INITIATIVE ON
Aquatic Foods

Decision Support Tool for sustainable aquaculture development (Aqua-DST) – a case study in the Upper Myanmar

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Photo: Htet Htet Linn

The context

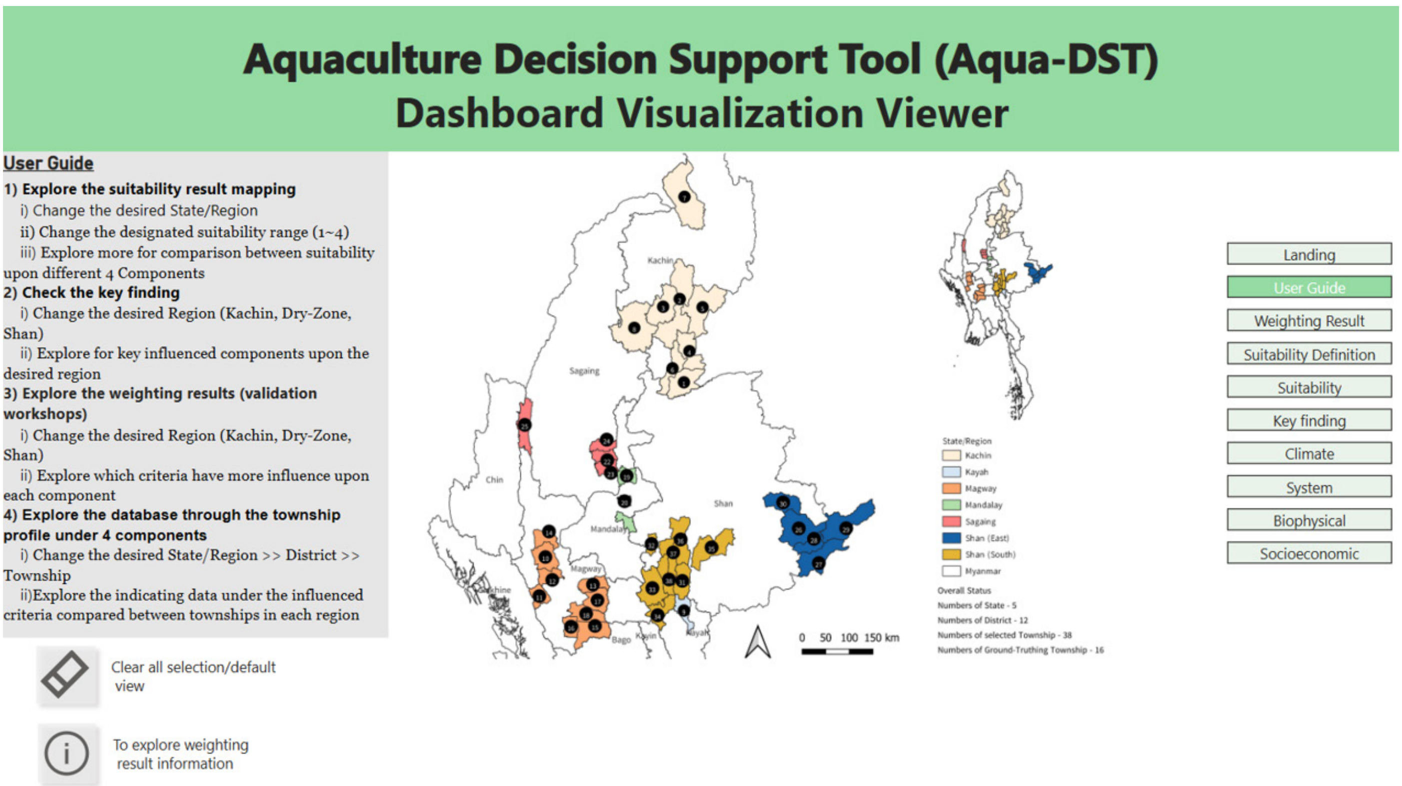
Aquaculture has emerged as a critical sector for food security, economic development, and rural livelihoods (Subasinghe, R., Soto, D. and Jia, J., 2009). Aquaculture generates higher incomes per acre than agriculture and significantly impacts rural development and poverty reduction through income spillovers to non-farming households through retail and labor (Filipski, 2018, Belton B. H., 2015). Studies (Belton B. F., 2017, Walker, 2010, Bondad-Reantaso, 2005, Yue, 2021, Ahmed, 2018, Primavera, 2005) suggest that challenges to aquaculture development in Myanmar include productivity constraints, environmental stress, disease emergence, labor demands, and impacts on ecosystems such as mangroves.

