIS is community involvement in the collection and processing of local spatial knowledge (Local Spatial Knowledge) so as to increase community empowerment and awareness in managing the surrounding environment. PGIS is able to provide a more comprehensive and broader perspective for the community in understanding its area (Verplanke, McCall, Uberhuaga, Rambaldi, & Haklay, 2016).

This research was carried out to test the cartometry method with participatory approach for the mapping of customary region which was located in/near the Indonesian national forest. The case study taken is Kasepuhan Ciptagelar region, Indonesia. Kasepuhan Ciptagelar is one of the several indigenous communities in Java that still

survives to this day amidst the swift currents of modernization and urbanization that surrounds it. Kasepuhan Ciptagelar is one of the largest Kasepuhan of several Kasepuhan on Java Island, located around the Mount Halimun Salak National Park which is only about 175 km or 5 hours drive from the center of the National Monument, Province of the Special Capital Region (see Figure 1). One of the differences between Kasepuhan Ciptagelar and other indigenous peoples such as Baduy is that it has characteristics of moving groups for a certain period of time which cannot be planned according to their local beliefs (semi-nomadic) (Abdulharis, Sarah, & Hendriatiningsih, 2007).

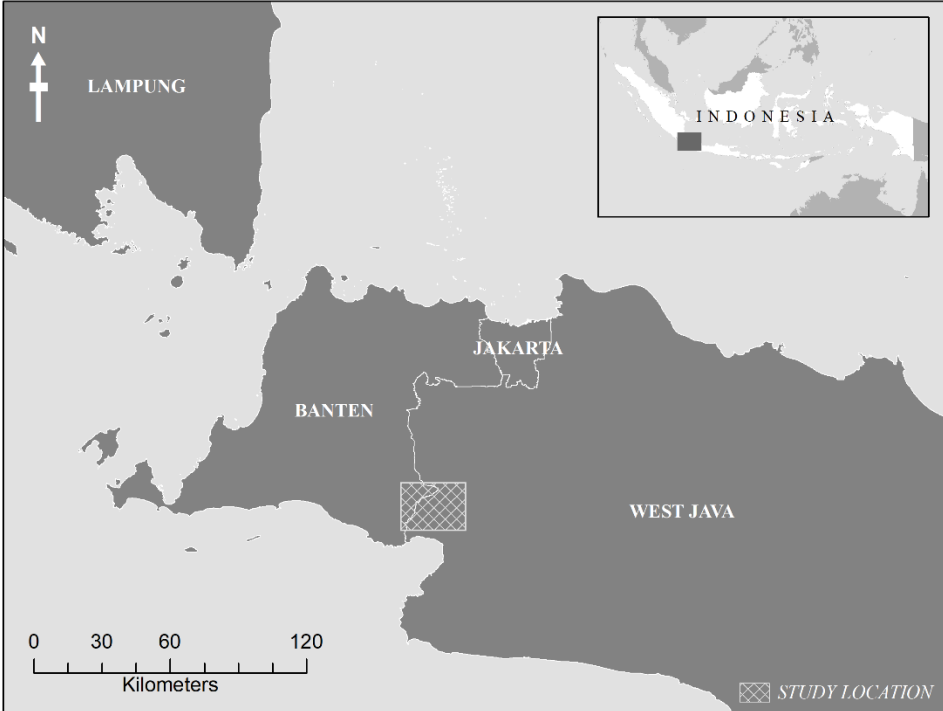


Figure 1. Crosshatch symbol showed the location of Kasepuhan Ciptagelar

2. METHOD

The stages of the research conducted to test the application of the participatory GIS method (PGIS) as an alternative solution in identifying the boundaries of indigenous peoples can be seen in Figure 2. The data used are: 1) very high resolution satellite imagery; 2) high resolution upright satellite imagery; 3) Digital Elevation Model (DEM); 4) Indonesian topographical map (RBI); and 5) multi-resolution satellite imagery. The upright high-resolution satellite imagery used is multi-sensor such as WorldView, Quickbird, and Pleiades with an average spatial resolution of under 1 meter or sub meter with acquisition time 2013-2015. However, at the time of the research the scope of the availability of very high resolution satellite imagery did not meet the needs (Figure 3) so other data was used, namely SPOT 6 high resolution satellite imagery in 2013. In addition to image data, DEM TerraSAR-X equivalent to 1:50.000 of scale and a topographical map of Indonesia with a scale of 1: 25,000 was also used as data to assist the process of identifying the territorial boundaries of indigenous and tribal peoples. Then for the purpose of visualizing the entire results used World Imagery (WGS 84) satellite imagery background obtained from the ESRI base map because it can be directly accessed online and covers all areas needed (ESRI, 2016).

