GSMA

Mapping resilience: Participatory digital mapping for mangrove conservation

February 2025

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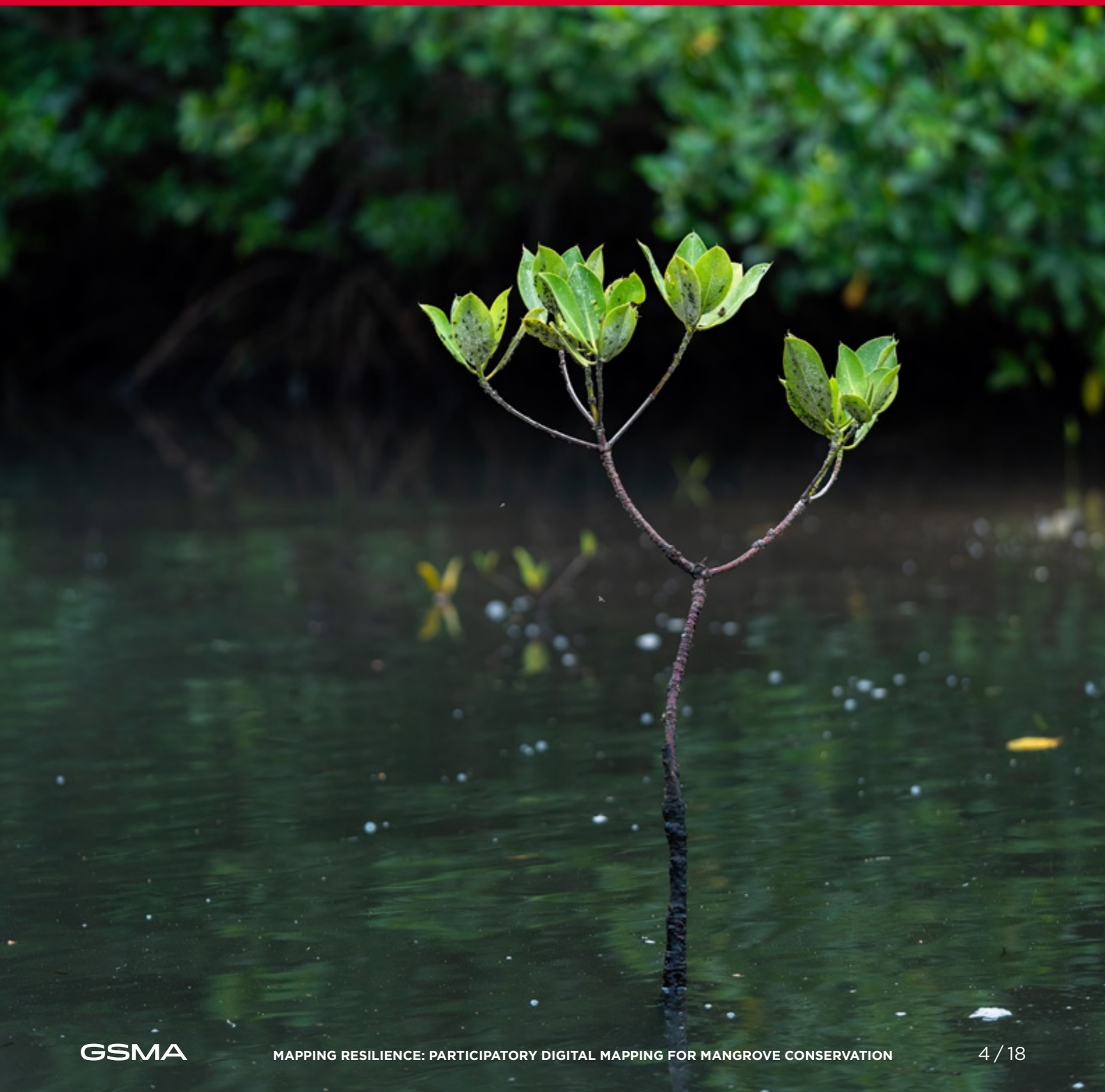


The GSMA is committed to fostering a sustainable and inclusive digital transformation that improves the livelihoods of people and the sustainability of our planet worldwide. Indonesia, an island nation with a carbon-intensive economy, is already experiencing the adverse effects of climate change. The GSMA and the Indonesian government have rolled out several projects as part of Indonesia's commitment to strengthen its ability to adapt and become more resilient to climate change.

