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Integrating participatory GIS into spatial planning regulation: the case of Merauke District, Papua, Indonesia

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Abstract: In many cases, government institutions insufficiently consider the traditional land use of community areas in spatial planning policy. Although numerous investigations into the participatory mapping of community lands have occurred, their results have not been adequately incorporated into the policy realm. In Indonesia, Spatial Planning Regulation (SPR), or locally known as *Rencana Tata Ruang Wilayah (RTRW)* is an instrument to guide land use practices in the categories of development and protected areas. Using a case study for the Merauke district in Papua province in Indonesia, we demonstrate how participatory mapping results of important community areas were integrated into district-level spatial planning through Participatory GIS (PGIS). There are three phases to the process of integrating PGIS into Spatial Planning Regulation. The first phase is to develop a shared vision between the customary communities and the district government and gain a commitment from both parties to use the results in further planning processes. The second phase is to facilitate the PGIS process, which is conducted by the community and a facilitator – in this case a team of WWF Indonesia Sahul Papua Region Office –, and the final phase is to integrate the PGIS results of the important community areas into spatial planning regulation. The results of our case study showed that of the total area adopted by the RTRW, about 69% were important community areas designated as cultural preservation areas. The remaining important community areas were allocated to two other land use categories: protected areas (22%) and development areas (9%). In this case, 91% of the community areas (647,850 hectares) were secured from other land use purposes such as large-scale agriculture, mining, forestry, and infrastructure. The PGIS approach can be applied to districts across Indonesia for mapping community land use practices and integrating them into Spatial Planning Regulation.

Keywords: Community mapping and spatial planning, ecosystem services, participatory, PGIS

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1. Introduction

For more than two decades, Participatory GIS (PGIS) has been widely used to support the mapping of community resources in order to secure sources of community livelihood and their cultural value areas (such as sacred sites, historical places, ancestor routes). In some tropical countries, community mapping is more accepted by the government, due to the state's recognition of customary right to land¹ as part of the law. For example, in countries such as Mexico, Colombia, and Papua New Guinea, the customary right to land has been formally recognized under state (constitutional) law, and land is clearly allocated for community land use (White et al. 2002; Assies 2007), allowing communities to manage their own land and resources. Nevertheless, in some other tropical countries, including Bolivia, Mozambique, such legal recognition does not exist, creating significant obstacles for the formal adoption of the PGIS results (Mwanundu 2009). Hence, for communities to secure their resources, alternative legal instruments and procedures are required. In Indonesia, spatial planning is defined at three levels (national, province, and district/city). At the district level, spatial planning policy contains the necessary local knowledge but has not yet adequately incorporated local community resources. This article emphasizes three main issues: (1) the importance of PGIS as a tool to increase awareness of community resource management and help to address potential land conflicts to secure their land use, (2) the ability of PGIS to inform spatial planning policy when employed correctly, and (3) the opportunity of Indonesia's 2007 spatial planning regulation (SPR) to serve as a mechanism to align and incorporate PGIS into development planning.

1.1. Description of PGIS

According to Rambaldi et al. (2006b), PGIS "combines a range of geospatial information management tools and methods such as sketch maps, participatory 3D models, community-based air photo and satellite imagery interpretation, GPS transect walks and GIS-based cognitive mapping". The integration between community participatory action learning and the application of geospatial technology characterizes PGIS. Corbett et al. (2006) stated that the term participatory implies that "the community takes as high as possible a degree of control over the decision-making process, managerial power and responsibility during all of the different stages involved" (15).

Mapping experts have acknowledged several PGIS techniques. The first possibility is to just use a simple method using paper to draw a sketch without coordinates. More advanced methods of PGIS use a coordinate system to pinpoint the

¹ Customary right to land: relationship, whether legally or customarily defined among peoples, as individual or groups, with respect to the land (FAO, 2002, Land Tenure Studies: Land tenure and rural development).

original field object on a map (Corbett et al. 2006), which can be made to scale. More complex methods can be applied to use a systematic planning model, such as conservation planning using GIS, and records of discussions to develop scenarios through participatory planning. Another variant of mapping uses Participatory 3D Modeling (P3DM), satellite imagery, or aerial photography. Field observations using a mobile device such as global positioning systems (GPS) and a personal data assistant, such as a smartphone or tablet with GPS may be used (Corbett et al. 2006). For example, P3DM was used in Fiji to incorporate community-mapping results into development planning for ecotourism, biodiversity conservation, and to preserve local community cultural values (Corbett et al. 2006; Rambaldi et al. 2006a,b). We conclude that, although the use of PGIS has led to some achievements to date, the results have generally not been incorporated by planners and decision-makers into spatial planning regulation.

1.2. PGIS for strengthening community resources management

In community mapping, maps are generated that retain a community's place names, symbols, priority features, and local knowledge systems, often to address pertinent local issues (Corbett et al. 2006). In community-based natural resources management, PGIS is applied for community land mapping (mapping the land tenure for individual, family, and customary land); community-based forest management (e.g. delineating boundaries of community forest areas as a part of sustainable forest management, hunting areas, and water springs); and ecosystem services which contribute to community livelihoods and cultural values. This approach has been used extensively in the context of developing countries. For instance, the inadequacy of community land boundary information can give rise to land use conflicts among sectors such as agriculture, mining, forestry, and infrastructure due to overlapping land use allocations (White et al. 2002; Peters 2004).

PGIS can help resolve these land use conflict issues, as studies have demonstrated. In Southern Ghana, Kyem (2004) showed how community facilitators used PGIS to solve land use conflicts that were caused by excessive use of community resources. Human rights activists used a participatory community land use mapping approach (PLUM) to define community land rights in Africa, Asia and Latin America (Barry and Meinzen-dick 2010). In Tinto, Cameroon, PGIS was applied to inform community land use related to forest management, contributing to enhance local governance through participation, to integrate community forest management, to provide access and direct benefit, and to improve forest and biodiversity conservation (McCall and Minang 2005). Further, mobile devices and GPS have been used as a form of PGIS technology to demarcate ancestral areas as part of community cultural areas (Rambaldi et al. 2006a,b). These cases demonstrate how community maps can inform other stakeholders about the traditional land use system, for the purpose of land use planning and better understanding for outsiders, and bridging knowledge gaps (Colchester et al. 2003; Rathwell and Armitage 2015).

Furthermore, PGIS can help identify places of value for the community. This includes places that yield important ecosystem services and places of cultural value (Ramirez-Gomez et al. 2016) such as places for food, water, sacred places, and recreation. PGIS results can strengthen community resource management because of the recognition of ecosystem services on which people depend for their livelihoods and cultural identity (Reid et al. 2005). To date, PGIS applications for mapping ecosystem services are primarily used to define areas of provisioning and cultural services (Brown and Fagerholm 2015). Provisioning and cultural services correspond to two of the six high conservation values (HCV) principles recognized in HCV guidance instruments (HCV Consortium 2008), used to define HCV areas that should be excluded from land development. Inappropriate land use practices can negatively impact ecosystem functioning and often result in a loss of livelihoods and cultural values, contributing to growing inequity and disparities, including increased poverty (Reid et al. 2005).

1.3. PGIS results to enrich spatial planning

The results of PGIS when documented and shared, provide authorities with enhanced insight to ensure recognition of community land use and promote access and legal recognition for community resources that align with development plans and spatial planning policy. PGIS is therefore a key tool for integrating community lands as communal assets in development policies such as spatial planning. Spatial planning regulation (SPR) is a legal instrument that government planning agencies use to design spatial arrangements of national, province, district land use purposes and to control land use practices.

A number of studies documented experiences with PGIS that have resulted in the support of spatial planning (Colchester 2002; McCall and Minang 2005; McCall and Dunn 2012). McCall (2003) showed that in planning processes, PGIS was initially used to demarcate the boundaries of community space ('claiming the territory'), and that the results could be adopted by participatory spatial planning for good governance. There are eight major characteristics that describe good governance; these include the act of being participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive, and following the rule of law.² Effective SPR, which supports good governance, should also incorporate sustainability aspects, which implies the integration of socio-cultural values next to economic goals in spatial planning. When comprehensive spatial planning is implemented, it can create strong relationships between the community, planners, and decision-makers and increase legitimacy, transparency, and ownership (McCall and Dunn 2012). When dealing with spatial planning problems, PGIS can contribute to the empowerment of local communities (McCall 2003).

² United Nations Economic and Social Commission for Asia and the Pacific, What is Good Governance?