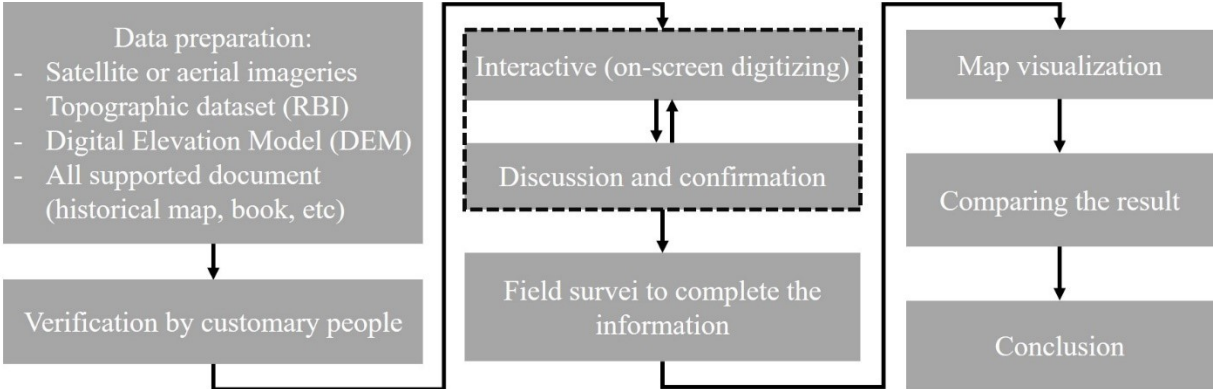


Figure 2. Research stages

Supporting documents are also used in research for example maps that are still used as a reference for the Kasepuhan Ciptagelar community. The map was sourced from the Indonesian Resource Center for Indigenous Knowledge (INRIK) Research Center, Padjadjaran University and the results of field observations in June - October 2001 (Figure 4). In addition, other supporting documents can be in the form of legal products relating to the Kasepuhan Ciptagelar community. After all data and documents have been collected, the next step is the preparation of work maps both print and digital to serve as the basis for drawing boundaries of customary territories. The drawing of the boundary was carried out through a participatory GIS approach involving representatives of the Kasepuhan Ciptagelar community group. On-screen digitizing is done as a way to trace the boundaries of indigenous territories with the help of elements that have been presented through a work map. Usually the method is used to digitize data that was previously only available in print format, for example through tracking elements on a scanned map (Haddock, 1998). Furthermore, if the delineation process experiences obstacles, for example, difficulty in interpreting objects, then a field survey needs to be carried out. The last step is to make sure there are no topological errors, attribute completion and visualization of results.



Figure 3. Kasepuhan Ciptagelar Map as the Sample of Supporting Document

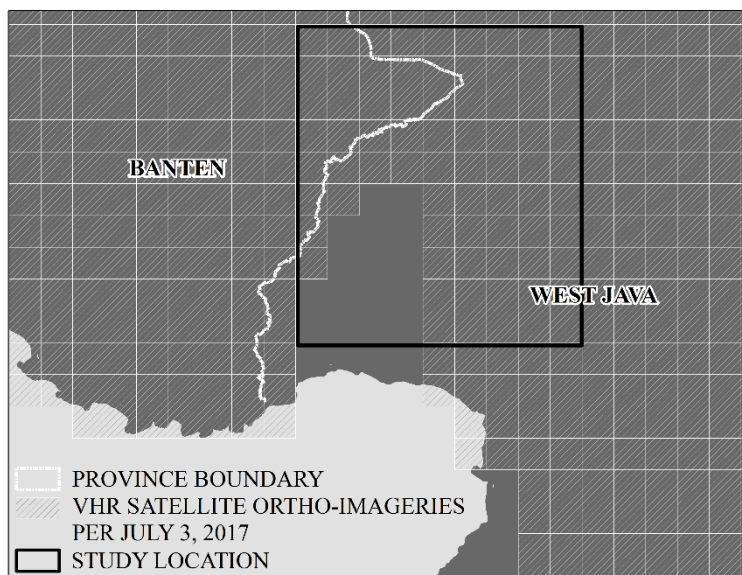


Figure 4. Availability of Very High Resolution Satellite Ortho – Imageries per July 3, 2017

