TECHNICAL BRIEF

Strengthening Aquatic Food Systems with Decision Support Tools: Evidence from Ghana and Myanmar

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Back cover photo: Workshop participants at the IWMI Office, Accra, Ghana. *photo:* Klinsman Amissah/IWMI

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Contents

Summary

Aquatic food systems in low- and middle-income countries face increasing pressures from climate variability, land use change, and limited access to reliable planning data. Decision Support Tools (DST) developed by the International Water Management Institute (IWMI) are helping bridge these gaps by transforming Earth observation, hydrological data, and socio-economic information into actionable insights. This brief compares two DST ecosystems: Ghana's Small Reservoir Decision Support System and Myanmar's Aqua-DST, highlighting shared lessons, innovations, and implications for scaling.

KEY HIGHLIGHTS:

- Ghana's DST integrates satellite-based reservoir monitoring, drying-risk assessment, and aquaculture suitability mapping to support planning across over 900 small reservoirs.
- Myanmar's Aqua-DST combines climate, biophysical, and management indicators with multi-criteria evaluation to guide pond-based aquaculture expansion and township-level decision-making.
- Both tools demonstrate strong co-creation and user engagement, involving government agencies, farmers, youth groups, and development partners.
- Multi-criteria analysis frameworks and machine learning modeling help balance trade-offs across technical, environmental, financial, and social dimensions.
- Dashboards and visual interfaces accelerate adoption by making data accessible to non-technical users.
- Cross-country learning shows that DSS scalability depends not only on technical design but on institutional ownership, data availability, and integration into extension services.

The Challenge

Aquatic food systems across low- and middle-income countries face growing pressures from climate variability, rapid population growth, and competition for land and water resources. These pressures are particularly acute in regions where aquaculture and inland fisheries provide essential protein, livelihoods, and economic opportunity. Yet decision-makers often lack timely, spatially explicit, and integrated data to plan and manage these systems effectively.

In Ghana, small reservoirs (Figure 1), over 2,000 waterbodies across the northern regions (Figure 2) are increasingly relied upon for livestock, domestic use, irrigation and aquaculture. However, reservoir drying, siltation, and competing water demands make planning highly uncertain. Traditional data sources provide only partial views of water availability, infrastructure conditions, and suitability for aquaculture investments.

Similarly, in Myanmar, pond-based aquaculture is central to rural food security and income generation, yet expansion is constrained by fragmented datasets, limited biophysical assessments, and the absence of standardized tools for site selection and management. Climate hazards: floods, droughts, and extreme temperatures, further complicate decision-making.

Across both countries, the core challenge is the same: decisions are being made in data-scarce, rapidly changing environments. Without reliable and integrated information on water availability, biophysical suitability, market access, and farm-level risks, opportunities for aquaculture development remain underutilized or misaligned with local realities. Decision Support Tools offer a pathway to overcome these gaps by bringing together geospatial intelligence, hydrological data, and participatory knowledge into coherent, actionable insights.

Figure 1. Reservoir in northern Ghana (left) and aquaculture ponds in Myanmar (right). (*Source:* Shelly Win)

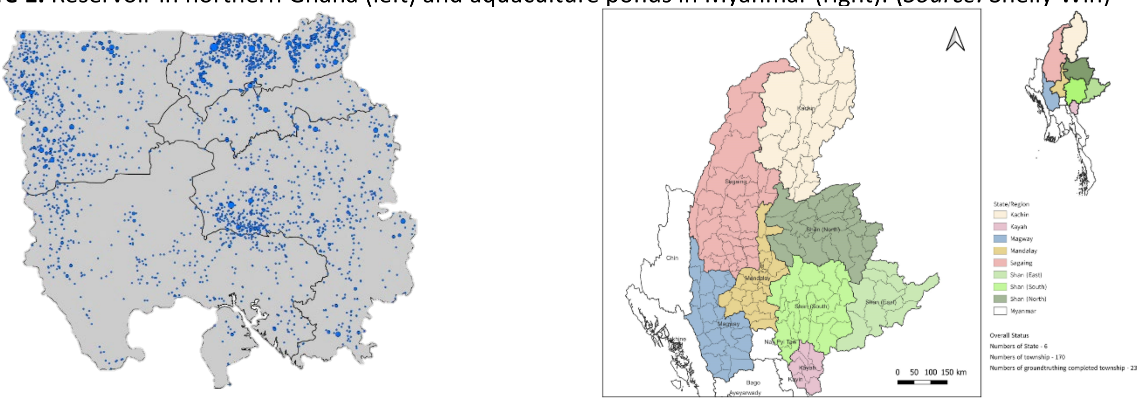


Figure 2. Spatial overview of small reservoirs in northern Ghana (left) and aquaculture townships across Myanmar (right). (*Source*: Author's creation)