The Indonesian government has identified North Kalimantan as a priority location for mangrove conservation and restoration under the Mangroves for Coastal Resilience Programme.[1] Setabu Village, located in North Kalimantan's Kayan Sembakung Delta, is well known for its mangrove forest and endemic Indonesian Bekantan (Proboscis monkey) habitat. The forest, rich in natural biodiversity and home to a diverse range of tree species, serves as a major attraction for tourism in Setabu Village. It is also a source of livelihood for seaweed and shrimp farmers. However, recent shifts in livelihood patterns pose a threat to the ecosystem.

In 2023, the GSMA and mobile operator Indosat Ooredoo Hutchison (IOH) partnered to rollout a project, focusing on innovative digital solutions to reduce the destruction of mangroves in collaboration with the North Kalimantan community. The primary objective of this project is to develop and map the geographic features of the sea and coastal areas around Setabu Village and its affected areas to enable village governments to take action to minimise environmental damage and raise the level of digital and climate awareness for the local population.

1. World Bank. (n.d.). Mangroves for Coastal Resilience Project.

The challenge

Mangroves play a vital role in supporting the environment and the coastal communities that surround them. They provide clean water, improve air quality, preserve biodiversity, and are critical to mitigating climate change by reducing global warming impacts. However, in Kayan Sembakung Delta, North Kalimantan, the livelihood practices of local communities, particularly shrimp farming[2] and seaweed cultivation,[3] pose significant threats to local mangrove forests.

In 2022, Nunukan Municipality, located within the Kayan Sembakung Delta, lost 80 hectares of mangroves through unlawful land conversion.[4] In the same region, Setabu Village has experienced significant mangrove loss due to large-scale seaweed farming. Meanwhile, the district's seaweed production has grown to an estimated 7,000 tonnes per month, generating around seven billion rupiah (£350,000) in revenue for seaweed farmers.[5] This has fostered tensions around land use and mangrove conservation among different factions within the local community.

In Setabu Village, the high value of seaweed has attracted both locals and non-locals, resulting in widespread seaweed farming despite limited available space. The absence of clear regulations allowed individuals to claim land easily for new seaweed farming areas, raising concerns about encroachment and conflicts between farmers.

These activities led to extensive mangrove deforestation, exacerbating ecosystem breakdown and threatening mangrove survival. At the start of the project, 54% of the village's mangroves were classified as degraded.[6] Unchecked exploitation of mangroves—including the creation of river pathways for fishing boats and drying areas for seaweed—further disrupted the delicate ecological balance.

The lack of knowledge about sustainable land use and absence of village regulations deepened conflicts among community members over resource allocation. For example, disputes frequently arose between seaweed cultivators and fish netters over damaged foundations and unregulated marine space usage, including extensive cutting of mangroves to reach the ocean. These tensions underscored the need for a structured approach to managing shared resources.

Local officials had previously initiated meetings and discussions with key stakeholders, including community leaders, traditional figures,[7] youth representatives, seaweed farmers, fisheries extension officers, and security personnel. These collaborative discussions aimed to resolve conflicts and ensure equitable resource management. However, these discussions did not have an evidence base to guide decision-making and agreement, and land use decisions were therefore not enforced.