Small-scale aquaculture (SSA) farmers, apart from those in Ayeyarwady, Yangon, Bago, and Rakhine, face underdeveloped aquaculture opportunities in other suitable regions, limiting broader benefits (DoF, 2020). They are typically defined as resource-poor individuals or groups with low production capacity and limited technical and financial resources, they often lack access to certification support (DoF, 2020). The Myanmar Sustainable Development Plan (MSDP) (Myanmar, 2018) emphasizes developing small-scale aquaculture as a poverty reduction strategy. Similarly, the Agriculture Development Strategy (ADS) highlights the critical role of small-holding fish farmers and Small-Medium Enterprise (SMEs) in driving growth through diversified farming practices and enabling the right operating environment (MOALI, 2018). SSA farmers are currently facing difficulties in obtaining land and appropriate land rights for the aquaculture business, poor access to finance capacity and input supplies, and the prevalence of fish disease due to a lack of effective water management and use of old ponds (FAO, 2010, Mekong-Economics, 2018).

Fishponds located without consideration of water availability and flood risks may perform in a sub-optimal manner, with productivity undermined by water shortages and/or inundation and flood damage of pond infrastructure. Its expansion often faces challenges like environmental constraints, climate risks, and socio-economic trade-offs. To address these challenges, decision-makers require robust tools that integrate multi-dimensional data for strategic planning and risk management.

The Aquaculture Decision Support Tool (Aqua-DST https://www.iwmi.org/news/aquaculture-decision-support-tool/), a trial version launched in October 2024, is an innovative, user-friendly platform designed to guide sustainable aquaculture development through science-based suitability analysis. By performing suitability analysis, Aqua-DST helps identify high-risk areas prone to flooding and water scarcity, which allows planners and others promoting aquaculture to support more informed locations for aquaculture ponds. By also identifying demand-supply deficit areas in terms of input availability, the Aqua-DST enables value chain actors to identify business opportunities that will also improve aquaculture adopters' access to feed and other inputs. The tool facilitates informed decision-making for township-level aquaculture expansion in Upper Myanmar. This includes the Kachin, Magway, Mandalay, Sagaing, and Southern and Eastern Shan states/regions. In its first version, the tool covers 37 townships in Upper Myanmar as shown in Figure 1.

Figure 1. Aqua-DST dashboard landing page and study area.



Key messages

1. **Comprehensive and Integrated Approach**:
   Suitability analysis emerges as a valuable tool by providing an empirical method to evaluate land availability for aquatic food production. It integrates critical biophysical, socio-economic, and infrastructural, environmental and climatic factors that influence system suitability. By identifying the most appropriate areas for development the suitability analysis supports decision-makers and stakeholders in land use planning and policy discussions, ensuring that integrated aquatic aquaculture initiatives are implemented where they can best meet development goals, promote environmental sustainability, and achieve long-term success.

2. **User Empowerment**:
   Aqua-DST equips a diverse group of stakeholders—including planners, NGOs, private investors, and local communities—with actionable insights to inform decision-making, investments, business plans and enhance aquaculture development efforts.

3. **Scalable and Adaptive**:
   Flexibility of the tool allows its application across multiple spatial scales, from regional and township levels to site-specific assessments. This scalability ensures its relevance in addressing varying aquaculture planning needs.

Problem statement

Aquaculture development is hindered by:

1. **Inadequate Access to Spatial and Environmental Data**

   In Southeast Asia, limited access to spatial data impedes the identification of suitable areas for aquaculture expansion, affecting the sector's growth potential (GIZ, 2017). Similarly, in Myanmar, the scarcity of high-quality geospatial datasets hinders effective aquaculture planning (Khin Maung Soe, 2020).