1.4. Spatial planning regulation in context: Indonesia

In Indonesia, the spatial planning law was first issued in 1992. Since then, it has been a challenge to integrate community land and SPR for regional development. The spatial planning law was revised in 2007 by the Indonesian parliament to encourage the adoption of SPR. The 2007 law added language that made SPR legally binding and organized according to an 'island-based' spatial planning approach: detailed national spatial planning divided into seven groups of islands. In addition, spatial planning at the province and district level was termed *Rencana Tata Ruang Wilayah (RTRW)*. The RTRW has been divided into two types of planning: (1) general spatial plans based on administration boundaries and (2) detailed plans, such as *kawasan strategis* (Strategic Areas) based on themes such as security and sovereignty, economic, socio-cultural and environmental values, and areas for high technology development (Ministry of Public Works 2007). In general, the spatial pattern in RTRW divides the land into two zones: protection areas and development areas. Each zone has its own land use allocation classification system. Protection areas consist of conservation areas, protected forest, nature reserves, and local protected areas including cultural heritage, riparian forest, and coastal forest. Development areas include dryland agriculture, wetland agriculture, forest production, plantations, mining and settlements.

In the RTRW, forestry lands (consisting of conservation areas, protected forest, and production forest) are administered by the Ministry of Environment and Forestry (MoEF). The land that falls under the MoEF regulations is approximately 130 million hectares based on data from April 2011.³ In order to achieve recognition of customary land for government approval, the community must show clear evidence of land tenure. In 2012, the constitutional court of Indonesia declared that customary community forest should be excluded from state lands (Constitutional Court 2012). In order to integrate community land use into formal policies (such as district RTRW or district strategic areas), a formal mandate for conducting PGIS must be issued, or statements can be requested from local authorities. There is no systematic approach to obtaining a mandate in this situation. It depends on communication, advocacy and on the engagement process. However, a clear benefit of the spatial planning law released in 2007 is that the opportunity exists to accommodate PGIS results.

The aim of this paper is to discuss and examine a scheme for integrating PGIS results into SPR. The basic concepts of community-based forest management consider the fifth and sixth principles of the High Conservation Values approach (HCV Consortium 2008) within the customary land of eight sub-tribes in Merauke district, Indonesia. These forest management practices by communities focus on livelihood (5th HCV principle) and cultural values (6th HCV principle) which can be aligned with district spatial planning regulation to guide land use. The SPR

³ Ministry of Forestry. 2011. National Forestry Plan (*RENCANA KEHUTANAN TINGKAT NASIONAL/RKTN*) TAHUN 2011–2030. Ministry of Forestry.

is named *Rencana Tata Ruang Wilayah Kabupaten Merauke/RTRWK Merauke*. The mapping results of the PGIS are called *Tempat Penting Masyarakat (TPM)*, or ‘important community areas’, due to the benefits to and direct use by communities. In our study, we overlay two land use pattern maps to compare the original map of *Tempat Penting Masyarakat* with a land use allocation map of district spatial planning created by the Merauke Regional Planning and Development Agency (BAPPEDA).

This study contributes to the expansion of the existing planning process by integrating the PGIS results on community land use and forest management, especially their livelihood and cultural values, with SPR. This helps address a fundamental question of how PGIS results on community land use can be adopted in SPR in developing countries.

2. Materials and methods

The methods section is divided into two parts: the description of the study area and the different phases of the PGIS process.

2.1. Study area

The study was conducted in Merauke district, one of 29 districts in Papua province, Indonesia (see Figure 1). The total area of the district is approximately 45,075 km² (an area slightly larger than Denmark) with a total population of about 210,000 in 2013 (BPS-Kabupaten-Merauke 2013). The district is inhabited by the Marind Anim tribe across the 20 sub-districts. The Marind Anim tribe strongly depends on floodplains of small rivers for cultivating sago palms (*Metroxylon* spp.) (which also grow in the wild on the island), swamps and rivers for fishing, and on the grassland for hunting fresh meat (Verschueren 1958). They also plant gardens that fulfil their need for vegetables and fruits (Sohn 2006; Corbey 2010). From a cultural perspective, their mythological traditions relate to natural histories, such as the origin of certain species, the behavior of animals, the history of eddies in the river and the migration routes of their ancestors through the landscape (Van Baal 1966).

Merauke District is part of the TransFly Ecoregion, a priority landscape within the World Wildlife Fund’s Global 200 Ecoregions. The area covers important wetland habitats such as swamp areas, peatlands, monsoonal forest, and mudflats which function as a habitat for migratory birds (Morrison et al. 2009).

The main threats in this region include plans for large-scale plantations for food and energy crop (biofuel) production. For example, the government decided in 2011 to develop a giant agricultural estate called the Merauke Integrated Food and Energy Estate (MIFEE), which has been renamed to Modern Agriculture Land by the current government. This estate is planned to occupy approximately 1.2 million hectares by the year 2018, equivalent to 27% of the entire Merauke district. This scheme was recently confirmed by the government and is divided into

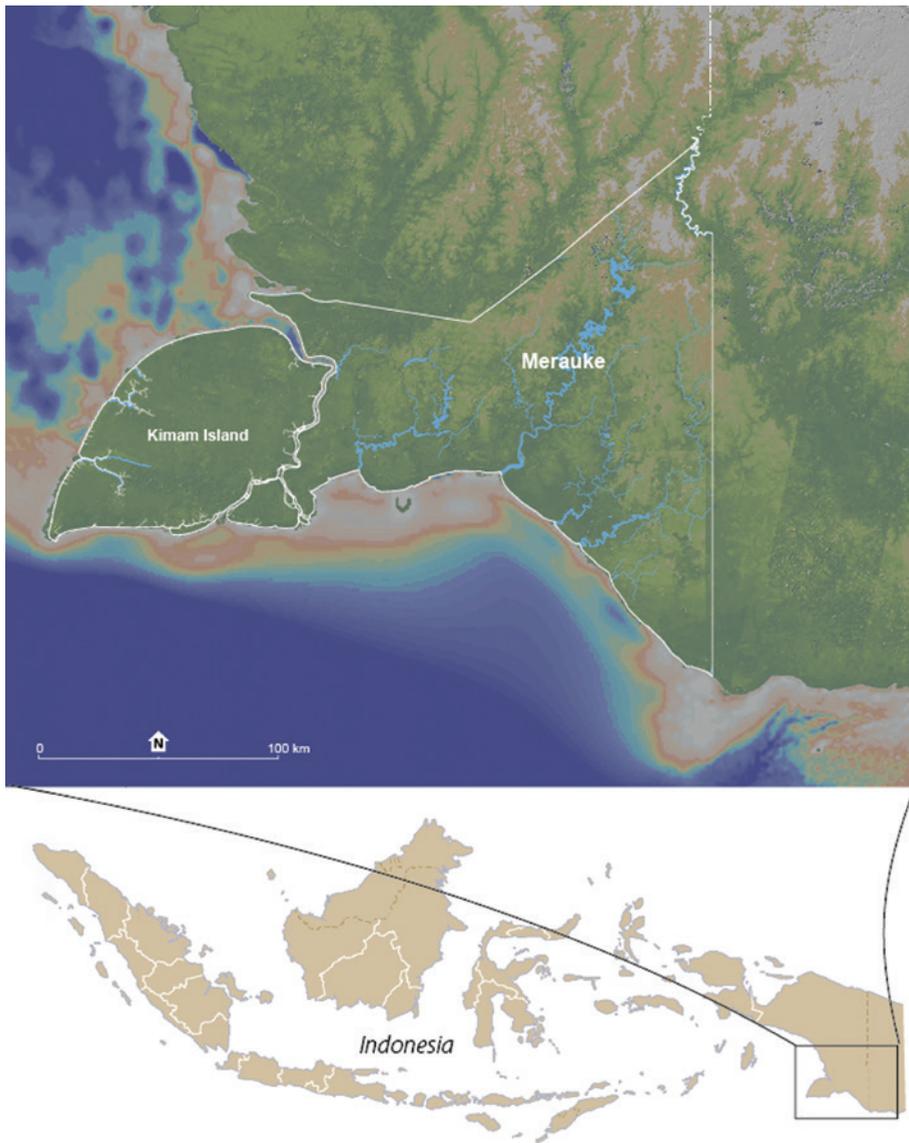


Figure 1: Map of Merauke district, Indonesia.

ten areas. The first project development started from the first to fourth block area and included about 228,023 hectares from 2011 to 2014. Within the fiscal year 2015, the government planned to develop another 250,000 hectares (Coordinating Ministry of Economic Affairs 2011). The main commodities grown on the estate are grouped into food and non-food commodities. Food commodities include rice,

corn, soybeans, wheat, sorghum, vegetables, and fruits. The non-food commodities are palm oil, sugar cane, and rubber. A second term of the project started in 2015 and will be executed until 2019. This is part of a larger development master plan that includes six economic corridors in Indonesia (corridor Sumatera, Kalimantan, Jawa, Bali-Nusa Tenggara, Sulawesi, Maluku-Papua; Coordinating Ministry of Economic Affairs 2011). Given these development plans of the national government, it is very important to ensure that communities in Merauke district have the ability and a strategy to manage their resources in order to avoid overlapping use with concessions for agricultural commodities.⁴

2.2. Phases in PGIS

This PGIS study was performed in three phases. First, efforts were made to obtain both the consent of the communities to support the PGIS process and the political will from government decision-makers to adopt the final outcomes into SPR. The first phase was conducted in 2006 and was facilitated by WWF Indonesia. Second, the PGIS method was agreed upon by tribe leaders, and the process was facilitated by capable facilitators in 2006–2007. This also involved collaboration with customary institutions of Marind Anim tribe. Third, the PGIS results were integrated into SPR by government planners and planning experts. This legal process was led by local government in 2008–2011 and was based on public consultation. Capturing the knowledge and wisdom of the community in this way offers pivotal information for decision-making to reduce land use conflicts and achieve sustainable development (Corbett et al. 2006). Each of the three phases is described below in more detail.