The Decision Support Tools Development Approach

Across Africa and Asia, IWMI has developed a suite of Decision Support Tools (DST) that translate complex datasets into practical guidance for governments, communities, and development partners. These tools share a common design philosophy: combine Earth observation, hydrological modelling, socio-economic data, and multi-criteria evaluation to support decisions in data-scarce and climate-stressed environments. A key strength of IWMI's DST ecosystem is its modular architecture. Tools are developed around four core components (Figure 3) also reflected in the Ghana and Myanmar systems:

1. Data Acquisition and Integration

High-resolution satellite data, hydrological outputs, climate hazards, reservoir and pond inventories, and field observations provide a harmonized evidence base. *(Examples: Sentinel-2 reservoir mapping in Ghana; climate, soil, and hazard datasets for Aqua-DST.)*

2. Analytical and Modelling Frameworks

IWMI tools apply methods such as:

- Multi-Criteria Evaluation (MCE)
- Analytic Hierarchy Process (AHP)
- Hydrological modelling
- Spatial classification and machine learning
- Weighted scoring and scenario analysis

These methods allow decision-makers to understand trade-offs among technical, environmental, financial, and social indicators.

3. Decision Dashboards and User Interfaces

Visual dashboards make analytical results accessible to non-technical users, allowing them to explore maps, compare scenarios, and interpret suitability scores. Tools like the Small Reservoirs Dashboard and Aqua-DST mirror the interactive design principles seen in other IWMI dashboards. (Dashboards typically include maps, charts, MCDA rankings, and scenario comparison features.)

4. Co-creation, Capacity Building, and Institutionalization

IWMI DST development is grounded in iterative engagement with ministries, extension officers, youth groups, and farmers. Through workshops, validation sessions, and training, users help define indicators, weight criteria, and interpret outputs, ensuring the tools reflect on-the-ground realities and institutional needs.

IWMI's DST ecosystem strengthens planning, investment prioritization, and climate resilience. The Ghana and Myanmar systems apply this shared design logic to aquatic food systems, one centered on reservoir-based aquaculture in Ghana and the other on pond-based aquaculture in Myanmar, demonstrating the adaptability of these approaches across diverse geographic, institutional, and data environments.

What Makes an IWMI DSS?

- **Scalable**
- **Data-agnostic**
- **Modular**
- **Policy-relevant**

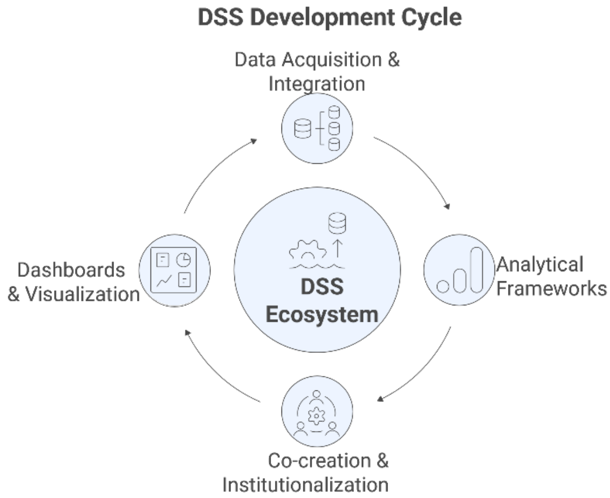


Figure 3. Decision Support Tool Development Cycle (*Source:* Author's creation)

The Ghana DST Ecosystem

Ghana's Decision Support System for small reservoirs integrates earth observation, reservoir characterization, multi-criteria aquaculture suitability analysis, and dashboard-based dissemination. Developed across multiple IWMI initiatives, the system supports planning for irrigation, livestock, domestic water use, and increasing interest in reservoir-based aquaculture. The ecosystem consists of five interconnected components (Figure 4).