2. **Inefficiencies in Identifying Suitable Areas for Aquaculture Expansion**

   The absence of integrated spatial tools in Myanmar leads to inefficiencies in identifying optimal sites for aquaculture. Land-use planning often lacks comprehensive data integration, making it challenging to consider factors such as climate, water resources, and socioeconomic conditions. This inefficiency is evident in the limited adoption of Integrated Agriculture-Aquaculture (IAA) systems, which offer sustainable adaptation and mitigation strategies but require better integration into broader planning frameworks (Anschell, N., and Salamanca, A., 2021).

3. **Limited Capacity to Predict and Adapt to Climate Hazards and Socio-Economic Changes**

   Aquaculture in Myanmar and Southeast Asia faces significant risks from climate change, including increased flooding and droughts. The lack of robust predictive modeling and adaptive capacity exacerbates these challenges. While climate change impacts water availability across sectors, aquaculture has the potential to be an adaptive strategy supporting resilience under changing climatic conditions. Yet, the limited integration of aquaculture into broader climate change adaptation strategies further hinders the sector's resilience (Anschell, N., and Salamanca, A., 2021). Effective coordination between agricultural and fish farming sectors in irrigation water management is essential to balance competing water demands and the localization of fishponds requires careful consideration to reduce climate risks under current and projected climate scenarios.

4. **Insufficient Integration of Aquaculture Planning into Broader Land-Use and Policy Frameworks**

   In Myanmar, aquaculture development often occurs without sufficient alignment with broader land-use policies. Weak policy integration limits the sector's growth potential and sustainability. Informal easing of paddy-to-fishpond conversion, occupying under 5% of paddy land in key regions like Ayeyarwady, highlights the need for urgent aquaculture and land-use policy alignment (DoF, 2020). For example, inland aquaculture development has been constrained by restrictions that prevent the conversion of farmland to ponds, despite evidence that fishponds can provide significantly more revenue and employment than the same area of rice paddy (World Bank, 2019). This underscores the need for cohesive land-use strategies that effectively integrate aquaculture.

Addressing these challenges requires a multifaceted approach, including the development of integrated spatial tools, robust climate adaptation strategies, and cohesive policy frameworks to promote sustainable aquaculture development in Myanmar.

Rationale for Aqua-DST implementation

The rationale for implementing Aqua-DST lies in its ability to integrate comprehensive data—such as climate hazards, water availability, land-use patterns, and socio-economic indicators—into a single, user-friendly platform. This integration helps local authorities, policymakers, and private sector actors make data-driven decisions that align with national and regional aquaculture development goals. By identifying high-risk areas prone to flooding, drought, or other environmental challenges, Aqua-DST not only promotes efficient land-use planning but also provides an evidence-based foundation for achieving strategic aquaculture growth, promoting resilience, and supporting sustainable livelihoods in aquaculture-dependent communities.

The Aqua-DST implementation journey (see Figure 2) began in 2022 with foundational work focused on integrating geospatial technologies into decision-making processes. This phase involved conducting fishpond area delineation using advanced remote sensing technologies, including Google Earth Engine and Sentinel-2 satellite imagery. These methodologies provided accurate spatial data to support aquaculture resource management. This approach was inspired and referenced from the pioneered Rice-Fish Decision Support System Modelling (Smith, B.R., Teoh, S.J., Leemans, K., Aung, H.M., Kyaw, W.P.K., Soe, M.H.M., Maung, K.M.D., Akester, M. & Dubois, M., 2021) for Ayeyarwady Delta Region.

In Early 2023, multi-criteria evaluation workshops were held in key State/Regions, including, Magway, Mandalay, and Shan (East and South). These workshops engaged stakeholders to gather diverse inputs on aquaculture practices and priorities from different geographic areas. Concurrently, the database design for data collection was developed to ensure efficient management.