3. RESULT AND DISCUSSION

3.1 Ciptagelar Customary Zone

The determination of the Kasepuhan Ciptagelar customary territory was carried out following the schedule of the Kasepuhan Ciptagelar community. There is the term "rice culture community" which is attached to the people of Kasepuhan Ciptagelar because rice is not only a food commodity but also as part of culture (Kusdiwanggo, 2014). The schedule of meetings with the Kasepuhan Ciptagelar community was held in the evening starting at around 08:00

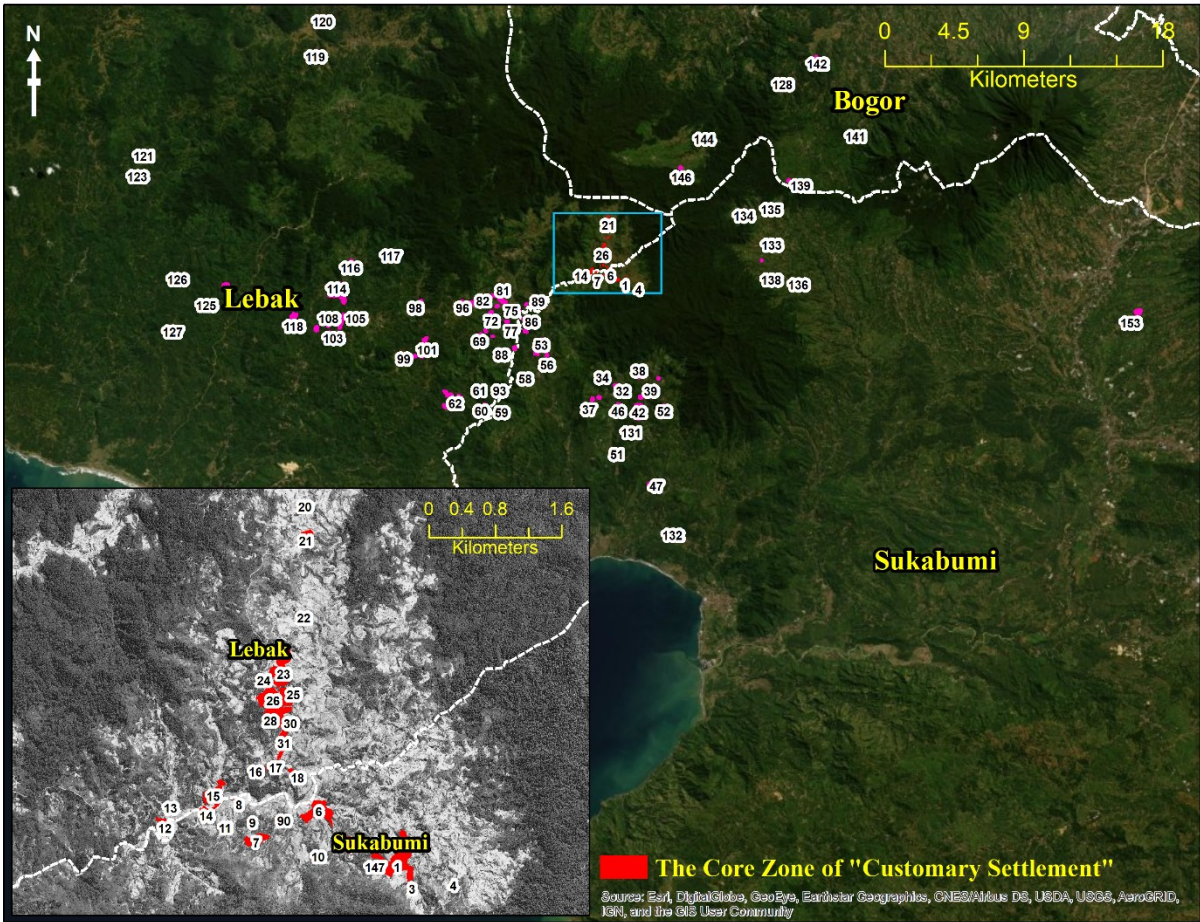
PM of local time (GMT+7) because in the afternoon they carried out daily activities. The meeting was held in the main building in the Kasepuhan Ciptagelar settlement called Imah Gede (Figure 5). Before setting boundaries, the current supreme leader of Kasepuhan Ciptagelar (Abah Ugi Sugriana Rakasiwi) conveyed some characteristics that they believed could meet the requirements to be recognized as the Customary Law Community, namely: 1) a belief system; 2) agricultural systems; 3) institutional system; and 4) the origins of Kasepuhan Ciptagelar. One important step in determining the customary boundaries of Kasepuhan Ciptagelar is the identification of settlements that are still at Kasepuhan Ciptagelar. Settlements that are categorized as still holding the Kasepuhan Ciptagelar are settlements that still follow customary law. The Kasepuhan Ciptagelar people have customary rules for various aspects of life such as: 1) customary rice planting and harvesting systems; 2) frequency of planting and harvesting rice 1 time / year; 3) the resident's house must be roofed in addition to tiles made from earth, the kitchen must be made of natural materials (woven bamboo, wood, etc.), and others. During the identification process conducted in a two-way discussion there were orientation constraints because not all Kasepuhan Ciptagelar people were accustomed to reading maps. Satellite imagery, RBI maps, and DEM greatly facilitated the process of identifying settlements even though there were some corrections to the toponyms of several villages on the RBI Map that were not appropriate in the field. The name of the village and other objects in the field are important because it is the closest identity to the Kasepuhan Ciptagelar community. However, these obstacles can be overcome and the transfer of local knowledge about customary settlements can go as expected. The settlement identification process was done iteratively through clarification which resulted in 153 settlements spread across several districts (Figure 6).