An aerial photo of the coastal area of Setabu Village shows extensive cutting of mangrove and nipa trees to create artificial canals and drying areas for seaweed

2. GIZ. (2022). Studi Pengembangan Data Dasar Sosial Ekonomi di Delta Kayan Sembakung Provinsi Kalimantan Utara.
3. Zulham, A., et al. (2018). Socio economic assessment of seaweed farming in Nunukan Regency, North Kalimantan. IOP Conference Series: Earth and Environmental Science. Vol. 216, No. 1.
4. Ahmad, D. and Utomo, A.P., (2022). Luas Hutan Mangrove Nunukan yang Diduga Dirusak Oknum Pengusaha Ternyata Lebih dari 80 Hektar. (Accessed 13 January 2025).
5. This information comes from an interview with the Village Head, who estimated seaweed production based on his own knowledge.
6. According to the calculation following participatory mapping, Setabu Village has 213.3 hectares of existing mangroves. Of this, 54% has been disturbed by seaweed drying and the presence of channels, mostly along the coastline. Forty-four per cent of the mangroves are well-preserved, including conservation areas and some tourism zones, while the remaining two per cent has degraded due to extensive channel development in RT 09.
7. Traditional figures refer to individuals who are respected or honoured within a community. They are often highly valued for their age, wisdom, experience or contributions to the community.

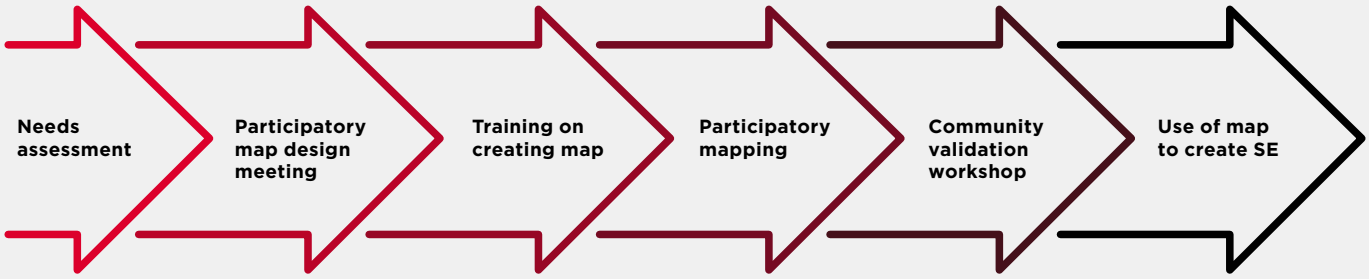
The digital solution

The solution to these challenges was to create a digital map illustrating current land use and mangrove coverage. This allowed the community to discuss current challenges and plan accordingly, based on real-time data generated by village members.

At the project inception stage, The GSMA conducted a needs assessment ensuring that the project design resonated with the local context. This process involved engaging with local communities, stakeholders and experts to understand their experiences, concerns and environmental challenges. The assessment revealed extensive mangrove deforestation in the village, mainly attributed to local economic activities like seaweed farming. By incorporating these insights, The GSMA aimed to create a more effective and sustainable solution that directly addressed the needs of the community.