2.2.1. Clear consent and political will (good governance of spatial planning)

Obtaining clear consent and endorsement from traditional leaders and authorities to conduct PGIS is a fundamental phase to allow the integration of the PGIS output into SPR. According to McCall and Dunn (2012), adhering to the principal values of good governance such as accountability, legitimacy, transparency, respect and acceptability is necessary to formally accept and adopt the PGIS results into a spatial plan (McCall and Dunn 2012).

In this case, the mapping goal was agreed to by the head of district and customary leaders to ensure adoption by the government. This involved balancing the interests of the government and local communities. The government wanted to obtain support from the community regarding their broader plan for regional

⁴ Yulianus Bole Gebze, Marco Wattimena, Wika Rumbiak, and Tri Waluyo, "Report on Results Identification of Important Community Areas of the Tribe Large Marind Anim in Bio-Vision Trans Fly Eco-Region (*Hasil Identifikasi Tempat Penting Masyarakat Suku Besar Marind Anim Dalam Bio-Visi Ecoregion Trans Fly*)."
Edited by Yulianus Bole Gebze, Albert Gebze Moyuend, Romanus Mbaraka, and Thomas Barano. Published in Merauke district, Papua province of Indonesia, collaborative programme: Merauke district government, Customary Marind Anim tribe, and WWF-Indonesia.

development, while the community wanted to secure their resources. The agreement was stated in a stakeholder forum; an oral statement was used to express accordance between the Head of Regency of Merauke and the three customary institution leaders. This was an effective and efficient approach to obtaining an agreement between both parties that helped to achieve a common vision based on criteria from SPRs and requirements regarding land use allocation while respecting the communities' local livelihoods and cultural values.

2.2.2. Working with the community to conduct participatory GIS

When exploring community knowledge through mapping, it is important to take into account that this knowledge is mainly based on their cognitive map. Studies in human ecology indicate the importance of examining the relationship between human behavior and their environment (McLain et al. 2013). In order to make PGIS truly participatory, certain principles and ethics need to be applied, such as transparency, openness and honesty, and respect for local wisdom and traditions. Additionally, it is important that the process and its outcomes are recognized by the community (Rambaldi et al. 2006a).

The method of PGIS was divided into a three-step process (shown in Figure 2). These three steps are (1) preparation (2) data gathering and (3) the mapping process. These steps are explained in detail in the following section.

2.2.2.1. Preparation

During the preparation step, the aim of participatory community mapping is clearly defined. The participatory community mapping purpose is to support community-based forest management including their cultural heritage. The objective defined in this case was to capture the community knowledge on traditional land use, based on two important categories of information: local livelihoods and cultural values. This goal of mapping was meant to guide the entire process and indicate a clear target to deliver the desired results. The preparation also included defining ethical principles and procedures for the mapping process. If this preparation of the participatory mapping process is not done properly, it can cause issues during the remaining steps (Rambaldi et al. 2006b; Mwanundu 2009). An important principle in this study was that community members identified experienced, trusted individuals to represent their sub-tribe with well-established knowledge of local traditions and customs. Certain principles were also developed by the WWF team to guide the facilitator and the process. For example, one principle stated that the facilitators should not impose their own thoughts or opinions or influence the local community's opinion. Furthermore, the facilitators should not discuss issues that are believed to be taboo or private for the local residents during the mapping process with the community. Practical ethics for PGIS include several other guiding principles that had to be applied by the mapping facilitator, such as having an open and honest dialogue, defining a clear purpose and objective, obtaining informed consent from stakeholders, and being neutral and avoiding the creating of false expectations (Rambaldi et al. 2006a).

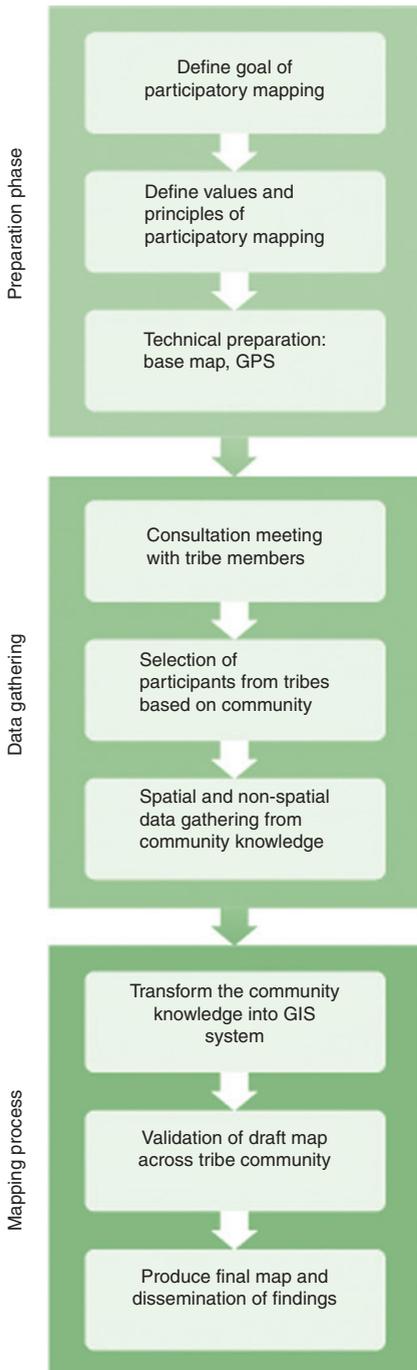


Figure 2: The flow of PGIS mapping with indigenous people.

The method of the mapping process was also preliminarily discussed with the sub-tribe leaders in order to agree on the mapping principles in the preparation step. The sub-tribe leaders and members then internally discussed and confirmed the mapping process before it was accepted by sub-tribe members. This included the community rules regarding taboos that could not be discussed during the mapping process. Furthermore, the values and principles used by facilitators were communicated to the tribe leaders. The leaders then conducted an internal assessment, after which they presented their feedback to the tribe members. Tribe members who were eligible to represent the sub-tribe and act as a key resource person were those who were well known to the sub-tribe members. Furthermore, the technical material was prepared, such as geo-referenced Landsat images, transparency sheets, pens for recording the information, and key questions that could be asked during the process. The community felt confident using a sketch map tool based on transparency sheets overlaid on geo-referenced Landsat images. They had the freedom to delineate the TPM. A GPS was used for sampling and validation of certain TPM that were not taboo areas (such as hunting areas, sago palm area, and old villages). The final map is owned by the community, and the team committed itself to provide a printed map for each sub-tribe. It was agreed that the final product of TPM would be formally handed by community leaders to the government as an input into SPR.

2.2.2.2. Data gathering

In order to describe the TPM in terms of community livelihoods and cultural identity, a set of values were identified by the WWF team based on the High Conservation Values (HCV) framework (Daryatun et al. 2003; The HCV Consortium 2008). The HCV5 category of this framework deals with community livelihoods, and identifies the location of provisioning services, while HCV6 covers cultural value and identity, to identify the location of cultural services (Reid et al. 2005). The data gathered for mapping was based on a set of key questions. The questions were grouped into two categories: provisioning and cultural services. First, the sub-tribe members were asked to describe their traditional land use system and to discuss how it needs to fulfill their livelihoods – this would include hunting areas, traditional protected areas (areas provisioning for traditional medicine, wood for houses, wood for canoes, etc.), and the location of water sources and sago palm cultivation. For example, where are their hunting grounds? Where do they gather water and carbohydrates (such as sago palm and sweet potato)? Where are their main locations for collecting traditional medicine? Where are their main fishing areas?