Figure 5. Verification process

The process of identifying the main settlements with Kasepuhan Ciptagelar includes the classification of the core settlements of Kasepuhan Ciptagelar (Figure 6). The core settlements, including Imah Gede, are part of the Kasepuhan Ciptagelar customary area. After the settlement is identified, then the boundaries of garapan land, customary forests (“Tutupan”, “Titipan”, and “Awisan”) are drawn, the results of which are visualized in Figure 7. The boundary markers between “Garapan” land and customary forest are generally rivers and ridges. With proper geovisualization techniques such as 2.5D and 3D using DEM data, it can facilitate the drawing of boundaries in hilly areas (Wibowo, Ambhika, & Pratama, 2019). Human perceptions are very diverse in seeing an object on a map so that using visualization using DEM makes it easier to imagine the navigation process in 3D in tracing boundaries (Ware & Plumlee, 2005). Plan view is a conventional cartographic visualization technique which not everyone can easily understand (Germs, Maren, Verbree, & Jansen, 1999). In addition to rivers and ridges, markers of “Garapan” land boundaries with customary forests are land cover boundaries. There is one location that needs direct verification in the field to ensure the boundaries of “Garapan” land with customary forests, namely around Situ Sinar Galih (around the three-way boundary between Lebak Regency, Bogor Regency, and Sukabumi Regency). The research team and Kasepuhan Ciptagelar community representatives conducted field verification to ascertain the difference between land cover in satellite imagery and those in the field due to temporal differences in data.

One other obstacle encountered was the difficulty in determining the outer boundary of the customary forest area in the north so the team drew the boundary to follow the boundary between Lebak Regency and Bogor Regency. That is because the Kasepuhan Ciptagelar community has not been able to clearly determine the boundary markers. Obtained information from Abah Ugi Sugriana Rakasiwi about the status of customary forests, especially “Titipan” forests which are Kasepuhan Ciptagelar. The “Titipan” forest is an area of Baduy and Kasepuhan Citorek which is entrusted to (the responsibility of) Kasepuhan Ciptagelar. The “Garapan” land, customary forests and settlements have been identified with the largest proportion being customary forests reaching 43%. However, based on the identification results there is a record for delineating the boundaries of “Garapan” land in the southern part (orange in Figure 7). In this area there are settlements that do not have the customary rules of Kasepuhan Ciptagelar so that the research database is described as “Garapan” land claims. These conditions serve as notes for input for policy makers (local governments) in verifying and validating the customary boundaries of Kasepuhan Ciptagelar.