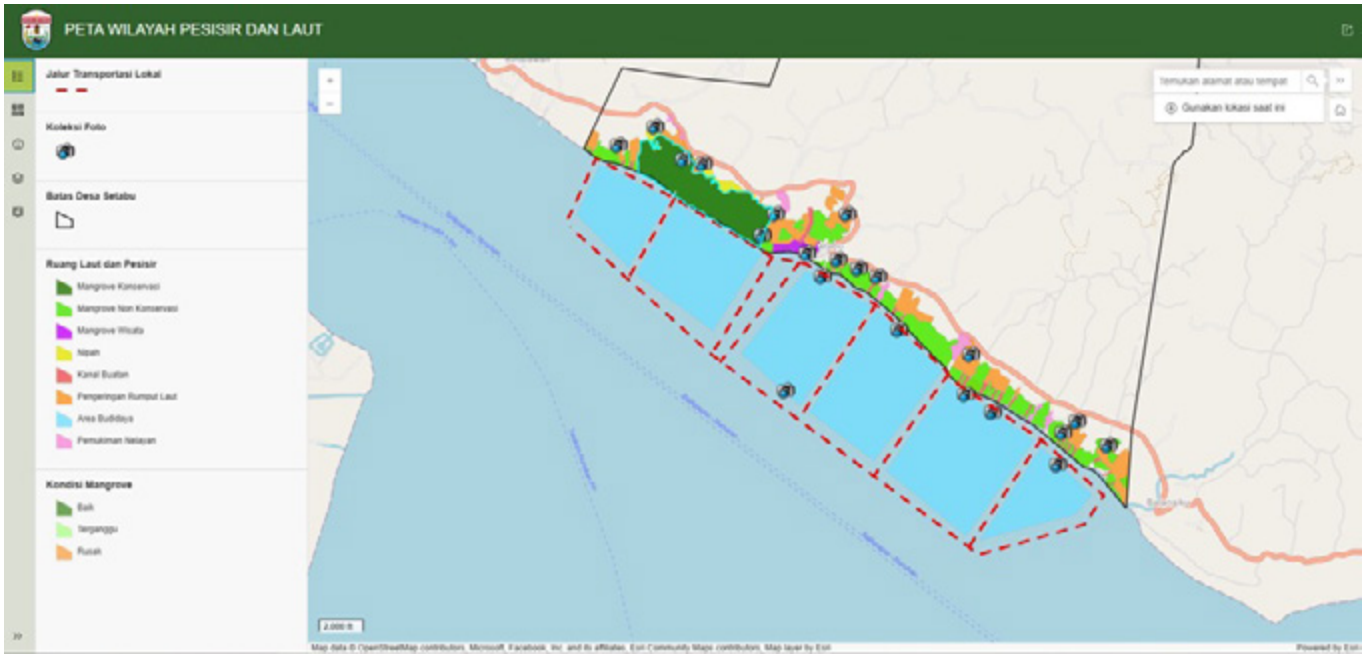
Following the assessment, the Village Head invited interested parties, including seaweed farmers, community members and village officers, to co-create the digital map and assign roles. This was followed by a focus group discussion to explore issues and align perspectives on mangrove conservation in coastal and marine areas for economic activities, training on how to develop the map, conversations on natural resource management and climate change, two days of map-making and a final validation workshop with key stakeholders to confirm the data. With the map in place, the village took the opportunity to issue a Surat Edaran (SE),[8] a semi-formal circulated letter that aimed to establish relevant regulations and appoint local coordinators to oversee mangrove areas and seaweed-related activities. Six zones were created by the community, based on natural river flows to ensure better management protection. The specific activities occurred between February and May 2023 and are described in Figure 1.

Figure 1
Outline of activities



8. A Surat Edaran issued by the village government is an official letter sent to residents or stakeholders to inform, guide or explain policies, rules or instructions related to village matters, like governance, development, public health, safety or social issues.

The digital map encompasses the entire 351.4 hectare coastal and marine region of Setabu Village. The map provides comprehensive coverage of this area and is available to download to mobile devices for offline use. Users accessed the map through a link shared by the Head of the Village using their smartphone. The map is displayed in ArcGIS Online, an interactive mapping platform, and users can explore detailed information using the menu feature on either their smartphone or PC. It allows users to assess the condition of vital areas such as seaweed cultivation areas, mangroves and nipa palm zones, which play a critical role in mangrove health. The map also provides insights into artificial rivers and economic zones, including fisher settlements and seaweed drying areas. Crucially, the map delineates the specific area allocated for seaweed cultivation in the sea.



A sea and coastal map of Setabu Village. The interactive map can be accessed here.