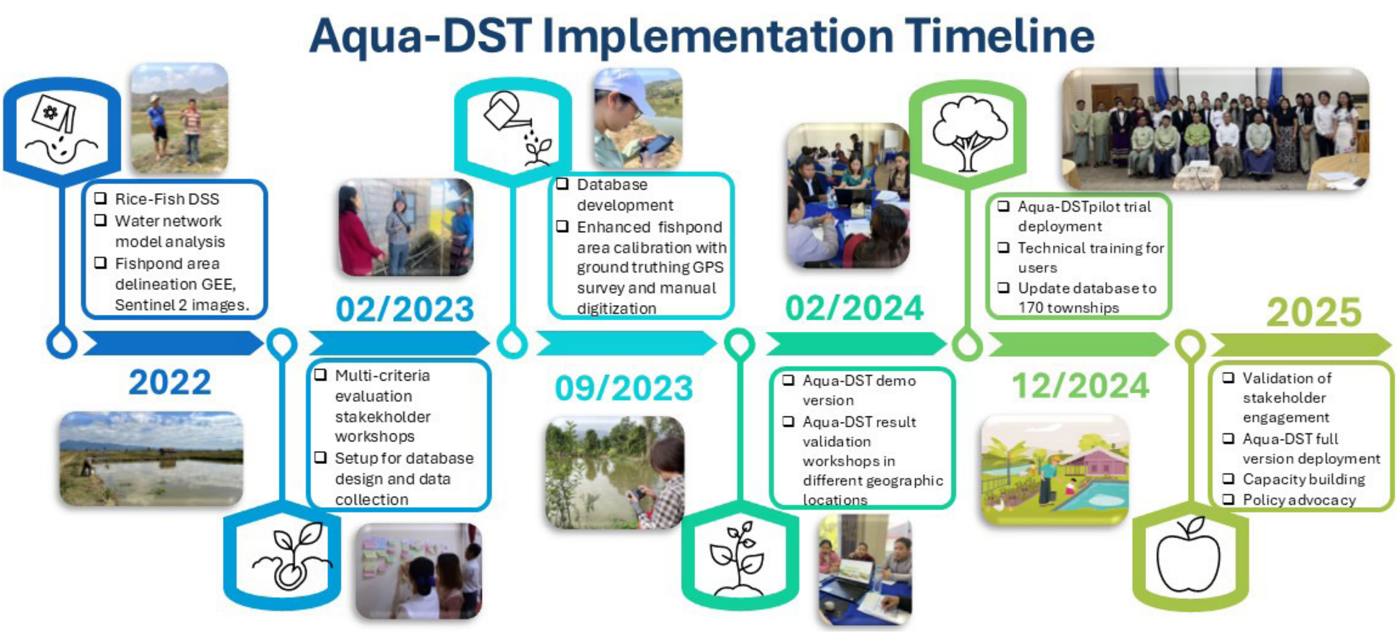
By September 2023, the project advanced to developing a comprehensive database. This included enhanced mapping of fishpond areas using ground-truthing GPS surveys and manual digitization techniques. These efforts improved data accuracy and provided a reliable foundation for the Aqua-DST system. The database serves as a central repository for managing aquaculture resources across multiple regions.

In February 2024, the Aqua-DST demo version was released for testing. Validation workshops were conducted across various geographic townships to evaluate the tool's functionality and gather feedback from local stakeholders. These sessions ensured the system's outputs were aligned with user needs and regional requirements, paving the way for broader adoption. The Aqua-DST dashboard visualization viewer was launched in October 2024. This interactive platform allows users to access, visualize, and analyze aquaculture data effectively. The dashboard represents a critical milestone in improving the accessibility of decision-making tools for diverse stakeholders.

By the end of 2024, the project concluded with the delivery of comprehensive technical training to users. This ensured stakeholders were equipped to use the Aqua-DST system effectively. Additionally, the geospatial database will be expanded to cover data from 170 townships in the Upper Myanmar region, significantly broadening the tool's application and impact. Beyond 2024, the Aqua-DST full version with all 170 townships in Upper Myanmar will be deployed after the validation with stakeholders engaged in the workshop.

This phased implementation integrates advanced geospatial techniques, stakeholder engagement, and capacity-building efforts to develop a robust decision support system for aquaculture and resource management in Myanmar.