With the second category of questions, respondents were asked to describe important community areas in relation to cultural values such as sacred sites, historical places, and ancestral routes. What are the important mythological routes where ancestors are believed to migrate through the landscape and where are they located? Where are the historical places of the village or tribe? Where are sacred areas located? How is the story of their family name related to certain species and

its habitat? These questions reflected the important community areas that were needed to preserve their livelihoods and cultural values.

2.2.2.3. Mapping process

The community drew a cognitive map that included their knowledge within the two categories mentioned above on transparency sheets that were eventually overlaid on satellite imagery Landsat images (with a resolution of 30 m). The Landsat images were geo-referenced and projected. The information from the transparency sheets was converted into digital format and integrated into GIS by the WWF team. These processes were conducted for each of the eight sub-tribes of the Marind Anim tribe. They also described their social structure and hierarchy. The next step was to gather representatives from all sub-tribes to review the data and maps. In this step, the map legends from the eight sub-tribes were synchronized and integrated into a single encompassing legend by sub-tribe leaders and a GIS officer. Once the map legend was approved by tribal leaders, these became representative maps for the entire Marind Anim tribe. The final map was signed by the tribal leaders as a final confirmation and approval, which was witnessed by the facilitators and district government officers.

2.3. Integrating PGIS results into SPR

The process of integrating the PGIS results into SPR was executed as the final phase of the method. The SPR objectives provided a good understanding of the scope of the planning process. However, initially, there was no clear methodology regarding how the community mapping results should be integrated into the SPR. The procedure that was followed and described below, evolved through a process of experiments and learning, using new spatial planning instruments such as Strategic Environmental Assessment (SEA), as adopted by the Environmental Protection and Management Law in 2009.

First, the PGIS results were formally presented by the communities to the local government. Furthermore, frequent meetings between the local government authorities and the facilitators were organized by the Regional Planning and Development Agency (BAPPEDA) and the WWF team. Subsequently, the PGIS data were interpreted by government planners based on the terminology of TPM and their corresponding meaning in formal terms of the SPR. With the help of the SPR objectives for 2010–2030, specific spatial data requirements had been identified (see Table 1). Some of the input maps were collected by planners from different agencies, including the map of TPM. The purpose of all data gathered was to conduct regional analysis to define the land use allocations and, concurrently, to conduct a strategic environmental assessment. The results of the analysis were eventually used by the planners to formulate recommendations for the regulation of each land use class allocation (for example, land use allocations under protection areas including wildlife sanctuaries, riparian buffer zones, buffer zones for

Table 1: Spatial data needed for the analysis of district spatial planning.

Biophysical data	Social data	Economics and infrastructure data
Forest cover, watershed, riparian forest, coastal forest, river systems, critical areas vulnerable to disasters e.g. flooding, drought and fire in peat forest areas, landform, soil types, climate, mud flats, swamp/wetland areas	Existing population and distribution, education level, health services e.g. number of nurses and doctors, important areas for supporting community livelihood and cultural areas	Market places, roads, settlement areas, offices area, bridge, electricity, power plant, clean water services, drainage system, and transportation systems via air, river, and sea.

coastal areas, water springs and sources; land use allocation under development areas including agriculture, plantations, and settlements).

The government planning consultants often required more detailed clarifications regarding the PGIS results. For example, the technical information from the spatial data (projection system, base map, and tabular data) required an explanation from the WWF team to the government planning consultant (for example, the projected Landsat images used for PGIS were based on the Universal Transverse Mercator (UTM) coordinate system, and the coordinates were collected using GPS to do geometric processing). Furthermore, they needed to know how they should use the results and understand the relative importance of the classification of TPM. Furthermore, the classification of the TPM needed to be translated by government planning consultants into the classification of land allocation as part of the SPR framework.

After this translation process, the PGIS results were ready to be inserted into the SPR, for which purpose the Strategic Environmental Assessment tool (SEA) was used. The SEA guidance was developed by the Ministry of the Environment (currently the MEF; Setyabudi 2008) and emphasizes three principles; namely *keterkaitan* (interdependence), *keadilan* (justice), and *keseimbangan* (equilibrium). *Keterkaitan* means considering the linkages between regions, sectors, and from local to global level and vice-versa. *Keadilan* emphasizes that the land use allocation policies, plans, and programs using the resources are not controlled by certain people because they have a capital or influence, but are meant to benefit all people, to reduce poverty and provide jobs for marginal communities. *Keseimbangan* involves the landscape's carrying capacity and uses of resources, the utilization balance between protection and restoration, and balancing resource management and utilization with impact. As part of the Indonesian spatial planning process, a SEA is mandatory: the law (No. 32/2009 article 19) states that the SPR should be assessed by a SEA, in order to ensure that environmental, social and economic features of the region are considered effectively in policy plans and programs.

PGIS can contribute to reflecting aspects of social justice and the balance of modern life and traditional ways in the SEA principles related to spatial planning (Bina 2007), helping to ensure that communities have the right to access

their land and resources. The participatory mapping of community land use and resources is thus a robust input for SEA in the Indonesian context, in terms of social aspects. A technical challenge in the process arose when the TPM was required to be spatially explicit in land use allocation, even when standard formal spatial planning symbols were not available. TPM was delineated with a new symbol of hollow polygons in the map legend as cultural preservation areas (see Figure 6B).

The WWF team worked with planning consultants of the district government who used the SEA result to derive recommendations for proposed land use allocation. The primary recommendation was that the spatial plan should explicitly delineate the TPM and associated land use allocations in regulation. The consultants used the technical results regarding land use allocation for developing a draft SPR for the Merauke District. Then, the draft SPR was reviewed by the public, the general public and the province of Papua, before the document was submitted by the district government to the local parliament for formal endorsement. The SPR was then formally endorsed.⁵

Figure 3 summarizes the process of spatial planning and the process of integrating the PGIS results into the SPR (Ministry of Public Work 2009) (Figure 5). Finally, we also calculated the area of the original TPM compared with the TPM

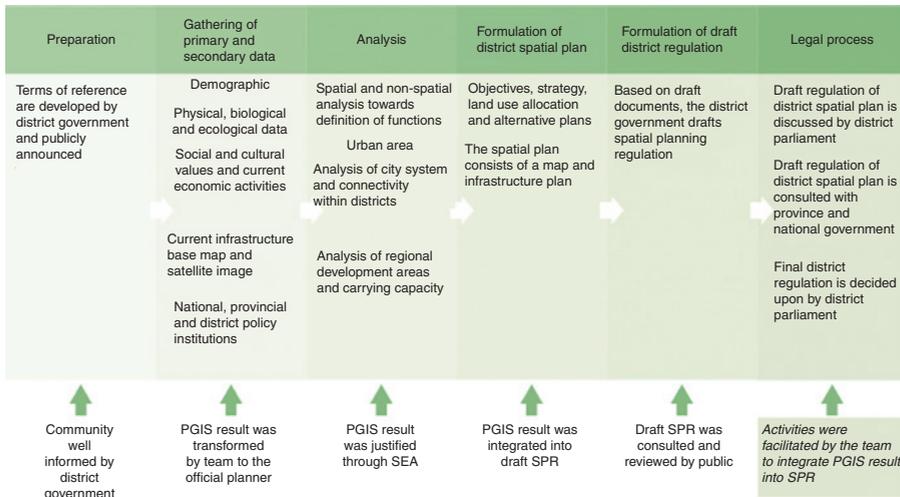


Figure 3: The process of integration of the PGIS results into a formal framework for district spatial planning (Source of formal Spatial Planning Process: Ministry of Public Work 2009).

⁵ Regional Development and Planning Agency (Bappeda)-Merauke. 2011. Spatial Plan Regulation of Merauke District No 14/2011. Merauke district, Papua province of Indonesia: Regional Development Planning Agency.

as integrated into the SPR using the spatial analysis tool from the ArcMap 10.2.2 software.

3. Results

The three-phase process described in the Methods section was conducted to effectively integrate the PGIS results into the SPR (as shown in Figure 4). First, a clear common objective was set and political will and community consent were



Figure 4: The process of integration of PGIS results into spatial planning regulation was conducted in three phases.

obtained. Second, the mapping process was done with members of the community. The final phase was to integrate the community map into the SPR of the Merauke district RTRW at a scale of 1:50.000.