The results

The development of a digital map was instrumental in creating a SE, which includes guidelines for seaweed foundation installation and the appointment of local coordinators to oversee cultivation. Within a month, mangrove cutting decreased significantly. This reduction has been sustained for over a year since implementation and the community has observed improvements in mangrove health and an increase in crab and fish populations.

Previously, community members, especially seaweed farmers, asserted land ownership without oversight, often cutting down mangroves to change land use patterns. The digital map has transformed this practice by enabling informed decisions for individuals, seaweed farmers, and stakeholders like local authorities and conservationists. Since its implementation, those wishing to establish new seaweed farming areas are required to seek permission from the appointed coordinators. This has led to a more organised and regulated process for setting up foundations. The map helps identify suitable seaweed farming locations and provides crucial information on mangrove status and conservation zones, enhancing efforts to protect these ecosystems.

The participatory map also revealed that the mangrove-covered area in Setabu Village is 92.7 hectares, rather than the 74 hectares previously believed. In response, the local government is working to legally protect the entire mangrove-covered area, aligning with Indonesia's national conservation targets.

The map remains a critical tool for planning and managing seaweed cultivation. Its primary uses include identifying suitable farm locations and informing village spatial planning and development. Large-scale mangrove cutting has ceased, and no new canals or fields for drying seaweed are being created. Small-scale selective cutting continues for farming needs, such as using mangrove wood for poles, but its impact remains minimal. Previously, extensive mangrove clearing occurred for drying platforms, settlements and canals, but this practice has now stopped.

The local government is leveraging the map to achieve several objectives:

1 **Education:**
Raising awareness about mangrove protection and appropriate zones for seaweed farming and conservation.

2 **Supporting the carrying capacity of the sea:**
The community often overlooks the sustainability of marine areas. The SE, which regulates the development of both seaweed farming and pemukat (fishing nets), aims to help preserve the sea.

3 **Policy development:**
Integrating the map into village spatial plans and creating regulations to safeguard mangroves.

4 **Expanded applications:**
Collaborating with NGOs and tourism boards to incorporate additional data, such as protected forests and demographic trends, for broader development goals.

This initiative highlights the potential of digital tools in fostering sustainable resource management and strengthening community resilience.

Making it impactful

By focusing on participatory, accessible, and locally relevant solutions, the project successfully addressed immediate challenges while laying the groundwork for sustained impact and scalability.

Some of the key lessons learnt through this process on how to make a digital innovation impactful are described here.

1 Address a relevant and current challenge in the community, with consensus building and evidence.

- Tensions within the community regarding land use were mitigated by introducing a tool that added value to existing structures and challenges. By addressing a highly relevant issue collaboratively, and at the right time, the solution aligned with community needs and allowed for evidence-based decision-making.
- The village had prior experience with land mapping in collaboration with a university, which inspired the Village Head to propose mapping the coastal and marine areas. This underscores the value of scaling known and effective solutions to new challenges that the community views as beneficial.
- The reduction in mangrove cutting and sustained improvement in mangrove conservation underscores the effectiveness of providing tools that complement local priorities.

2 Use a participatory design and community-centred approach

- The needs assessment and collaboration with local organisations, ensured that the solution was hyper-local and tailored to the specific requirements of the stakeholders.
- Involving local communities in the project's design ensured its relevance and acceptance. Utilising local officials and respecting traditional practices made the solution more relatable and easier to adopt for community members.
- Setabu has emerged as a model village in the district, gaining recognition for its exemplary management of local marine resources. It has also earned the distinction of being selected for the prestigious Smart Village programme, an initiative led by the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration. This recognition underscores Setabu's forward-thinking and innovative approaches. A key factor in the success of its digital initiatives has been the active participation of local stakeholders, who have contributed by appointing coordinators and defining land-use zones, maximising the benefits of the mapping technology.