What are the Key Strength of the Ghana DSS:

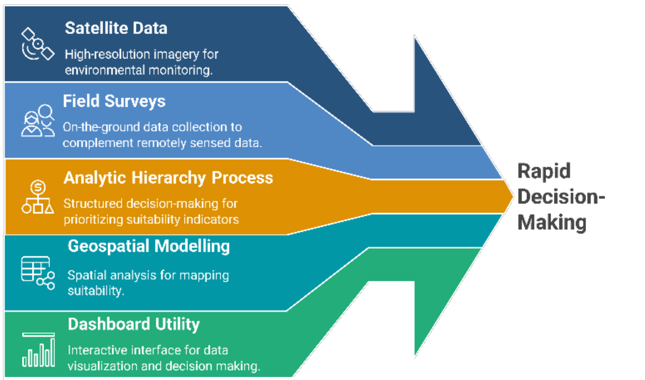


Figure 5. Key components of the Ghana DST integrating data, modelling, and dashboards to support rapid decision-making. (*Source:* Author's creation)

Geospatial Reservoir Intelligence

Northern Ghana contains more than 2,000 small reservoirs that underpin rural livelihoods but experience highly variable hydrological conditions. To monitor these dynamics, IWMI developed a semi-automated workflow for detecting water extent and tracking reservoir conditions using Sentinel-2 imagery, cloud masking (s2cloudless and MAJA), MNDWI thresholding, random forest classification, and geometric post-processing.

The resulting database provides annual and seasonal trends in reservoir surface area, drying frequency, and landscape characteristics. Analysis of five years of imagery (2018–2024) revealed strong seasonal contraction, with some reservoirs declining by more than 70%, and identified reservoirs at very high, high, moderate, low, or extremely low risk of drying based on landscape setting, catchment characteristics, and hydrological behavior (Figure 5a). These classifications support decision-makers responsible for targeting rehabilitation investments, planning water allocation, and identifying candidate sites for aquaculture development.

Reservoirs were further grouped by size classes (Figure 5b) and landscape positions (valley, plateau, mid-slope), enabling a standardized comparison across districts. This spatial intelligence formed the backbone of subsequent suitability assessments and dashboard applications (Figure 6)..

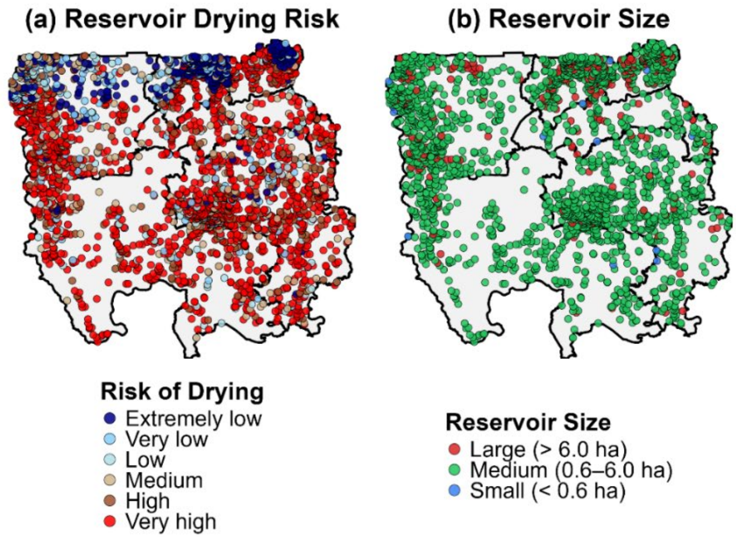


Figure 4. A Map of Reservoir drying risk (a) and Reservoir Sizes (b) for Northern Ghana (*Source:* Author's creation)