3.1. Strong political commitment and community consent

It was apparent prior to this project, that robust political commitment was needed at the beginning of the process. The main reason for that was the need to integrate community forest management into the District development plan. This was clearly stated by the head of the Merauke district during a workshop that discussed the agreement of a multi-stakeholder collaboration on the management of production forest based on local knowledge. Community forest management was assumed to be able to both provide community livelihoods and safeguard important cultural values. Three points were explicitly stated as requirements for effective community resource management (encompassing sustainable forest management). The first was that participative community mapping of their land use should be done, the second was recognizing the community land management territory, and the third was delineating the land rights boundaries⁶ (see Figure 4).

The willingness of the community to manage their land and resources was expressed at the community vision on Biodiversity – Social – Cultural Workshop that took place in Madang on 16–18 May 2006. PGIS advisor Julianus Bole Gebze stated, “We, the peoples of the TransFly, are proud of our land, our stories, our heritage and our natural environment. Our children learn to look after our land through the law of our ancestors, with careful management and by joining hands across borders. May our monsoon forests and savannas continue to teem with birds, our rivers with Barramundi and Saratoga and our swamps with crocodiles, our spirits fill our children’s dreams and may we dwell in a community of wealth and beauty.”⁷

The permission to conduct participatory community mapping was agreed upon by the Marind Anim tribe. The main motivations for the tribal leaders to agree with conducting this mapping were the support for community-based forest management and the maintenance of their cultural heritage for livelihoods and cultural identity. Therefore, the community leader requested that mapping be done to secure their land within the framework of the district development plan. It was then already clear that the Merauke district had been planned by the national government as a location for MIFEE (Coordinating Ministry of Economic Affairs 2011), although the number of hectares of land was still under debate. This posed a potentially troublesome land use conflict between the community and the MIFEE

⁶ Sofyandy, Dendy. 2006. “An agreement of Multi-Stakeholders Collaboration on Sustainable Production Forest Management Based on Local Wisdom (*Kesepakatan Kerjasama Multi-Stakeholder Pengelolaan Hutan Alam Produksi Lestari Berbasis Kearifan Lokal*).”

⁷ Julius Bole Gebze, his speech on Biodiversity and Socio Cultural Workshop on 16–18 May 2016 in Madang, PNG.

project because these acceleration and expansion plans could affect their livelihood and resources.

3.2. Participatory community mapping results

There were two important types of results from PGIS. First, the social structure of the Marind Anim tribe that had never been publicly divulged, was clearly described. The second was the map that delineated important community areas. Both of these are explained below.

The social structure of the Marind Anim tribe is shown in Figure 5. This structure was revealed when the mapping principles were established by the team in the preparation phase, and offers valuable insight into local institutions for natural resources management. For example, who in the tribe have leadership roles in the community, and have authority in customary law and knowledge on natural resources management?

The structure was categorized into three levels. First, the highest level of community leaders is called the *Kunam*, who are selected after passing several initiations based on the criteria of the customary law. They are believed by tribe members to be people who understand the customary law, have valuable tribal knowledge and who maintain the cultural values and wisdom of the tribe. They have a role in the community as persons who can help to solve problems and make decisions based on customary law.

In the PGIS process, *Kunam* were the leaders facilitating and integrating map results from the eight sub-tribes. The second level of community leaders is called *Mitawal*. The person in this position is selected and coached by the *Kunam* to be a future leader. Their knowledge of the customary law is less than that of the *Kunam*. They are monitored by the *Kunam* to assess their attitude, wisdom, and

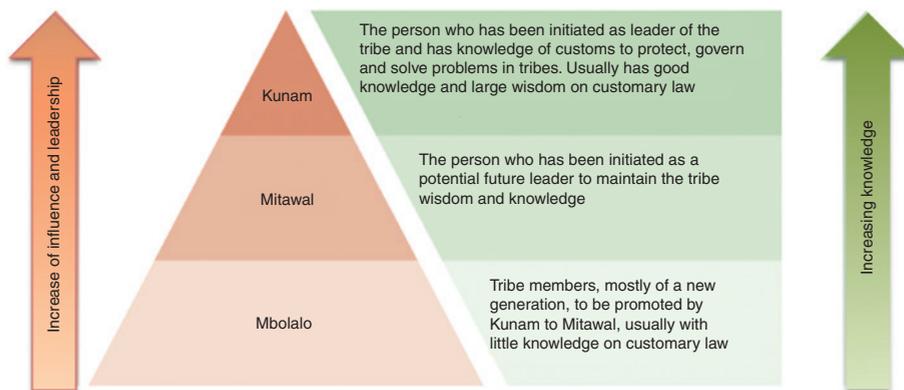


Figure 5: Social structure of Marind Anim tribe.

behaviour towards other tribe members. Not all of the *Mitawal* will reach the highest level of social structure. The third level is called *Mbolalo* referring to common members of the tribe who are young and have the potential to be promoted by the *Kunam* to become a *Mitawal*.

3.2.1. Map of *Tempat Penting Masyarakat (TPM)*

The map shows the TPM that are distributed along the main rivers of the Merauke district (Figure 6A). The map legend was divided into two groups of ecosystem services (Table 2). The first group in the legend represented the cultural services such as the ancestral routes, ancestral transit, and sacred sites. The second group reflected the provisioning services such as sago production, traditional conservation areas where non-timber forest products are harvested, and water sources.

As shown in Table 2, the total area of TPM is approximately 710,305 ha. The sacred site area makes up the largest percentage of community land use; this area covers nearly 279,562 hectares, which is 39% of the total important community areas. The second largest is the cultivated sago palms that cover an area of approximately 190,157 hectares (27%). In total, the cultural service areas comprise 373,568 hectares (53%). The total area of the land important for services provision was approximately 336,737 hectares (47%).

Each class of the TPM was defined as follows² (Figure 6A and Table 2):

- Ancestral routes: The route that the souls of their ancestors follow to reach their final destination for peace and rest.
- Ancestor transit: The stopover area for the ancestral soul before it reaches its final destination.
- Ancestral sacred sites: The area is taboo for any activities that fall outside the boundaries of religion and traditional ritual ceremony.
- Cultivated sago palm (in local language called *dusun sagu*).
- Traditional conservation areas: The community area that provides traditional medicine, wood for building houses, and hunting areas, based on a traditional harvesting system called *Sasi*, according to rotational harvesting.
- Traditional water resources: The spring water, rivers, swamps, or artificial wells in peat lands that serve as freshwater sources during dry and wet seasons.

3.3. The PGIS results incorporated into SPR

Figure 6B shows the TPM as integrated by government planners into SPR as a *Kawasan Pelestarian Budaya* (Cultural Preservation Area). The land use classes in spatial planning are divided into two categories: protection and development areas. The total land use allocation for protected areas is higher at 63%, compared