Source: This picture used Esri basemap satellite imagery (© Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community)
Figure 6. The core zone of customary settlement

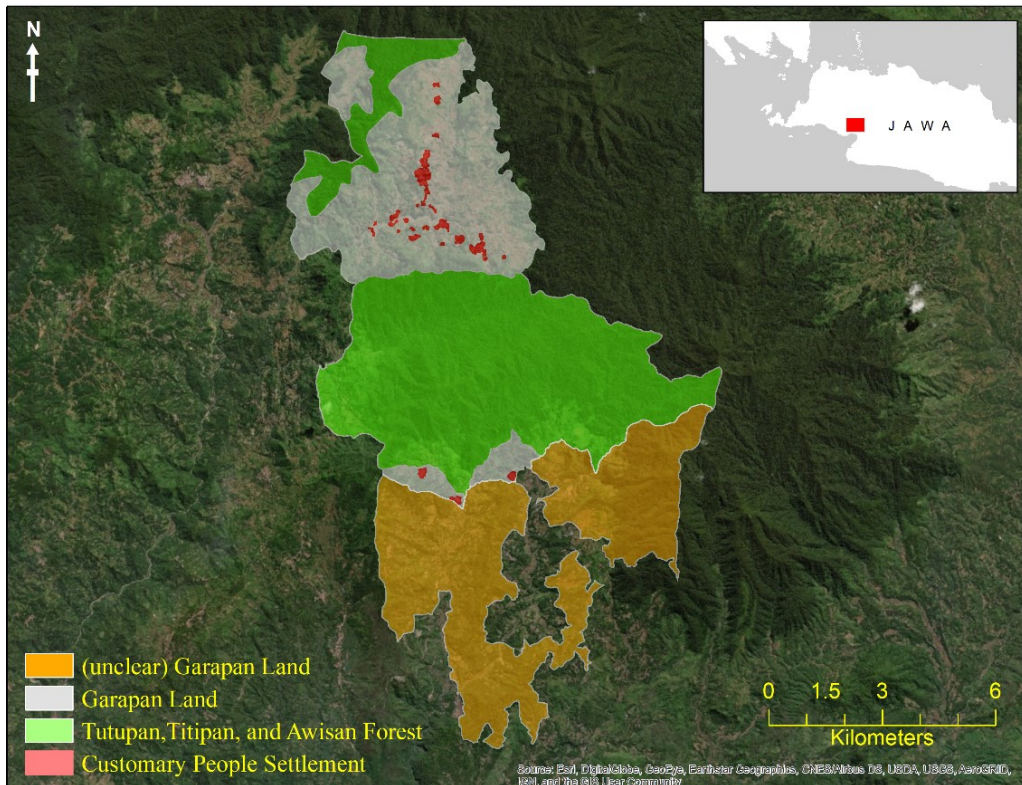


Figure 7. The visualization result of Kasepuhan Ciptagelar customary boundaries

3.2 The Various Version of Ciptagelar Customary Boundaries

After obtaining the Kasepuhan Ciptagelar customary territorial boundaries in accordance with the research stages, overlapping with other data is then performed which also describes the Kasepuhan Ciptagelar customary territorial boundaries, administrative boundaries, and national park areas (Figure 8). There is a very significant difference between the boundaries of the Kasepuhan Ciptagelar area of research results and those produced by INRIK Unpad, which is listed in Lebak Regional Regulation No. 08 of 2015 (abbreviated as PKL), and produced by the Customary Territory Registration Agency (BRWA). The difference in the delineation of the Kasepuhan Ciptagelar area shows the inconsistency of information.

There is a need for verification and validation from parties who have the authority to determine one version of the boundaries of the Kasepuhan Ciptagelar region. In addition, the four versions (according to BRWA, INRIK, Lebak Regional Regulation No. 08 of 2015, and resulted in this research (PGISC)) of the boundary area of Kasepuhan Ciptagelar are located at the district and provincial borders (West Java and Banten). This must be considered comprehensively starting from the determination of the regulatory instruments that will be used for the determination and who has the authority to determine the Customary Law Community. If it is not regulated comprehensively, it can cause sensitive problems because it is related to regional and population management. Another problem that may arise is the complexity of the management of the area that can trigger land conflicts because it turns out that the Kasepuhan Ciptagelar region (various versions) experiences a spatial overlap with the Mount Halimun Salak National Park (TNGHS) (Deddy, 2006)(Ruwiastuti, 1997). Verification and validation by the legal authority (government) are also needed to clarify the status of the Kasepuhan Ciptagelar area which overlaps with state forests.