3 Leverage local leadership

- The Village Head was a champion for the initiative and helped gain the trust of community members, ensuring a smoother implementation. Local leaders acted as bridges between the project and the community, fostering ownership and long-term commitment.
- The commitment of local leaders to natural resource management and their interest in opportunities to leverage technology solutions encouraged other village officials and community members to see value in the technology and be part of the process.

4 Ensure accessibility

- The map's user-friendly design, including its low-tech accessibility through mobile devices, made it widely usable. Minimal training requirements ensured rapid adoption.
- Ensuring the map is free to use—and that network connectivity is improved—removed barriers to adoption and use.
- Dissemination through personal networks, such as WhatsApp and social media, proved cost-effective and efficient in reaching a broader audience.

5 Climate co-benefits through education and skill development

— The project doubled as an educational platform, enhancing community understanding of natural resource management and climate change mitigation. Having learnt more about climate change and its effects, community members reported having a deeper commitment to the tool and village regulations, while enhancing discussions on new ways of improving their resilience to climate change and livelihoods.

6 Strengthen governance and sustainability

— The project worked within existing power structures while also decentralising decision-making and enforcement to representatives actively engaging with seaweed farmers. This approach fostered collaboration and localised accountability.

— The integration of the map into decision-making processes empowered community members to prevent unauthorised activities, such as logging, and supported mangrove conservation efforts.

— The map facilitated greater transparency, as seen in collective decision-making regarding canal openings, preventing destructive activities and promoting informed governance. Documenting these decisions in the SE gives the map greater power to act as a tool for accountability.

7 Build on existing partnerships

— Collaborating with organisations with established local expertise, ensured the project was grounded in existing knowledge and relationships. This partnership approach enhanced the project's credibility and efficiency.

> **"The map has played a crucial role in preventing unauthorised activities, especially for new seaweed farmers. For instance, when a community member wanted to reopen a previously prohibited logging area, the map provided clear information on the areas where logging was not allowed. This knowledge enabled a prominent village officer/seaweed coordinator to educate the individual on the negative impacts of logging and report the situation to the Village Head. The map also facilitated a collaborative decision-making process, as the Village Head required a minimum number of residents' approval to open a canal, discouraging logging and promoting a deeper understanding of the importance of mangrove conservation."**
>
> Excerpt from MIH Indonesia endline report, 2022.

Looking to the future

Moving forward, these are the GSMA's recommendations for sustaining the impact of the digital map:

1 Invest in time and resources to support digital enhancements

— To enhance the map, it will be vital to establish cross-sectoral coordination, particularly with sea transportation authorities, to incorporate sea routes in the marine and coastal map. More time is needed to facilitate comprehensive community interventions and observe significant changes over time.

2 Overcome barriers to access to ensure long-term use

— Ensuring the sustainability of the map requires continuous efforts to overcome technological barriers to adoption and use. Regular updates to the map and feedback loops are essential for maintaining accuracy and responsiveness to the unique needs of the Setabu community. Providing free access remains a critical enabler, while also reducing entry barriers for users who may otherwise be excluded. Additionally, addressing data costs—by subsidising connectivity or promoting affordable data packages—can ensure that these innovations remain accessible and usable for all, fostering long-term engagement and equitable participation.

3 Explore additional applications of the digital map to diversify uses

— Beyond mangrove conservation and seaweed zoning, the map's potential for other uses, such as tracking protected forests and demographic trends, highlights its versatility and value for future planning. The photos collected during mapping provide insights into the current status of the sea and coast, offering visual evidence of their conditions. The map's data also enables the identification of tourist locations, which can be instrumental in planning and exploring tourism opportunities.

— The inclusion of additional data layers can further expand its utility, benefiting diverse stakeholders from conservationists to local governments. Training and sensitisation on climate goals and conservation will continue to be an important part of the sustainability of the tool.

— While the map currently addresses a local community challenge, there is an opportunity to scale to meet broader mangrove conservation goals as part of the United Nation's Sustainable Development Goals, allowing other communities to benefit from digital innovation.

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