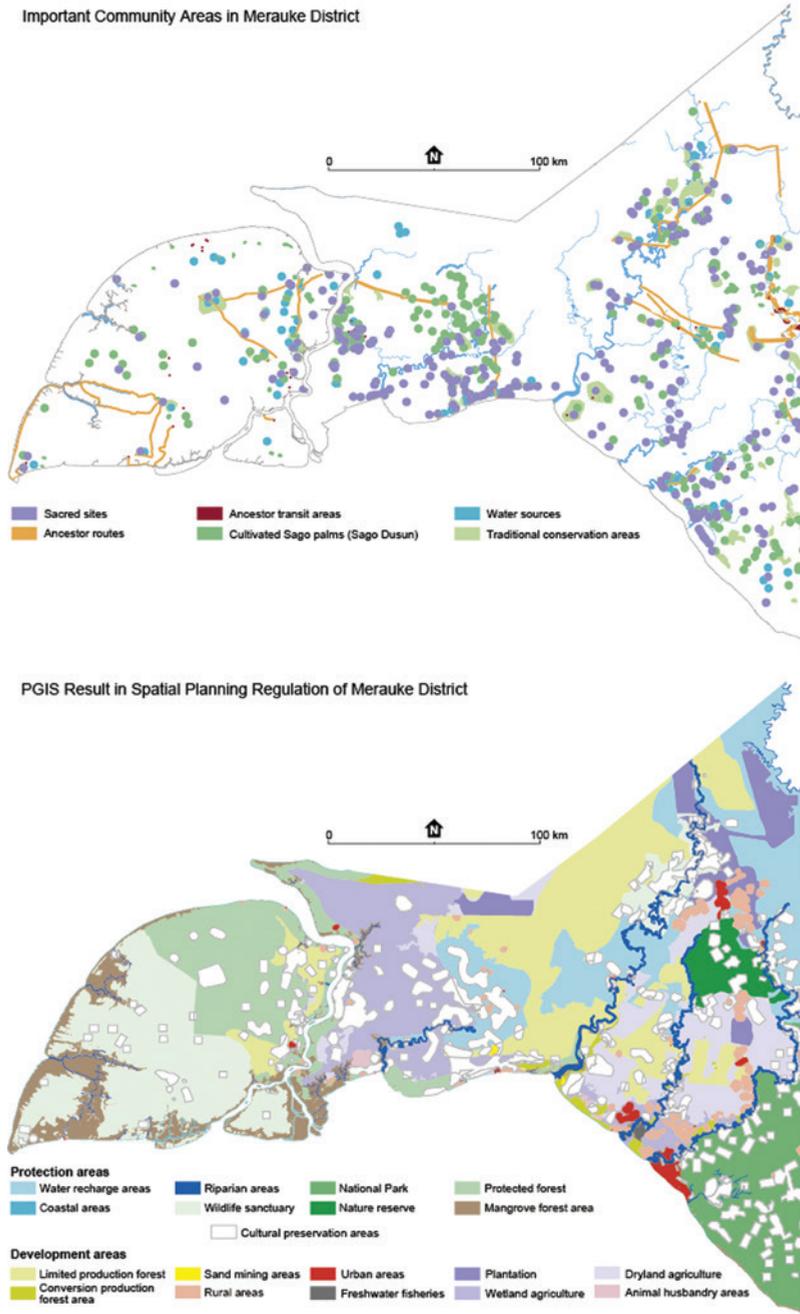


Figure 6: (A) Upper map; PGIS mapping result of important community areas of the Marind Anim tribe of Merauke district. (B) Lower map; PGIS mapping result as adopted by Spatial Planning regulation (RTRWK) of Merauke district.

Table 2: Mapping results for *Tempat Penting Masyarakat or important community areas*.

No	Category of important community areas	Size (ha)	Share (%)
1	Ancestor route	79,689	11.22
	Ancestor route associated with ancestor transit, traditional conservation areas, and water resources	10,575	1.49
	Total ancestor route	90,264	12.71
2	Ancestor transit	3110	0.44
	Ancestor transit associated with traditional conservation areas, and water resources	632	0.99
	Total ancestor transit	3742	0.53
3	Sacred sites	192,626	27.12
	Sacred sites associated with ancestor route, ancestor transit, traditional conservation areas, water resources, and cultivated sago palms	86,936	12.24
	Total sacred sites	279,562	39.36
	Subtotal cultural areas	373,568	53
4	Cultivated sago palms	157,945	22.24
	Cultivated sago palms associated with ancestor route, ancestor transit, traditional conservation areas, and water resources	32,212	4.53
	Total cultivated sago palms	190,157	26.77
5	Traditional conservation areas	84,616	11.91
	Total traditional conservation areas	84,616	11.91
6	Water resources	50,943	7.17
	Water resources, traditional conservation areas	11,021	1.55
	Total water resources	61,964	8.72
	Subtotal provisioning services	336,737	47
	Total	710,305	100

to development areas that make up 37% (Table 3). The major contribution to land use allocation consisted of cultural preservation areas, which occupied 13%. Within this land use allocation, community land uses have been recognized by the local government, which allows them to access and manage their land. Further analysis was conducted to document how much of the original mapping of community important lands (land uses) has been adopted by the district spatial plan (RTRWK).

The SPR No. 14/2011, regarding RTRWK Merauke, was endorsed by the local government on August 1st, 2011 for twenty years³. The RTRWK Merauke used specific terms to define important community areas (see Figure 6B). The total land use allocation for Cultural Preservation Areas is approximately 608,581 hectares (see Figure 6B and Table 3). The community land that is essential for local livelihoods, cultural values (sacred sites, and ancestor transit), and resources (cultivated sago palms, water resources, traditional conservation areas), was strongly emphasized in the district government plan. The ancestral routes were not explicitly adopted in the spatial plan; these form long polygons in the map of Figure 6A.

Table 3: Land use classes of Spatial Planning Regulation (RTRWK) of Merauke district.

No	Land use class	Size (ha)	Share (%)
Protection areas			
1	Coastal areas (<i>Sempadan pantai</i>)	9654	0.21
2	Nature reserve (<i>Cagar Alam Darat</i>)	87,386	1.89
3	Riparian areas (<i>Sempadan sungai</i>)	149,934	3.24
4	Mangrove forest area (<i>Kawasan hutan bakau</i>)	274,659	5.93
5	National Park (<i>Taman Nasional Darat</i>)	323,466	6.99
6	Protected forest (<i>Hutan Lindung</i>)	393,910	8.51
7	Water recharge areas (<i>Resapan Air</i>)	492,333	10.64
8	Wildlife reserve/sanctuary (<i>Suaka Margasatwa</i>)	582,907	12.59
9	Cultural preservation areas (<i>Kawasan Perlindungan Budaya</i>)	608,581	13.15
10	Coastal abrasion (<i>Abrasi pantai</i>)	–	–
11	Vulnerable flood areas (<i>Kawasan rawan banjir</i>)	–	–
Subtotal		2,922,830	63.14
Development areas			
1	Sand mining areas (<i>Kawasan Galian Glongan C</i>)	2289	0.05
2	Freshwater fisheries (<i>Perikanan darat</i>)	3728	0.08
3	Animal husbandry areas (<i>Peternakan</i>)	9155	0.20
4	Urban areas (<i>Kawasan perkotaan</i>)	35,515	0.77
5	Conversion production forest area (<i>Hutan produksi yang dapat dikonversi</i>)	39,188	0.85
6	Rural areas (<i>Kawasan perdesaan</i>)	104,867	2.27
7	Plantation (<i>Perkebunan</i>)	169,875	3.67
8	Dryland agriculture (<i>Pertanian lahan kering</i>)	293,916	6.35
9	Wetland agriculture (<i>Pertanian lahan basah</i>)	388,069	8.38
10	Limited production forest (<i>Hutan produksi terbatas</i>)	659,625	14.25
Subtotal		1,706,227	36.86
Grand Total		4,629,057	100

Sources: Bappeda-Merauke.⁵

3.3.1. Comparing the areas with a protection function in SPR with the original map of TPM

Further analysis compared the area with a protection status in SPR (Figure 6B) with the original TPM (Figure 6A). The results of the overlay between Figure 6B and Figure 6A are shown in Figure 7. The total area of community land uses that was matched with the cultural preservation areas of the Merauke district spatial plan was about 490,385 hectares (69% of total TPM area) (Figure 7). The community land uses that did not match with the cultural preservation areas of the Merauke district spatial planning covered approximately 219,946 hectares (31% of total TPM area). These areas were merged into other land use categories. The areas with a protection function corresponded to 157,465 hectares and the development areas to 62,481 hectares (Figures 9 and 10). The cultural preservation area is a part of the category of 'Areas with a protection function' in the Merauke district spatial plan. As much as 91% of the important community lands (or 647,850 hectares) have been allocated as cultural preservation areas and other land use

Overlaid map of PGIS result and spatial planning regulation of Merauke district

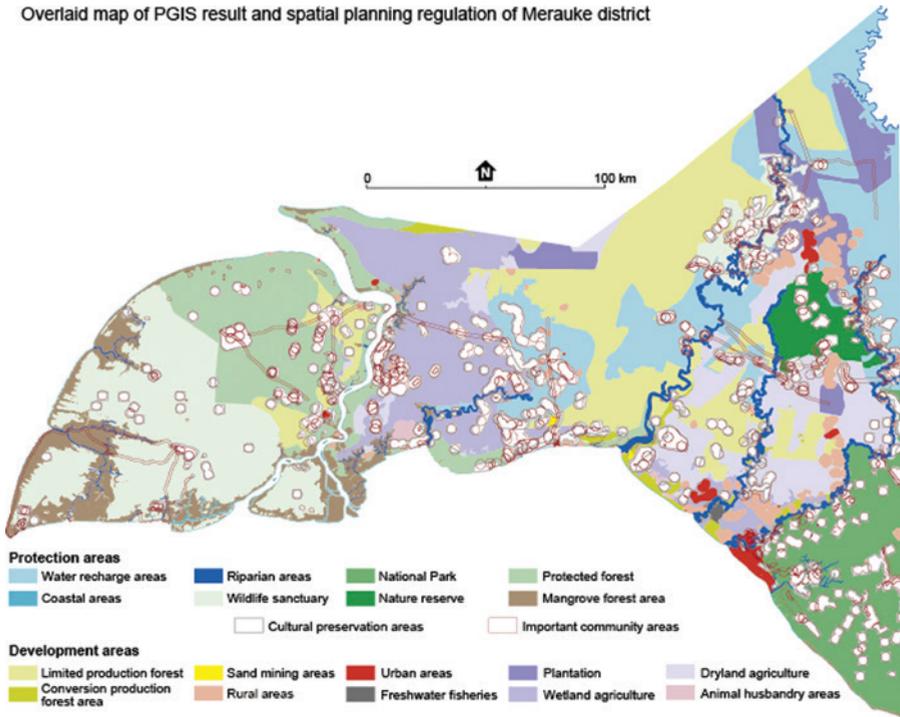


Figure 7: Overlaid map of PGIS results that have been integrated into spatial planning regulation.

categories with a protection function. The remaining community land use has been integrated into development areas (62,481.32 ha or 9%).

