BOLD THINKERS DRIVING REAL-WORLD IMPACT

Village Boundary Setting/ Resource Mapping in Indonesia: Drones, Data Management Systems, and Participatory Planning for Better Lives

Indonesia, composed of 17,000 islands made up of wetlands, rugged terrain, rural villages, and dense cities, has a contentious and costly boundary dispute problem. Overlapping land claims and confusion about administrative boundaries and jurisdiction ignite frequent conflict. Land features and oral history preserved theoretical boundary information for hundreds of years, but both have proved inefficient and increasingly unworkable in the modern era.

What happens when two villages both claim the same resource? To which village does a hamlet on a vague borderland belong? How can a country of 83,000 villages—with only 5 percent formally mapped—truly unlock, manage, and preserve the value of its land and natural resources?

Answers to these questions can guide national funding under a groundbreaking new Village Law, service delivery and spatial/economic planning at the sub-national level, and negotiations with investors and businesses to spur low carbon economic growth. Under the MCA-Indonesia funded Participatory Mapping and Planning Projects 1 and 6, Abt Associates worked with more than 10,000 village representatives to map boundaries across hundreds of villages using community-based methodologies, high-tech mapping techniques, and an in-depth understanding of Indonesia's rapidly changing legal/institutional framework.

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PMaP's 21-step boundary setting process—designed and refined by Abt—broke new ground in prioritizing inclusive participation as a vital component to solving local border conflicts. The process brought young people, marginalized groups, and women to the same table as village leaders to make decisions on village boundaries and investigate the geographic and cultural histories of their villages. Stakeholders thus became partners in the truest sense: agreeing on boundaries, learning to use new technologies and tools, and owning critical data points and milestones along the way.

- 8 Districts and 15 Sub-Districts, total area of 381,066.57 Ha
- 173 Villages Mapped
- 221 Pillars Installed
- 98% of Village Boundary Segments Agreed Upon
- >800 Maps Produced
- 2,181 Critical Cultural and Natural Resources Identified
- 58 Boundary Dispute and Conflicts Resolved
- 1,127 People Trained

Drone technology allowed villages to "zoom out" for a birds-eye view of their territory, identifying nearby roads and cultural and natural resources. Natural landmarks—like waterways, swamps, or forests--evolve over time, making them unreliable markers for permanent boundaries. GPS coordinates, satellite images/ maps and physical boundary pillars enable leaders to establish a concrete record of their land for legal confirmation and passing down to future generations. Abt also introduced a dual language Document Workflow Management System (Sistem MAK) so all partners could track each step, upload key documents for quality review, and facilitate rapid progress.

Boundary Uncertainty and Conflict

Because boundaries in Indonesia are often not well-documented, and consensus is limited, spatial uncertainty leads to a weak investment environment, limited ability to manage natural resources, boundary disputes, and conflict. Of 83,000 villages across the country, few have legally demarcated boundaries. Abt's analysis of land use and licensing/concessions found that certain parcels of land are licensed repeatedly or to different parties.