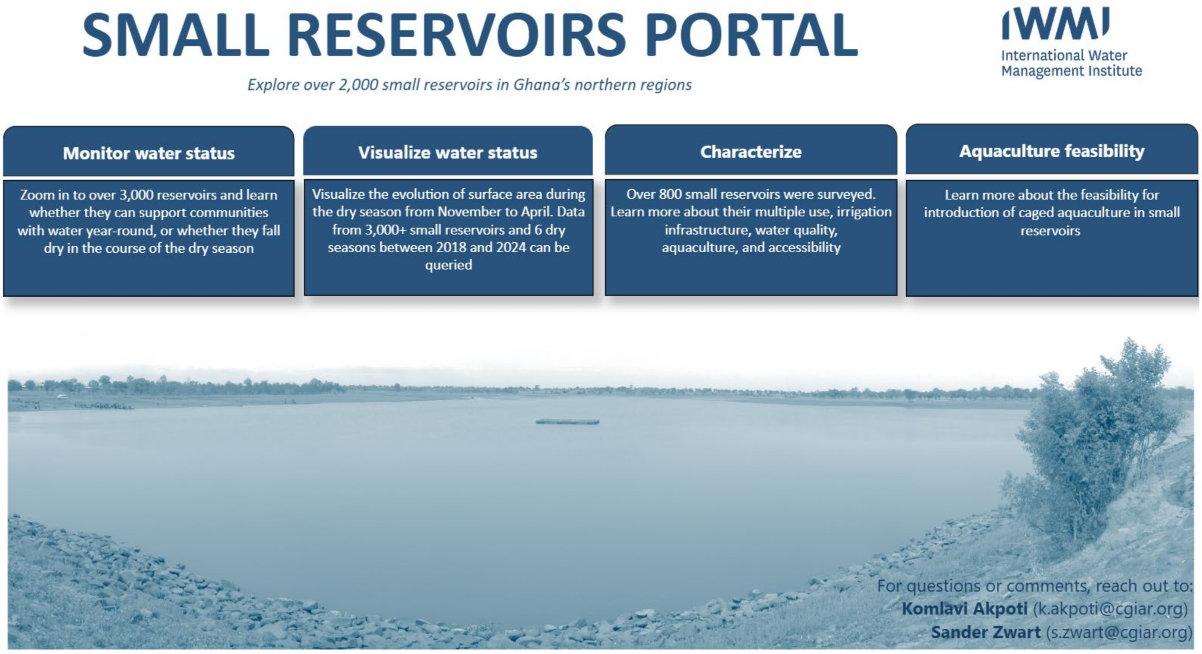


Figure 6. Dashboard interface showing reservoir attributes, drying trends, and suitability layers.

Small Reservoirs Dashboard

To make reservoir intelligence accessible to non-technical users, IWMI co-developed the Small Reservoirs Dashboard, a multi-module visualization tool that integrates reservoir characteristics and metadata, seasonal water dynamics and drying risk, landscape and catchment attributes and aquaculture suitability insights. Figure 6 is a snapshot of the home page of the Small Reservoirs Dashboard

The dashboard aggregates data from over 900 surveyed reservoirs, spanning infrastructure, use patterns, management arrangements, and environmental conditions, and overlays them with satellite-derived indicators. Users can view maps, charts, time series, and tables, enabling comparative assessments across communities, districts, and regions.

Aquaculture Suitability and Pilot Applications

Ghana's DST extends beyond mapping and monitoring to support aquaculture decision-making. Suitability assessments integrate reservoir hydrology, drying risk, water quality proxies, infrastructure, access, and fishery management considerations. These assessments guided a series of pilot interventions in the North East Region (Figure 7) where youth groups were supported to establish cage aquaculture operations. Pilot outcomes demonstrated the practical relevance of the DST:

- Reservoirs classified as low or moderate drying risk performed better in sustaining cage operations.
- Community engagement and multi-use negotiation were essential for site selection.
- Turbidity levels and fluctuating water volumes influenced fish survival in certain sites.
- Youth cooperatives, trained under the program, gained new livelihood opportunities and strengthened market linkages.

These pilots validated DST outputs while also generating field-level feedback for refining suitability criteria and designing future interventions. IWMI's community engagements at the pilot communities highlight improved livelihood prospects, strong youth interest, and opportunities for scaling reservoir aquaculture across northern Ghana.

Figure 7. A collage of images showing youth-led cage aquaculture and fish yield at a pilot site in Northern Ghana. (*Source*: Guilia Zane/IWMI)

The Myanmar DST Ecosystem

Myanmar's Decision Support System for aquaculture, Aqua-DST, was developed to address persistent data gaps and management uncertainties affecting small- and medium-scale pond farmers. Designed through IWMI and WorldFish collaborations, the tool supports climate-resilient aquaculture planning in a context where ponds are highly sensitive to floods, droughts, temperature extremes, and water-quality fluctuations. Aqua-DST integrates biophysical, socio-economic, and hazard information to guide both farm-level decisions and township-level investment planning.