The pattern of community land use distribution is shown in the graph (Figure 8), the horizontal axis indicates the size of community land use and the vertical axis shows categories of community land use inside the Cultural Preservation Areas of the Merauke SPR. The number of sacred sites and cultivated sago palms areas was higher than other community land use classes, which matched the land use allocation for the cultural preservation areas. The TPM was not matched for cultural preservation areas that were outside of the Merauke SPR. The corresponding graphs are presented in Figures 9 and 10.

Figure 9 shows the area of land allocation of the Protection Areas of the Merauke district spatial plan in relation to the initial community land use categories of TPM. The sacred sites frequently occurred in National Parks and riparian areas. Furthermore, the ancestral routes were often located in water recharge and freshwater mangrove areas. Figure 10 shows the relation between TPM and the land use categories of the Development Areas of the Merauke district spatial plan. The sacred sites often occurred in rural, urban, and limited production forest

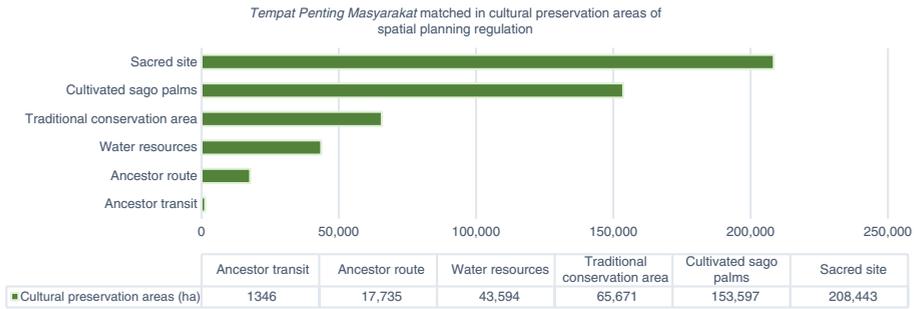


Figure 8: Distribution of the TPM (%) in cultural preservation areas of district Spatial Planning Regulation and the area (unit in hectares) for each class of Tempat Penting Masyarakat (important community area) in the table.

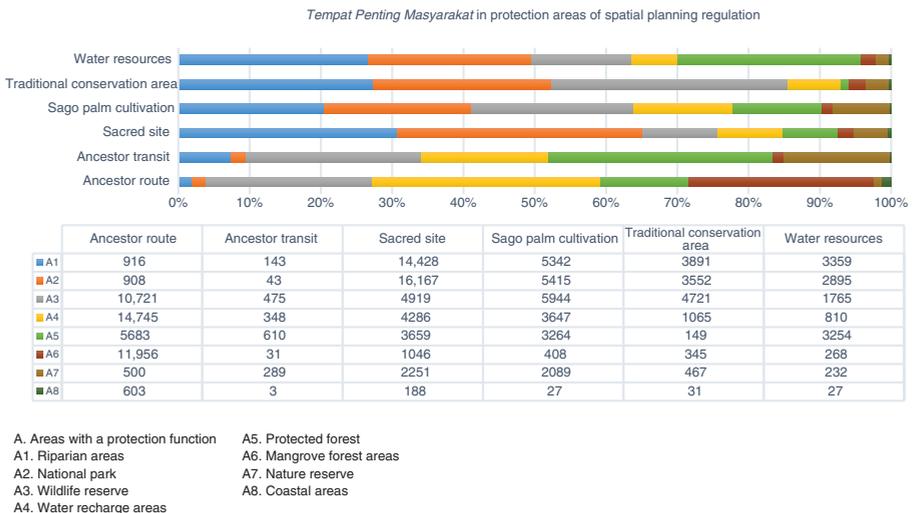


Figure 9: Distribution of the TPM (%) in protection areas of district Spatial Planning Regulation and the area (unit in hectares) for each class of Tempat Penting Masyarakat (important community area) in the table.

areas, and the ancestral routes in limited production forest, dry and wet agriculture and plantation areas.

4. Discussion

In this section the results of the mapping process are discussed into four parts: (1) the process by which the mapping team obtained community consent and an

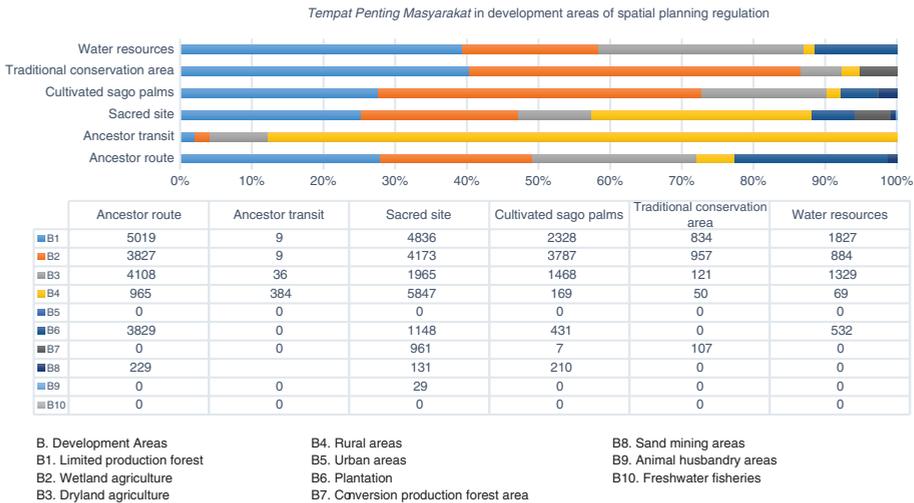


Figure 10: Distribution of the TPM (%) in development areas of district Spatial Planning Regulation and the area (unit in hectares) for each class of *Tempat Penting Masyarakat* (important community area) in the table.

expression of political will from the local authorities to implement the results; (2) the mapping process and the integration of the results into the district Spatial Planning Regulation; (3) relevance of the results for Merauke district; and (4) relevance of the results for spatial planning in Indonesia and other developing countries. Participatory community mapping is generally conducted to delineate community land use. However, in developing countries, these efforts are usually not focused on integrating the community map into formal spatial planning.

4.1. Political consideration to integrate and endorse the PGIS results

The required political will and clear mandate to endorse the integration of customary land in spatial planning can be expressed in three different ways. The first, and strongest form of endorsement, is a formal recognition of customary land under state law or constitutional law. The second option is a formal, but not legally binding request in the form of a written agreement with the authorities such as a letter of intent or a memorandum, stating that they were committed to secure the community land use rights according to the final PGIS outcomes. The third option is an unwritten agreement in the form of an oral statement or similar acknowledgement by the authorities.

These types of endorsement of the integration of customary land into spatial planning can have different consequences for the effectiveness of the process. The community already had a mechanism to select their representative based on their values, called *musyawarah adat*. Through *musyawarah adat*, the mapping team

obtained community agreement and political will by holding a multi-stakeholder workshop. The process was successful due to good communication between tribe leaders and tribe members encouraging them to build trust with facilitators. As a starting point, a multi-stakeholder agreement for participatory community mapping was created, i.e. the land of the eight sub-tribes of the Marind Anim was mapped to acknowledge their cultural values and livelihoods. The key principles were developed collaboratively between sub-tribes and adopted by facilitators.

However, the process is not always easily accepted by decision-makers because the map results may contain potentially sensitive issues and can create dilemmas for policy-makers. In several cases, government officials consider participatory mapping mostly as an obstacle for making decisions, because they tend to be focused more on their own opinions and interests. One example of this is the Water Opportunity Map Delfland Project implemented in 2002, in which participatory mapping in the Netherlands took place among the water board authority, municipalities, and other stakeholders. In this project, no agreement was reached regarding the implementation of the participatory mapping results due to different interests (Carton 2005). These situations have clearly shown that differing interests need to be reconciled by means of a shared vision.