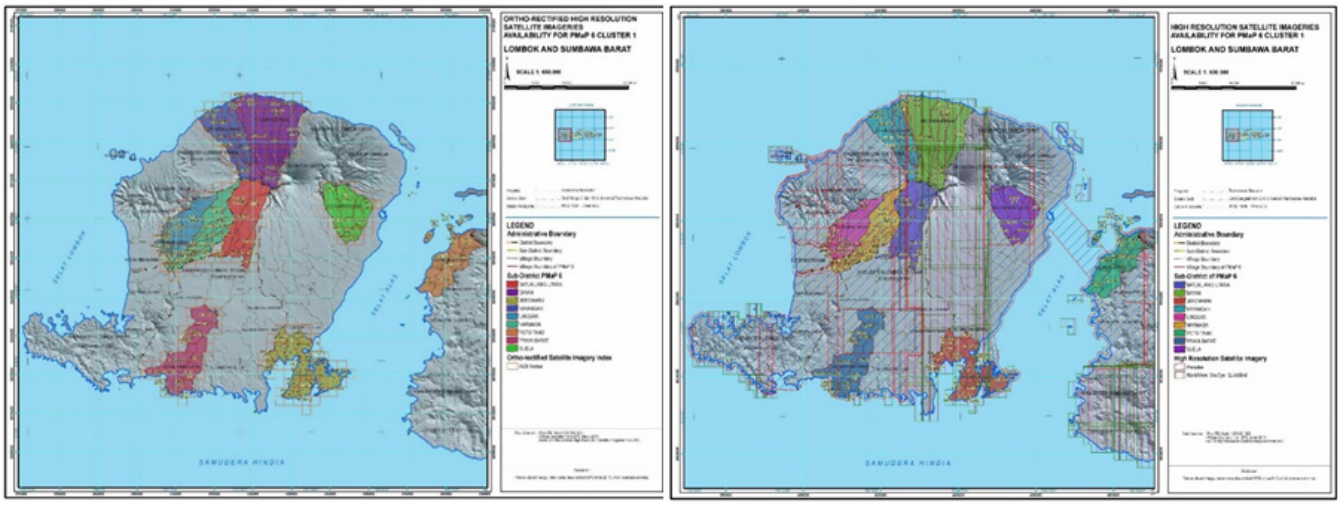
Mapping Together

Our approach to PMaP 6 combined community engagement and capacity building with proven mapping and surveying technologies into a rigorous 21-step Village Boundary Setting/Resource Mapping methodology. This process was fully compliant with new Ministry of Home Affairs regulatory requirements to insure legal validity, while incorporating spatial data and social inclusion to ensure credible and sustainable resolution of boundary disputes—a prerequisite for investments and planning. Technologies included high-resolution satellite imagery and UAV surveys to undergird the participatory,

gender-sensitive and dispute-sensitive methodology. The goal was to enable village communities to delineate village boundaries based on a cartometric process which will detail land use within a broader context of natural and cultural resource mapping. District governments were close partners in completing the work, allowing them to "own" the results and continue incorporating new data in the maps and databases over time. As a result, PMaP 6 districts will have highly accurate village boundaries with community and government legitimacy.

As part of preparatory work, the Abt team developed a geodatabase, base maps, and working maps that will enable village boundary-drawing on the maps—known as the cartometric process—within the Boundary Setting/Resource Mapping (VBS/RM) activity. These maps followed rigorous standards established in Indonesian law, which requires that they have scale of 1:5,000 and/or be corrected so that the aerial or satellite imagery appear without any distortion of the terrain—a process called ortho-rectification.

The team also collected thousands of additional data points and documents to establish complete, accurate, and digitally preserved Village Boundary records. These included relevant geospatial information on land use, such as concessions, licenses, permits, land tenure, comprehensive land maps, spatial plans, land cover/use, and land disputes. The collection and compilation of geospatial data occurs continuously through Step 21 as these data points and documents are used to engage key local stakeholders who ultimately own the results.



Sample Index (left) and Base Maps (right) for Key Working Locations Used to Delineate and Demarcate Borders—Down to the Centimeter

The maps above demonstrate the level of technical detail and innovative approaches required to complete this mapping effort. On the left, an index map of ortho-rectified high-resolution satellite imagery for Lombok Island and Sumbawa Barat (collected from the Government of Indonesia), is overlaid with the working area of PMaP 6. The map on the right shows high-resolution satellite imagery that was not ortho-rectified. In Sumbawa Barat, this gap required field experts to work with our local stakeholders to collect Ground Control Points and Independent Control Points to be used as inputs for the correction process, while closely coordinating with representatives from Indonesia's National Mapping Agency.

Ensuring Cultural Accuracy

PMaP-6 worked with communities to map natural and cultural resources—which have significant economic, health, recreational, and environmental value, and are often the focal points of local beliefs—as well as customary and indigenous areas (if available) in villages. The team used ortho-rectified high-resolution satellite imagery to delineate these resources, Afterwards, villages engaged in interpretation and delineation of the imagery, involving community leaders and elders, women's representatives, and representatives of village groups through focus group discussions guided by facilitator teams.

Through this process, the team and local stakeholders identified and delineated settlements, rice fields, dry agriculture, orchards, water resources, and archaeological and historic sites. The teams also formally named important sites to improve mapping and meet high national scale standards. Field checks confirmed delineation and naming of resources in partnership with village community representatives.

UAV (Drone) Surveys

Drone surveys supported village boundary and resource mapping and were particularly useful when ortho-rectified high-resolution satellite imagery was unclear due to spatial resolution or cloud cover. The imagery helped resolve conflicts between neighboring villages and enhanced aspects of the resource mapping effort, while the team's efforts to engage local villagers and train them in the use of this technology further facilitated ownership of the process by participating villages.