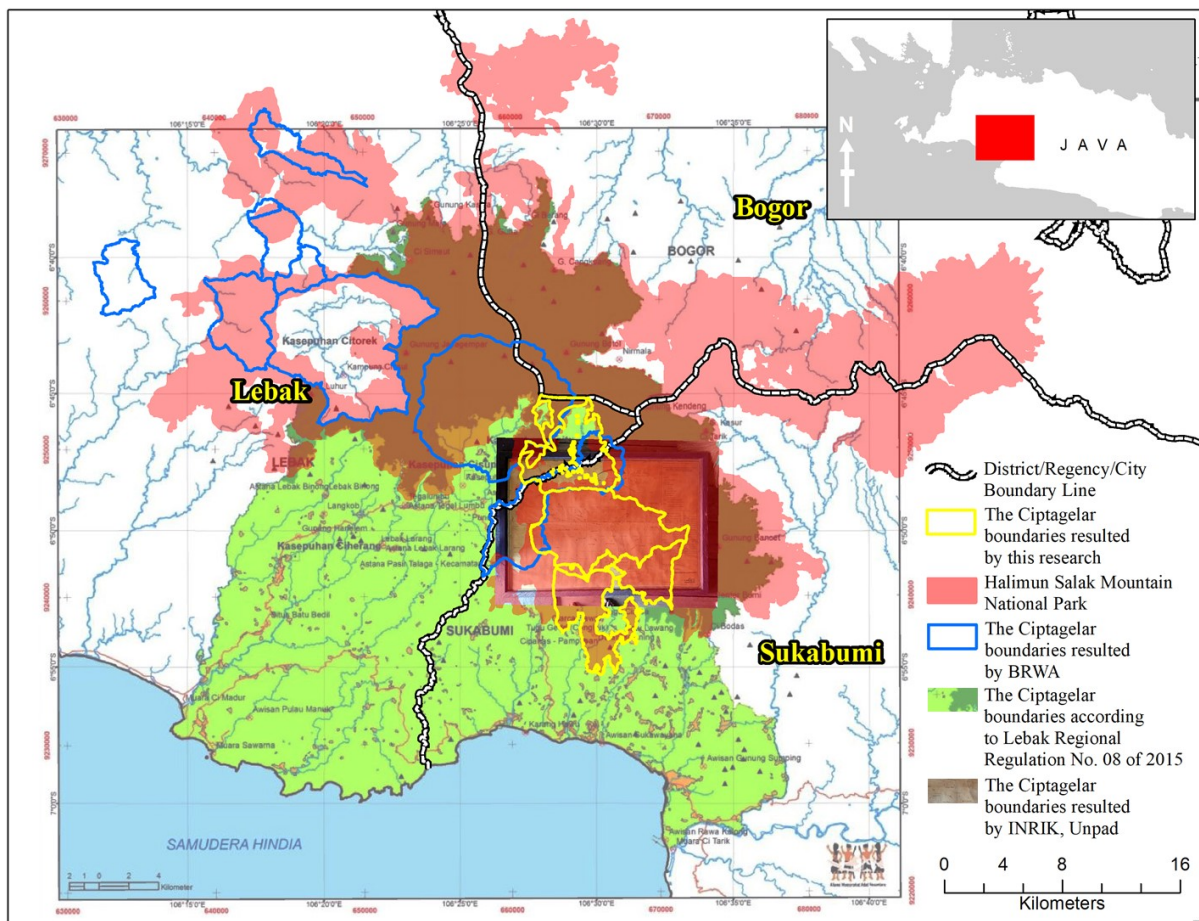


Figure 8. Differences of Ciptagelar boundaries

3.3 CUSTOMARY AREA ON THE NATIONAL FOREST

Further analysis of the customary territories in the TNGHS is only carried out on BRWA, PGISC, and PL data because the customary boundaries of the Kasepuhan Ciptagelar are clearly depicted. Each dataset of the Kasepuhan Ciptagelar customary area was analyzed using the intersection function with the TNGHS area dataset. For the record, specifically for PL's dataset was generated by using digitization process from the attachment of Lebak Regional Regulation No. 08 of 2015 as no data was obtained with the GIS format. The result is the area of the Kasepuhan Ciptagelar customary territorial (multisource datasets) within the TNGHS area calculated in the UTM Zone 48S projection system with WGS 84 of datum (see Table 1). The smallest customary area of Kasepuhan

Ciptagelar is in accordance with the results of this study (abbreviated as PGISC) which is 101.0 sq km +/- 0.4 sq km while the largest area is in accordance with the map attached to Lebak Regional Regulation No. attachment. 08 of 2015 which is 1034.6 sq km +/- 1.9 sq km. Then after the intersection analysis, the PGISC resulted the smallest intersection area too. The intersection area is 101.0 sq km +/- 0.4 sq km where the area before rounding is 100.9 sq km +/- 0.4 sq km. Thus, the results of this analysis can be used as material for consideration in verification and validation, especially in relation to mapping of customary land boundaries located in/near the Indonesian national forests.