4.2. Mapping process and integrating the TPM into SPR

A technical issue occurred when overlaying the original TPM results with the government spatial planning map. The overlay of the results showed that TPM occurred in three different zones in the government spatial planning map (cultural preservation areas, other classes of protected areas, and development areas). This occurred due to the fact that the original map was re-delineated by grouping polygons, by the GIS officer of government planners during the process of integrating the TPM into SPR. The overlaid result indicated the TPM often matched with cultural preservation areas, or other classes of protected areas; while some areas were not matched because they were merged into development areas. Further, the total area of TPM after the overlay was also slightly different from the original total size of TPM. The total area under TPM was 710,305 hectares in the original TPM map, of which 647,850 hectares were included in cultural preservation areas and areas with a protection function in government spatial planning.

In general, community land use patterns are distributed along major rivers. The map reflected their activities related to access and main transport by traditional canoe or boat before any road development. Furthermore, the landforms are mainly related to floodplains, which are flooded during the rainy season, while during the dry season, the water is limited to the swamps and rivers. The local communities also collected fish and hunted deer during the dry season because the animals were attracted to the swamp and river to obtain water. Other studies in the Amazon also show clearly that riparian forests are pivotal because they provide ecosystem services for community livelihoods (Celentano et al. 2014). The community uses rivers as a mode of transportation and to collect their food

and other resources from the riparian forest. This condition is similar to the local community in lower Tapajos River region in Brazil as they also intensively utilize riparian forest. Some areas are also suitable for the expansion of livestock and crops by the community (Oestreicher et al. 2014).

4.3. Relevance of the results for Merauke district

The 69% of important community areas now safeguarded as cultural preservation area can be managed for customary use through the existing community management system. The community has local institutions that allow for robust governance of community land use in order to provide forest resources for future generations. For example, there was an instance of illegal sand mining that took place in the Wasur National Park, Merauke. A decree on sand mining by the Head of District was not effective in stopping these illegal mining activities. Then the Kunam became involved and suspended these activities in a traditional way by declaring the area closed for human exploitation. This declaration is called “*Sasi*”. Similarly, other research has shown that indigenous knowledge in the Arctic has enhanced the governance process used to address environmental change at the local level of decision-making, creating credibility, and legitimacy of the process (Rathwell and Armitage 2015). However, the case may reverse, such was the case in Australia, where the institution of Aboriginal people had been strengthened through involvement with tourism activities in order to effectively manage the Purnululu National Park (Strickland-Munro and Moore 2013). Therefore, to be able to understand community forest governance specifically, further assessment of case studies is required. One example of more detailed assessment is a case study using a social-ecological systems approach, which described community forest governance as helping to avoid the “tragedy of the commons” (i.e. personal interest is contrary to the common good for all users through collective action to mitigate the resources depleted) in Mawlyngbna, India (Oberlack and Schmerbeck 2015).

In Merauke, approximately 22% of important community lands have been merged in protected areas and thus a collaboration with park management is necessary. The park authority should provide access and allow the community to conduct their traditional activities on their lands. Another case study in China illustrates that to increase the effectiveness of protected areas, the community should be a part of the management of the protected area (Xu and Melick 2007).

The remaining 9% should form an enclave from the development areas. This can be proposed as an additional activity to define the boundary in a detailed plan of spatial planning at a village level. This could be in the form of a development such as community forest management and traditional agriculture. The importance for a tribe or local people to secure their land resources in order to survive should not be understated. For example, a case study in Bangladesh that examined community livelihoods from non-timber forest product (NTFP) resources shows a strong dependence on their resources (Mukul et al. 2010). A case in Alcântara

(Brazil) illustrated that local people depend on traditional agriculture slash-and-burn methods to fulfil their livelihood, which deviates from cultivation of non-traditional crop commodities (Celentano et al. 2014; Oestreicher et al. 2014). Furthermore, another review paper on Participatory Mapping for community-based natural resource management in Cameroon found that the participatory mapping improved governance, through dialogue, stronger legitimacy and adopting the local knowledge for enhancing the community access to natural resources (McCall and Minang 2005).

Further work is additionally needed to determine the appropriate base map to use. This study used geo-projections of Landsat 7 images as a base map. A different base map was used for the Merauke SPR namely *Rupa Bumi Indonesia*. This may have affected the map accuracy. For future work, the best option for a PGIS base map would be to use the same base map is the *Rupa Bumi Indonesia* which is used by government planners to produce SPR as part of the 'one map policy'. The main reason this study did not use the same base map was because the community mapping was conducted before technical map guidance of spatial planning was developed. The 'one map policy' is a government initiative to make detailed base maps at different levels ranging from national-province-district and village levels; to date, the mapping effort is still restricted to the district level. These base maps can be used for spatial planning and community mapping in order to achieve more precision and accuracy. This would eliminate additional work while transforming the community map into a spatial plan because the projection would be the same. Furthermore, the map scale of the SPR was set at a medium level of 1:50.000. Detailed mapping at a scale of >1:25.000 should actually be done, including field validation, to define the physical boundaries of the community land use as a part of detailed spatial planning.

4.4. Relevance of the results for spatial planning in Indonesia

Our PGIS approach can be implemented in other district spatial plans in Indonesia in which the boundaries between state and community lands are unclear. In addition, the PGIS approach was integrated into district spatial planning for two neighboring districts of Merauke, Asmat and Mappi by the Lestari project (USAID). It could also enhance the recognition of the community land (use) rights on other islands in Indonesia. For example, the Talang Mamak, Sakai, Bonai, and Orang Rimba tribes in Sumatra⁸ and Dayak tribe in Kalimantan depend heavily on forests for their livelihoods and cultural identity.

An opportunity to apply this type of PGIS approach to other districts in Indonesia is provided by the ruling from the Constitutional Court of Indonesia

⁸ Silalahi, Mangara, and Ahmad Sardana. 2009. "Mapping of Indigenous People in Sumatra: Population, Distribution, Dependency on Natural Resources and Environmental (PEMETAAN INDIGENOUS PEOPLE DI SUMATERA: Populasi, Persebaran, Dan Ketergantungan Terhadap Sumberdaya Alam Dan Lingkungan)." Vol. 931. Jakarta.

that stipulated in 2012 that community forests that fall within the boundaries of customary land must be separated from state land. According to the court, these forests should be delineated out from state forests. The customary forests controlled by the Ministry of Environment and Forestry on behalf of the state should be defined as customary forests as long as their traditions system are still alive and in accordance with the development of society and follow the principles of the Unity State of the Republic of Indonesia as regulated by Law. This was the result of the judicial review by the Constitutional Court on forestry law. State and local governments are required to implement this decision. This will influence the legitimacy of the mapping of customary forests at the district level (Constitutional Court 2012). Further, an opportunity to conduct PGIS is supported and mandated by several laws, such as the Spatial Planning Law No 26/2007, the geospatial information law No 4/2011 and the environmental protection and management law No 32/2009. These laws require district governments to consider increasing the community role in the process for developing SPR. They also mandate that this process should be inclusive and participative (Coordinating Ministry of Economic Affairs 2011). In addition, the latest policy has been released through a decree of the Ministry of Agrarian and Spatial Planning No. 9/2015 on a set of steps to determine communal land (Ministry of Agrarian and Spatial Planning 2015).

The replication of our PGIS approach in Indonesia may be accelerated by government reformation of institutions and regulation as described above. Furthermore, it requires certain skills and knowledge of issues such as spatial planning policies, social culture and customary institutions, natural resource management, communication and technical skills for using GIS.

5. Conclusion

The results of this PGIS case expand on prior studies on the application of PGIS results by effectively securing the important community areas into spatial planning policy and district spatial planning regulation. The study results provide additional evidence of tacit knowledge of the community land use for cultural and provisioning ecosystem services, and show how it can be integrated into formal policy. These results show that PGIS is beneficial for the enrichment of Spatial Planning Regulation.

Indonesia's obligation to implement strategic environmental assessment according to Spatial Planning Regulation implies that the existing traditional land use system should be included within the community land use area and aligned in development zones managed by communities and/or as community preservation area. The adoption of community land into a spatial plan acknowledges the community's presence while helping to reduce potential conflicts and promote sustainable development. This framework can be used to enrich district or regional spatial planning. PGIS can be used by private stakeholders, NGOs, public planners and/or authorized agencies to stimulate development and to create a conservation plan. The method can be effective if there are favorable conditions to obtain a

political commitment from authorities and endorsement from the community in advance. For example, district and village authorities can review existing land use patterns and local assets on community land use before a regional development plan is created. PGIS is very relevant for application at the district and village level in the context of the Indonesian government system. Further detailed mapping at the village level is necessary to visualize the physical boundaries and management of the important community areas and incorporate these in detailed spatial planning. Furthermore, to apply this approach in other countries, obtaining the political endorsement at the national and provincial level remains crucial.

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