Aqua-DST Architecture

Aqua-DST applies a Multi-Criteria Evaluation (MCE) framework using the Analytic Hierarchy Process (AHP) to evaluate the suitability of ponds and landscapes for aquaculture (see Figure 8). Participatory weighting sessions with farmers, extension officers, and the Department of Fisheries (DoF) informed indicator prioritization, ensuring the tool reflects local knowledge and institutional realities (see Figure 8).

Key components include:

- **Climate and Hazard Indicators:** Flood, drought, temperature anomalies, and seasonal water availability influence vulnerability and production potential. These layers were integrated to identify areas at risk and guide climate adaptation.
- **Biophysical Indicators:** Soil type, pond depth, water retention characteristics, and productivity proxies collectively determine biophysical suitability. Remote sensing and hydrological datasets were harmonized with national biophysical inventories to ensure spatial consistency.
- **Aquaculture System Indicators:** Stocking density, feeding practices, water exchange frequency, and species-specific requirements were assessed to determine operational suitability. This aligns with diverse production systems used across Upper Myanmar.
- **Socio-economic and Accessibility Indicators:** Market access, road connectivity, input availability, labor characteristics, and community networks determine economic viability. These factors help prioritize locations where aquaculture is likely to be profitable and sustainable.

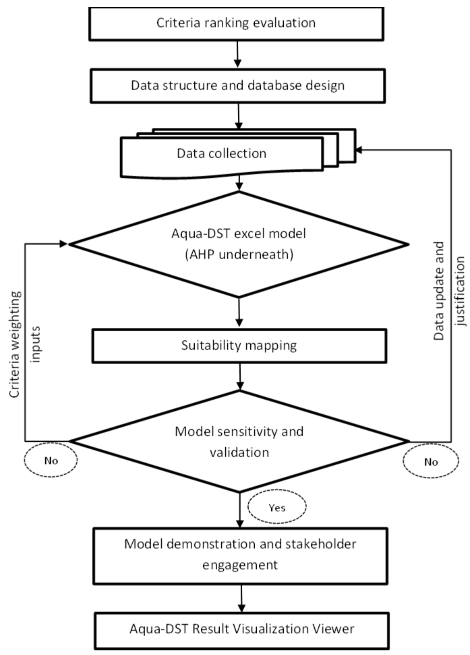


Figure 8. Methodological framework used in Aqua-DST. (*Source:* Author's creation)

The final output is a set of township-level suitability maps for 170 townships (Figure 9), offering a standardized lens for evaluating expansion pathways across Upper Myanmar

Use Cases and Field Applications

Aqua-DST has been used to support multiple decision domains including pond siting and expansion planning, farm-level management decisions, climate and hazard preparedness, and farmer training and advisory services.

Suitability maps help DoF and development partners target investments, prioritize climate-resilient expansion areas, and identify townships requiring adaptation support. The tool informs stocking strategies, species choices, and risk mitigation actions, particularly in areas with recurrent temperature stress, high turbidity, or flood exposure. Integration of flood and drought indicators supports contingency planning and climate adaptation investments at household and township levels. Aqua-DST outputs were incorporated into training manuals, extension sessions, and case demonstrations, enabling farmers to understand underlying risks and respond strategically.

These applications mirror lessons from Ghana's reservoir aquaculture pilots but operate at a different production scale, emphasizing pond management rather than cage culture.