Figure 2. Aqua-DST implementation timeline and progress.

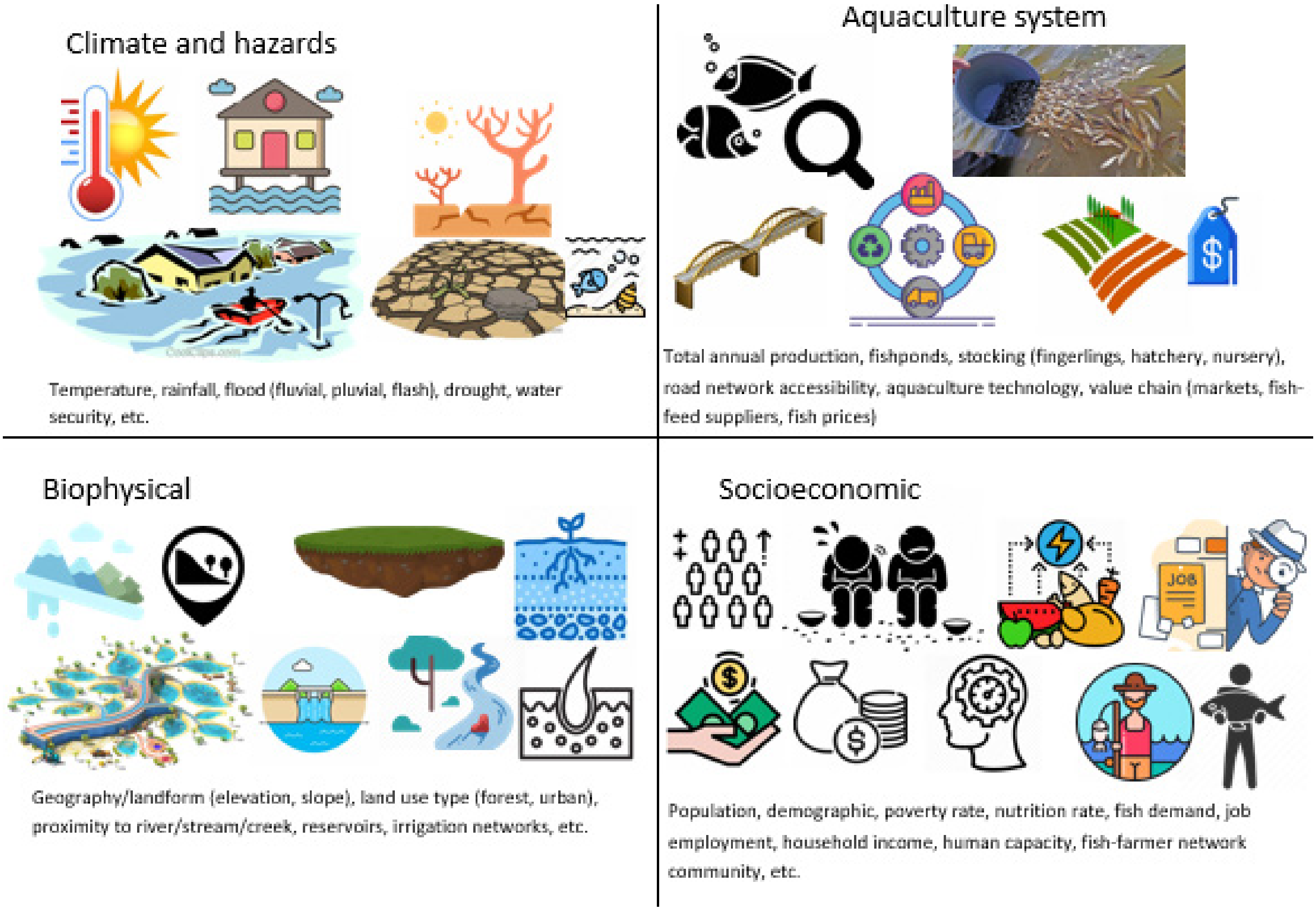


Co-design and validation of Aqua-DST

Suitability analysis approach

The Aqua-DST adopts a structured, participatory multi-criteria evaluation (MCE) framework for suitability analysis, integrating climate-hazard, aquaculture-related infrastructural/system, biophysical, and socio-economic criteria (Smith, B.R., Teoh, S.J., Leemans, K., Aung, H.M., Kyaw, W.P.K., Soe, M.H.M., Maung, K.M.D., Akester, M. & Dubois, M., 2021). Developed through a co-design process that merges scientific expertise with stakeholder input, the tool aligns with regional aquaculture objectives. The methodology includes defining the system and scope, data collection and management, and participatory weighting of criteria using the Analytic Hierarchy Process (AHP) (Goepel, 2018) for consistent decision-making. Key criteria, illustrated in Figure 3—such as temperature, rainfall, flood risk, landform, land use, infrastructure, water availability, markets, income, and population—were collaboratively identified to address regional aquaculture challenges. Criteria are standardized, aggregated, and categorized into suitability levels to generate actionable spatial outputs. Stakeholder workshops evaluate criteria importance, identify key factors for aquaculture scaling, and assess climate risk impacts across geospatial contexts.

Figure 3. Key criteria indicators under 4 components.



Data structure

Data inputs for Aqua-DST were sourced from diverse datasets, including satellite imagery, surveys, and government records, prioritizing aquaculture productivity, sustainability, and economic viability. Suitability criteria and variables were consolidated across five states/regions, covering 38 townships, with data categorized into four components by the IWMI team.

1. **Climate & Hazard**: Indicators like temperature, rainfall, and future climate scenarios (IPCC, 2021) influence land suitability. Hazard data on flooding (DDM), drought (Beguería. S., et al., 2023), and soil erosion (European Soil Data Centre, 2012) identify less viable areas for aquaculture.

2. **Aquaculture System**: Access to fishing infrastructure, markets, and transport facilities, sourced from DoF, WorldFish, and GAD (2019), enhances land suitability for aquaculture implementation.