Table 1. Customary area on the national forest comparison

Area	Scale	sq km	Intersection with TNGHS (sq km)	%	% Uncertainty of intersection (horizontal accuracy and human error on digitizing)	sq km Uncertainty of intersection (horizontal accuracy and human error on digitizing)
TNGHS	assumed at 1:50,000	1128.2	1128.2	100.0	0.0004	+/- 0.5
BRWA	assumed at 1:25,000	243.8	203.0	83.3	0.0020	+/- 0.4
PGISC	1:25,000	101.0	101.0	100.0	0.0040	+/- 0.4
PL	1:200,000	1034.6	449.3	43.4	0.004	+/- 1.9

4. CONCLUSION

Based on the results of research on the test of cartometry method with participatory approach for the mapping of customary region which was located in/near the Indonesian national forest, several conclusions can be drawn. First, the Kasepuhan Ciptagelar customary area consists of three main functions, namely “Garapan” land, customary forest (“Tutupan”, “Titipan”, and “Awisan”), and customary settlements. Second, there are obstacles in the delineation of customary territorial boundaries, namely the ability to read maps, temporal differences in data, and lack of information about the markers of customary territorial boundaries. Third, there are potential problems that may arise, namely: 1) differences in the boundaries of the Kasepuhan Ciptagelar region according to various sources; 2) the Kasepuhan Ciptagelar area is in more than one district and province; 3) the complexity of the management of the area because it turns out that the Kasepuhan Ciptagelar region (various versions) experienced a spatial overlap with the Mount Halimun Salak National Park area (TNGHS). Fourth, the use of various types of data such as imagery (satellite / aerial photography), RBI maps, DEM, and supporting data (ancient maps, customary rules, etc.) and the use of appropriate visualization techniques can facilitate the process of identifying the boundaries of the Kasepuhan Ciptagelar customary area. Fifth, community group participation and two-way discussion are key factors in the process of identifying customary land boundaries using participatory GIS methods. Sixth, this research resulted smallest area of the Kasepuhan Ciptagelar customary area and the smallest intersection area with TNGHS compared to BRWA and Lebak Regional Regulation No. 08 of 2015 dataset. Seventh, comprehensive (multisector) verification and validation is needed to clarify the boundaries of the Kasepuhan Ciptagelar area so as to minimize problems that might occur. The last, PGIS method can helps stakeholder to map the customary region which was located in/near the Indonesian national forests efficiently.

5. REFERENCES

- Abdulharis, R., Sarah, K., & Hendriatiningsih, S. (2007). The initial model of integration of the customary land tenure system into Indonesian land tenure system: the case of Kasepuhan Ciptagelar, West Java, Indonesia. In *XXX FIG Working Week and General Assembly: Strategic Integration of Surveying Services. 13-17 May 2007, Hong Kong, China: land tenure 14 p.*
- Agrawal, A. (2007). Forests, Governance, and Sustainability: Common Property Theory and its Contributions. *International Journal of the Commons, 1*(1), 111–136. Retrieved from <https://www.jstor.org/stable/26522984>
- Ananta, A., Arifin, E. N., Hasbullah, M. S., Handayani, N. B., & Pramono, A. (2013). Changing ethnic composition: Indonesia, 2000-2010. In *XXVII IUSSP international population conference* (pp. 26–31).
- Badan Pusat Statistik. (2015). Mengulik Data Suku di Indonesia. Retrieved July 25, 2019, from <https://www.bps.go.id/news/2015/11/18/127/mengulik-data-suku-di-indonesia.html>
- Bakker, L., & Moniaga, S. (2010). The space between: Land claims and the law in Indonesia. *Asian Journal of Social Science, 38*(2), 187–203.
- Bruce, J., Wendland, K., & Naughton-Treves, L. (2010). Whom to pay? Key concepts and terms regarding tenure and property rights in payment-based forest ecosystem conservation. *Land Tenure Center Policy Brief, 15.*
- Chambers, R. (1994a). Participatory rural appraisal (PRA): Challenges, potentials and paradigm. *World Development, 22*(10), 1437–1454.