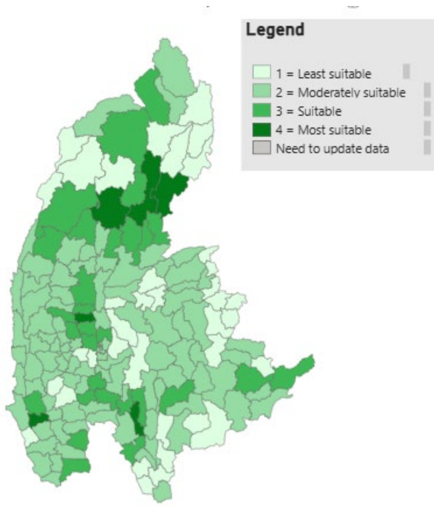
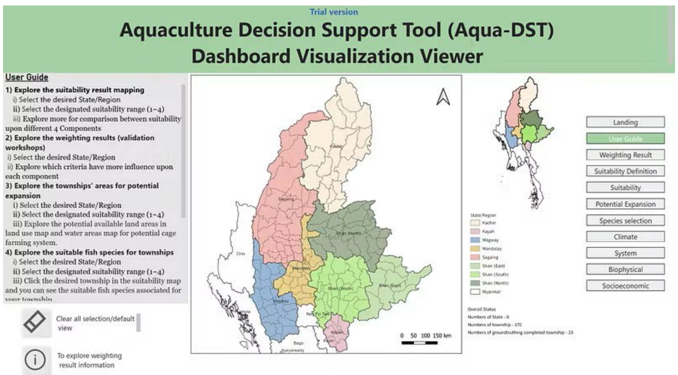


Figure 9. Township-level suitability map for pond aquaculture in Myanmar. (*Source:* Author's creation)

Institutionalization and Capacity Strengthening

A major achievement of the Myanmar DST ecosystem (Figure 10) is its strong institutional uptake.



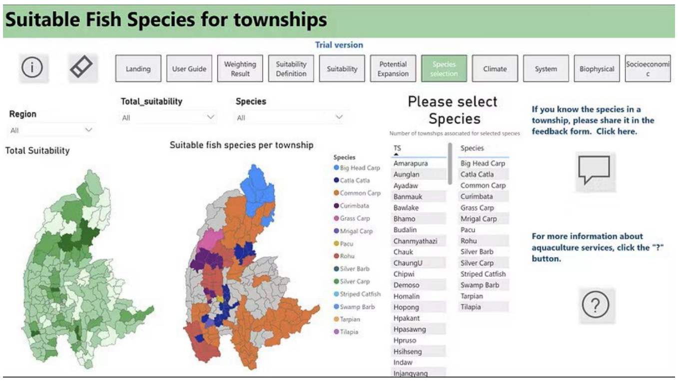


Figure 10. Aqua-DST dashboard screenshot. (*Source:* Shelly Win/IWMI)

The dashboard and analytical outputs were officially handed over to the Department of Fisheries (DoF), which now uses Aqua-DST to guide aquaculture development planning.

Capacity-building workshops, held in Mandalay, Naypyitaw, and Yangon, trained over 130 officials, university partners, aquaculture professionals, and civil society actors (Figure 11). Sessions covered indicator weighting, interpretation of suitability maps, and integration of Aqua-DST into extension workflows. Stakeholders emphasized strengths:

- Transparency of the MCE/AHP approach
- Ease of interpreting dashboard outputs
- Utility for climate adaptation and risk screening
- Relevance for investment planning and development programming

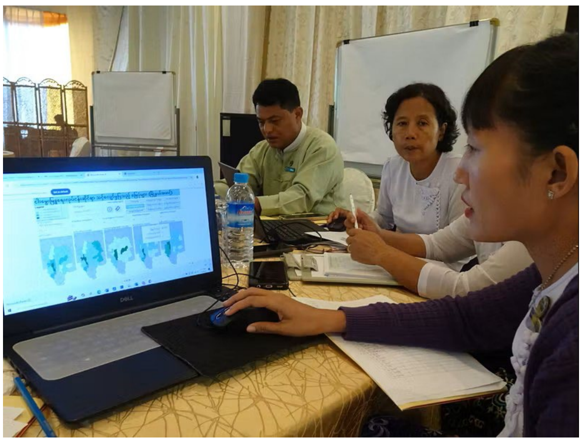


Figure 11. Training sessions with DoF officials (*Source:* Shelly Win/IWMI)

They also identified priority enhancements, including village-tract resolution, expanded water-quality datasets, incorporation of more species-specific parameters, and mobile-friendly interfaces for field use.

Comparative Analysis

Ghana and Myanmar present two distinct aquatic food system contexts: reservoir-based cage aquaculture versus pond-based farming. Yet, both countries face similar challenges: climate variability, fragmented datasets, limited decision-making tools, and diverse stakeholder needs. Their DST ecosystems reveal complementary strengths and shared design principles.