3. **Biophysical**: Key factors such as elevation, slope (SRTM, 2000), land use (ESRI, 2023), and water availability (IWMI hydrologic model) determine aquaculture potential. Geospatial fishpond areas were mapped using Sentinel-2 data and validated with ground-truthing GPS surveys in 23 townships.

4. **Socio-economic**: Local skill sets and socioeconomic factors, sourced from DoF, WorldFish, and GAD (2019), are critical for aquaculture adoption and sustainability.

Township-level data were validated in Python and R using descriptive statistics, outlier detection, and correlation analysis. Ground-truthing and stakeholder consultations ensured accuracy and practical utility.

Validation and Deployment of the Aqua-DST

The **Aqua-DST Trial Version 1.0** was rigorously validated in climate-sensitive townships—Myitkyina, Mandalay, Magway, Taunggyi, and Kengtung—through workshops engaging 127 stakeholders (78 males, 49 females). Interactive sessions featuring fishpond criteria, data structures, and weighting inputs fostered collaborative dialogue and consensus on suitability classifications while addressing data gaps in fish consumption, market access, and trade metrics. Workshop feedback informed critical adjustments, culminating in refined data structures and weighted values for improved model accuracy.

Aqua-DST Version 2.0 emerged as a game-changer with two integrated modules:

1. **Aqua-DST Excel Model**: Simplifies data input and weighting through the Analytic Hierarchy Process (AHP) with stakeholder participation.

2. **Dashboard Visualization Viewer**: Enables dynamic result mapping and scenario analysis for smarter aquaculture planning.

Version 2.0 was demonstrated to aquaculture experts—technicians from DoF and IWUMD, value chain actors from Myanmar Fisheries Federation (MFF), and representatives from NGOs and CBOs—gathering valuable feedback before public launch and hands-on training. Stakeholders lauded the tool's potential to save time and resources, offering a cost-effective solution for national and regional aquaculture development.

Dissemination of Aqua-DST through users

For the dissemination of Aqua-DST through the users (Figure 3), the Aqua-DST is being implemented and shared with:

1. **Government Agencies**: Supporting policy decisions at the township, regional, and national levels.