The Abt team used all collected imagery from the drone surveys to produce georeferenced products, with which they produced more than 800 final draft maps to be used in the final stages of the VBS/RM process and included in the GIS database. All these products underwent a quality assurance process. The resulting data collected from the drone survey and resulting high-resolution images, videos, and maps of the areas were integrated into a GIS database, which now belongs to our partner villages and key Government of Indonesia counterparts.

Organizing Field Data with Sistem MAK

The thousands of documents and records developed and collected throughout the VBS/RM process are a critical output for the sustainability of results, including drafting district decrees that legalize the results of the VBS/RM effort. Time and resource requirements needed to manage these records are significant, as they must be accurately compiled and multiple project, client, and stakeholder teams made aware of how/when each step is completed. Abt's technology team developed a dual language web-based workflow management system (Sistem MAK) to enable Field Technical Teams to collect, name, archive, and organize these records.

Sistem MAK proved useful not only for record management but also for PMaP 6 to monitor field team progress, as the accompanying dashboard showed the status of each step in real time. The workflow management system guided local data collection and archiving and enabled the team to quickly and easily collect and compile different community-collected outputs and products from the field.

Sustainable Outcomes through Empowering Technology

Resolving Indonesia's spatial uncertainty through citizen participation encourages investment in renewable energy, improves service delivery, and informs future land use planning. Through the PMaP projects, Abt Associates' use of drone technology and the Sistem Mak workflow management system helped community leaders in Indonesia map 287 villages, install more than 380 boundary-marking pillars, produce more than 800 maps, and resolve dozens of boundary disputes and conflicts. In addition to these physical results, the process of carrying out village boundary setting brought an inclusive range of citizens into the decision-making process. The experiences and practical training they received in using equipment, identifying and interacting with stakeholders, and employing mediation techniques laid the foundation for future initiatives in economic development and social change.

Indonesia's unique geography and cultural diversity requires unique technologies to help the country's achieve boundary mapping standards that enable investment, service delivery, and dispute mediation. Through PMaP methodologies, thousands of citizens now have the training to continue Indonesia's mapping process.

Voices from Indonesia

TUTI, SOCIAL COMMUNITY FACILITATOR

Growing up in the West Nusa Tenggara culture where boys take priority, Tuti couldn't continue her education to high school. She saved her income to continue her high school education and eventually took her equivalence examination. Tuti's community activities began when she joined a weaving cooperative that manages a home-based weaving industry that included buying the yarns and coloring materials and marketing. This experience gave Tuti confidence to join the PMaP 6 project.

Tuti's hard work and experience made her an effective Social Community Facilitator. She negotiated 22 segments of village boundaries, much higher than the average of eight to twelve segments for other community facilitators. One of these segments was also the most difficult, as it bordered the airport.

AGUS HARTAWAN, VILLAGE PARTICIPATION TEAM

During the PMaP-6 project, Agus served as the head of the Montong Tangga hamlet in the village of Tanak Beak, Batukliang Utara district. His project tasks included the mapping of village natural resources and research of village history. His team uncovered evidence of a Dutch settlement in the village, rediscovered their family origins, and reconnected with distant relatives, which helped them draw their family trees.

The certainty of the village boundaries also helped simplify Agus' tasks as head of hamlet. Inspired by PMaP activities and Agus' efforts, his village decided to conduct his own participatory planning and mapping for 11 hamlets in his village. "Now that the PMaP-6 project has been introduced, we can be sure of our village borders. The process was not easy, although not impossible, either," he added.

LALU SYAFARUDIN, VILLAGE PARTICIPATION TEAM

Lalu Syafarudin is a teacher in Penunjak village with a reputation of being deliberate and careful. Syafarudin was a popular pick for his local Village Participation Team.

"After several meetings and discussions, I understand [PMaP 6] and could see its future benefits. I have always wanted to know how to do village mapping and village history," Syafarudin said. "Our village has been founded for hundreds of years, and we never had certainty as to its boundaries. All this time, we referred to the maps issued by the local government. Although they don't differ too much, but with the PMaP 6 activities, we can be sure of the coordinates of the village boundaries."

PMaP 6 helped Syafarudin understand the areas of his village and make new acquaintances in neighboring villages. He says these friendly relations with the neighboring villages are beneficial, especially when resolving differences of opinions. Seeing the hard work of the Penunjak village participation team, the head of the village provided laptops and asked the participation team to undertake further mapping for the hamlets.