- Chambers, R. (1994b). The origins and practice of participatory rural appraisal. *World Development*, 22(7), 953–969. [https://doi.org/https://doi.org/10.1016/0305-750X\(94\)90141-4](https://doi.org/https://doi.org/10.1016/0305-750X(94)90141-4)
- Cooke, F. M. (2006a). *Asia-Pacific Environment Monograph 1: State, Communities and Forests in Contemporary Borneo*. (F. M. Cooke, Ed.). Canberra, Australia: ANU E Press.
- Cooke, F. M. (2006b). Recent Development and Conservation Interventions in Borneo. In F. M. Cooke (Ed.), *Asia-Pacific Environment Monograph 1: State, Communities and Forests in Contemporary Borneo*. ANU E Press.
- Deddy, K. (2006). Community Mapping, Tenurial Rights and Conflict Resolution in Kalimantan. In F. M. Cooke (Ed.), *Asia-Pacific Environment Monograph 1: State, Communities and Forests in Contemporary Borneo*. ANU E Press.
- Dokhi, M., Siagian, T. H., Sukim, Wulansari, I. Y., Hadi, D. W., & Sambodo, N. (2016). *Analisis Kearifan Lokal Ditinjau dari Keragaman Budaya*. Jakarta: PDSPK Kemendikbud RI.
- ESRI. (2016). World Imagery (WGS 84). Retrieved July 29, 2019, from <https://www.arcgis.com/home/item.html?id=898f58f2ee824b3c97bae0698563a4b3>
- Germers, R., Maren, G. Van, Verbree, E., & Jansen, F. W. (1999). A multi-view VR interface for 3D GIS. *Computers & Graphics*, 23(4), 497–506. [https://doi.org/https://doi.org/10.1016/S0097-8493\(99\)00069-2](https://doi.org/https://doi.org/10.1016/S0097-8493(99)00069-2)
- Global Forest Watch. (2016). World Resources Institute. Retrieved July 26, 2019, from <https://www.globalforestwatch.org/map?map=eyJjZW50ZXIiOnsibGF0IjoyNywibG5nIjoxMn0sImJlYXJpbmciOjAsInBpdGNlJowLCJ6b29tIjoyfQ%3D%3D>
- Haddock, G. (1998). Unit 14: On-Screen Digitizing. Retrieved July 29, 2019, from <http://ncgia.ucsb.edu/cctp/units/unit14/14.html>
- Kusdiwanggo, S. (2014). Fenomena Sakuren Komunitas Adat Ciptagelar. In *Temu Ilmiah IPLBI 2014* (pp. 25–30). Retrieved from https://s3.amazonaws.com/academia.edu.documents/45980687/TI2014-C-p025-030-Fenomena-Sakuren-Komunitas-Adat-Ciptagelar.pdf?response-content-disposition=inline%3Bfilename%3DFenomena_Sakuren_Komunitas_Adat_Ciptagelar.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20190730%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20190730T080809Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=581f8978c0f15d4e04eec729e6a8f646624f40aabe801c08307427869f85ca41
- Pacheco-Angulo, C., Vilanova, E., Aguado, I., Monjardin, S., & Martinez, S. (2017). Carbon Emissions from Deforestation and Degradation in a Forest Reserve in Venezuela between 1990 and 2015. *Forests*, 8(8). <https://doi.org/10.3390/f8080291>
- Ruwiastuti, M. R. (1997). *Hak-hak Masyarakat Adat dalam Politik Hukum Agraria*. (D. Bachriadi, E. Faryadi, & B. Setiawan, Eds.). Jakarta: Lembaga Penerbit Fakultas Ekonomi Universitas Indonesia.
- Verplanke, J., McCall, M. K., Uberhuaga, C., Rambaldi, G., & Haklay, M. (2016). A Shared Perspective for PGIS and VGI. *The Cartographic Journal*, 53(4), 308–317. <https://doi.org/10.1080/00087041.2016.1227552>
- Ware, C., & Plumlee, M. (2005). Chapter 29 - 3D Geovisualization and the Structure of Visual Space. In J. Dykes, A. M. MacEachren, & M.-J. Kraak (Eds.), *Exploring Geovisualization* (pp. 567–576). Oxford: Elsevier. <https://doi.org/https://doi.org/10.1016/B978-008044531-1/50447-4>
- Wibowo, T. W., Ambhika, N., & Pratama, A. P. (2019). Teknik Geovisualisasi untuk Percepatan Pemetaan Batas Desa di Daerah Berbukit. *MAJALAH ILMIAH GLOBE*, 21(1), 35–44.