2. **Non-Governmental Organizations**: Assisting in community-based planning and capacity building.

3. **Private Sector and Value Chain Actors**: Enabling market-driven aquaculture investments.

4. **Research Institutions**: Providing a tool for advanced studies in aquaculture and environmental sustainability.

5. **Local Farmers and Communities**: Equipping them with actionable insights for pond management and risk mitigation.

Figure 4. Aquaculture end-users.

The first step to tickle the achievement of this objective is capacity building two-day technical training program including a series of presentations, a demonstration of Aqua-DST, and intensive groupwork exercises and presentations by the trainees, to get hands-on practice to understand better the usefulness and applicability of Aqua-DST and the powerfulness of its suitability result visualization dashboard viewer to disseminate the information on decision-making that can reduce risks and thus increase the sustainability of ponds. We offered the two-day in-person applied Aqua-DST training in Mandalay and Naypyitaw effectively and efficiently. A total of 56 (22 female) participants were trained on how to use Excel Aqua-DST, DST Dashboard Interface, and how to look for and read the data and information provided by the Aqua-DST.

Aqua-DST should be utilized to strategically identify and allocate potential land areas for aquaculture development. By leveraging Aqua-DST, the Department of Fisheries (DoF) and government authorities can proactively set land-use policies tailored to promote aquaculture in the most favorable areas within each township.

By integrating comprehensive databases from the Department of Fisheries (DoF) and other relevant sources, Aqua-DST's capabilities can be significantly enhanced, making it a versatile, foundational system to address multiple outputs. In essence, Aqua-DST is the cornerstone for operationalizing the National Aquaculture Development Plan (NADP) at the township level, driving policy advocacy, aligning land use with aquaculture potential, and ensuring sustainable aquaculture development for the future.

The following activities should be implemented for the dissemination of Aqua-DST through the users.

1. **Capacity Building**: Conduct technical training and dissemination workshops to ensure effective adoption by stakeholders.
2. **Validation and Stakeholder Engagement**: Host workshops to refine Aqua-DST based on user feedback and real-world needs.
3. **Policy Advocacy**: Facilitate high-level dialogue meetings to integrate Aqua-DST into national aquaculture policies.

Conclusion

The Aqua-DST represents a transformative approach to sustainable aquaculture development. By integrating diverse data sets into a user-friendly platform, the tool not only identifies growth opportunities but also empowers stakeholders to address environmental and socio-economic challenges effectively. The Aqua-DST is beneficial for identifying underdeveloped aquaculture areas and providing insights into why these regions remain undeveloped. It effectively highlights challenges, weaknesses, and gaps in potential aquaculture sites. Further research can also help to the benefits of better governance and management upon aquaculture development. Priorities include the following:

1. **Expanding Geographic Reach**: Extend Aqua-DST to new districts and update the full version to cover 170 townships in Upper Myanmar.
2. **Enhancing Data Precision**: Incorporate village-tract-level data, advanced visualizations, and future climate scenarios for robust and policy-driven insights.
3. **Continuous Development**: Ensure iterative updates and dissemination to adapt to changing landscapes and strengthen future aquaculture planning.
4. **Monitoring & Evaluation**: Assess Aqua-DST's effectiveness in stakeholder engagement and its role in enabling transformative policy solutions.
5. **Farmer-Friendly Version**: Develop simplified outputs accessible through virtual aquaculture service providers for grassroots impact.
6. **Sustainable Deployment**: Build self-reliant systems within aquaculture communities to maintain updates beyond project funding.

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CGIAR Initiative on Aquatic Foods

The CGIAR Initiative on Aquatic Foods aims to tackle systemic challenges to the sustainability and resilience of aquatic food systems, including data gaps that lead to exclusion of the sector from wider food and nutrition policies and programs, and limited research investment. Working closely with research partners in fisheries and aquaculture, civil society, industry, and governments, the Initiative contributes to the reduction of greenhouse gas emissions from the production of aquatic foods and enhance ecological and social resilience through development and dissemination of improved fish strains, better management practices, integrated fish-rice production systems, and fish-friendly irrigation systems.

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