System Focus and Production Context

Ghana's system focuses on reservoir-based aquaculture embedded in multi-use water systems (irrigation, livestock, domestic use). DST focuses on hydrological dynamics, drying risk, and spatial suitability for cages.

In Myanmar, it is pond-based aquaculture across the Dry Zone and Upper Myanmar. DST emphasizes biophysical, management, and hazard considerations at farm and township scales.

Data Foundations

The two DST ecosystems also diverge in their primary data foundations. Ghana's system draws heavily on Earth observation, using satellite imagery to detect reservoirs, map seasonal water extent, classify landscape settings, and quantify drying risks. These EO datasets are complemented by reservoir survey data that capture infrastructure conditions, use patterns, and management arrangements across hundreds of sites.

Myanmar's Aqua-DST is built on a broader multi-source data foundation. Climate hazards, soil characteristics, water availability, pond attributes, accessibility metrics, management practices, and socio-economic conditions are combined into an integrated database. The focus on climate and hazard data reflects Myanmar's vulnerability to extreme weather events, while socio-economic indicators help identify areas where aquaculture is economically viable. Together, these data foundations illustrate two effective but context-specific approaches to supporting aquaculture development.

Analytical Approaches and Decision Interfaces

Ghana and Myanmar apply analytical approaches tailored to their aquaculture systems, yet both rely on multi-criteria decision analysis supported by the Analytic Hierarchy Process (AHP) to structure suitability assessments. In Ghana, Earth observation and geospatial analysis underpin the mapping of reservoir dynamics and drying risk, while AHP is used to prioritize social, economic, biophysical, and land-use indicators for aquaculture suitability. Expert-derived weights are applied through a weighted overlay model to generate a composite suitability score for each reservoir, enabling clear categorization and comparison.

Myanmar's Aqua-DST similarly adopts AHP as the backbone of its suitability evaluation. However, the tool integrates a wider set of climate, hazard, biophysical, and socio-economic layers because aquaculture in Myanmar is predominantly pond-based and more sensitive to environmental variability. Indicators were weighted through participatory workshops involving the Department of Fisheries, extension officers, farmers, and development partners, after which the weighted indicators were combined through a Multi-Criteria Evaluation (MCE) procedure. The outputs include township-level suitability surfaces and farm-level management insights that help planners navigate trade-offs between environmental risks, operational feasibility, and market access.

Despite differences in spatial scale and production systems, both countries rely on clear, decision-oriented interfaces to communicate analytical outputs. Ghana's Small Reservoirs Dashboard visualizes hydrological behavior, reservoir attributes, survey data, and AHP-derived suitability results, allowing users to compare reservoirs and identify priority sites for aquaculture development. Myanmar's Aqua-DST dashboard presents suitability categories, indicator layers, and scenario-based analyses in an intuitive interface tailored to national and township-level planning. Across both contexts, dashboards serve a common role: transforming complex multi-criteria analyses into accessible, actionable guidance that supports real-world decision-making.

User Groups and Institutional Roles

Each DST serves distinct user groups shaped by national institutional arrangements. In Ghana, district assemblies, agricultural and fisheries officers, youth cooperatives, and community leaders rely on the reservoir dashboard to guide decisions related to aquaculture expansion, water allocation, and reservoir management. Because reservoirs are multi-use systems, the Ghana DST supports negotiation among stakeholders and helps mitigate potential conflicts over water use.

In Myanmar, Aqua-DST is used primarily by the Department of Fisheries (DoF), aquaculture extension officers, farmers, and development partners. Township planners use the system to assess expansion potential and climate risks, while extension officers incorporate Aqua-DST insights into farm management training. The system's formal adoption by the DoF demonstrates a strong pathway for institutionalization, enabling integration into national aquaculture planning.

Comparative Insight

Despite the differences between reservoir-based and pond-based aquaculture systems, several important insights emerge across both countries.

First, Earth observation and spatial modelling provide critical intelligence in data-scarce environments, whether for mapping thousands of reservoirs or assessing climate exposure across vast farming landscapes. Second, co-creation is essential for tool adoption; stakeholder workshops in Myanmar shaped AHP weights, while user feedback in Ghana guided dashboard improvements. Third, suitability mapping helps structure complex decisions by balancing environmental, technical, and economic considerations, making investment more defensible. A final shared lesson is the importance of institutional embedding. Ghana's district-level engagement and Myanmar's national-level adoption show that DST sustainability depends on integrating tools into decision-making processes, not just producing analytical outputs.

Together, these experiences demonstrate that well-designed DST platforms, adapted to local aquaculture systems, can substantially improve planning, investment targeting, and climate resilience in aquatic food systems. Table 1 provides a summary of how the two DSTs compare with each other.

Table 1. Ghana–Myanmar DST Comparison Matrix

Dimension	Ghana	Myanmar	Cross-country insight
Primary system modeled	Small reservoirs	Ponds & aquaculture farms	DST can adapt to diverse aquatic systems
Data foundation	EO (reservoir maps) +socio + Survey	EO + farm-level biophysical datasets	Importance of scalable EO methods
Level of decision	National, community, reservoir	National, township, farm	DST must operate at multiple spatial scales
Main DST use case	Suitability + monitoring	Suitability + management	Both improve investment decisions
Users	Ministries, youth groups, agencies	DoF, F4L, farmers	Tailored interfaces improve uptake
Strengths	Strong EO technical base	Strong participatory weighting	Complementary models

Conclusion

Ghana and Myanmar illustrate how context-specific yet methodologically aligned Decision Support Tools can strengthen planning, investment, and climate resilience in aquatic food systems. By integrating Earth observation, multi-criteria analysis, and user-centered dashboards, both countries have transformed fragmented data into actionable insights that support farmers, planners, and institutions. The Ghana DST enhances decision-making in multi-use reservoir systems, while Aqua-DST guides pond-based aquaculture development across climate-affected landscapes in Myanmar. Together, these experiences demonstrate that digital, co-created DST solutions offer a scalable pathway for improving aquatic food production, supporting sustainable livelihoods, and informing policy in data-scarce environments.

Future work will focus on integrating real-time climate and water forecasting, expanding data layers such as water quality and fine-scale socio-economic indicators, and developing mobile-friendly DST interfaces for field use. Strengthening links between aquaculture tools and broader water-resource models will improve cross-sector planning, while institutional partnerships in both countries will support scaling and long-term sustainability.

LESSONS LEARNED

1. **DSS tools must be co-created with end-users.**
Ghana's iterative reservoir dashboard development and Myanmar's participatory AHP weighting confirm that co-design is essential for relevance and uptake.

2. **Earth observation and modelling are powerful in data-scarce environments.**
Reservoir mapping in Ghana and hazard mapping in Myanmar show how EO can provide consistent, scalable insights across large geographies.

3. **Complementarity of socio-economic and biophysical data strengthens investment relevance.**
Combining environmental suitability with socio-economic variables enables DSTs to answer decision makers' core questions: where to invest and where impact and returns are likely to be highest. Biophysical suitability alone is not sufficient without economic and social viability.

4. **Institutionalization matters as much as technical design.**
Myanmar's DoF adoption and Ghana's multi-stakeholder engagement show that long-term sustainability depends on developing tools with the participation of user agencies to ensure ownership.

5. **DSS ecosystems should link analysis with real-world pilots.**
Ghana's youth-led cage aquaculture pilots and Myanmar's farm-management demonstrations validated the tools and revealed practical constraints for scaling.

6. **Climate variability must be central to aquaculture planning.**
Drying risk in Ghana and flood/drought exposure in Myanmar highlight the need for DSS tools to incorporate climate hazards and seasonal dynamics.

POLICY IMPLICATIONS

1. **Strengthening national aquaculture planning**
Both countries show that DSS tools can guide ministries and local governments in identifying priority investment zones, enhancing resource allocation, and reducing planning uncertainty.

2. **Improving climate resilience in aquatic food systems**
Integrating hazard layers, drying risk, and seasonal water availability supports adaptation planning and reduces production risk for vulnerable communities.

3. **Enhancing youth engagement and livelihood diversification**
Ghana's experience demonstrates the potential for DSS-supported aquaculture to create new livelihood opportunities for youth groups and cooperatives.

4. **Supporting inclusive and evidence-based extension services**
Dashboards and suitability maps can be incorporated into field advisory programs, helping extension agents translate analytics into actionable recommendations.

5. **Enabling donor and private-sector investment**
Transparent suitability criteria and standardized mapping frameworks reduce uncertainty for investors, enabling more targeted finance for aquaculture development.

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