APPLYING A SOFT SYSTEM METHODOLOGY TO REVEAL PROBLEMS IN MANGROVE-AQUACULTURE SYSTEM

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Management of mangrove-aquaculture system (MAS) in the Mekong Delta needs the information of stakeholders’ perceptions that are difficult to obtain. Accordingly, we applied a Soft System Methodology (SSM) to reveal the perceptions and then determine problems, key stakeholders, and suggest feasible solutions for improving the MAS. We selected Kien Vang, Ca Mau, Vietnam as a case study. Results showed the current MAS problems of management difficulty, water pollution, and low yield of aquaculture. We identified key stakeholders as local forest department (FD) and farmers. Results suggested feasible solutions to improve the current circumstance of MAS including administration, water control, yield maintenance, and urgent needs of infrastructure investment.

Key Words: SSM, mangrove, stakeholders, Mekong Delta, systemization, system

1. INTRODUCTION

Mangrove is an ecological hotspot and a source of livelihood, i.e., in Ayeyarwaddy region (Myanmar)¹, Ca Mau (Vietnam)², and Central Java (Indonesia)³. For this reason, management often considers combined ecological and livelihood factors for mangrove protection. In Vietnam, particularly in the Mekong Delta, the combined approach is designed in an allocation program of mangrove-aquaculture⁴. However, this strategy can cause the expansion of aquaculture that can lead to the decrease of mangrove areas and then the excess of limits of mangrove’s functioning⁶. Multiple stakeholders (with their perceptions) involving in mangrove can provide useful information for management, particularly their needs. However, their perceptions are often unstructured and sometimes fragmented. Hence, their direct information may not fully reflect the real world of mangrove problems. This information should be structured through a systemization process with data organization and transformation⁸ to become more defined and systemic⁷, which can be achieved using a Soft Systems Methodology (SSM)⁹. Because of a soft system thinking where problem inquiry is systemic, SSM can help structure information¹⁰ and then reveal the perceptions comprehensively¹¹. In that sense, SSM can be potentially useful for mangrove system analysis.

Recent studies have reported a need of deep analysis of mangrove problems, particularly the MAS in Vietnam which is vulnerable to changes. Mangrove in this region has significantly decreased due to its partial conversion to agricultural and aquacultural areas over the past 50 years¹². Although the allocation has been effective since 2001 for forest protection and livelihood
improvement\textsuperscript{13}, it has not succeeded as expected. The MAS is not highly efficient due to limited understanding, improperly technical guideline, and permitted thinning and selective harvests\textsuperscript{8}. As such issues, there is a need of revealing the MAS problems at root to support comprehensive management. Accordingly, this study will apply SSM to reveal the MAS problems at root and systemically. Our objectives were to (1) identify the current problems, (2) reveal key stakeholders and their roles, and (3) suggest feasible solutions to improve the current MAS.

2. METHODOLOGY

(1) Study site

The study site is mangrove in Ca Mau district, Vietnam (Fig.1). This area has farmers who were currently contracting with the Forest Department of Ca Mau in mangrove allocation (at the time of our visit in 2020).

(2) Mangrove-aquaculture system (MAS)

The MAS includes mangrove and aquacultural areas. They are adjacent to each other (Fig.2). The current allocation ratio of mangrove to aquacultural areas in the study site is 70\% to 30\%, respectively.

(3) Soft Systems Methodology

We used the SSM introduced by Checkland\textsuperscript{14} and the SSM model adopted by Nguyen et al.\textsuperscript{8} (Fig.3). For this approach, raw data from discussions with stakeholders was input into the model to reveal the current situation (Output 1). Results from Step 2 (the real-world) were systemized at Step 3 to create a root definition that includes P (“what to do”), Q (“how to do it”), and R (“why to do it”)\textsuperscript{9}. We then applied CATWOE (customers (C), actors (A), transformations (T), Weltanschaugung or world-view (W), owners (O), and environmental constraints (E)) for data analysis. In next step, we formed a conceptual system in Step 4. In Step 5, we compared and matched the results of Step 2 (real-world) and Step 4 (systemized) to obtained comprehensive outcomes. In Step 6, we identified feasible changes to improve the current mangrove management. Finally, solutions for change (Output 3) were obtained in Step 7.

(4) Data collection

We discussed with stakeholders (5-7 participants) in the mangrove-aquaculture in 2020. Discussion groups include local people (in Kien Vang station) contracting with the FD for mangrove allocation, forest protection officials, and local forest researchers. All data collected in three separate meetings (one meeting for each group), and one mixed meeting (incl. all of the stakeholders) were used for SSM analysis.

3. RESULTS AND DISCUSSIONS

(1) Current situation

We collected the unstructured perceptions of local stakeholders and arrange them in a diagram with cause-effect relationships (Fig.3). This diagram indicated several current MAS problems consisting of water pollution control, farming, management, and salination. While the FD cared much about mangrove plants, the farmers concerned about their unstably aquacultural yield. This difference is due to their demands in relations to job’s duties and livelihood, which the former is for the FD and the later is for the farmers.

(2) CATWOE analysis and Root definition

As the situation was identified, we applied CATWOE analysis to reveal the MAS problems. Study outcome indicated that while the FD is the owner of the MAS, the farmers are active players in water quality (Table 1, Actors and Owners). In other words, the farmers have no right on the land (with water above) but through their aquacultural activities (plant design and water control) can affect mangrove health. In versus, the FD is the owner of the land but has less control on water quality (belong to its land). This collaboration can give the farmers opportunities to be active to earn income through aquaculture. The other issue is that the farmers concerned to salination in water body due to climate change.

Regarding the situation in Fig.4, discussions with the stakeholders, and CATWOE, our root definition is defined “a system owned by the FD promoting the allocation to protect mangrove and enhance local farmers’ livelihood”. This root definition was used to orient possible changes and solutions.

(3) Solutions

From the systemization, this study found out water quality control, administration, system improvement and yield maintenance are major factors that should be changed to improve the current MAS (Fig.5) in which the water quality control needs the collaboration between the FD and the farmers. The task of administration is majorly for the FD while the yield maintenance and system improvement are attributed to the farmers. This diagram also shows that the farmers
need to deal with many technical issues that are out of their hand due to their constraints of budget and knowledge. For this reason, financial and technical supports should be given to them to achieve the improvement of the current MAS.

Results from our study showed the benefit of applying SSM to reveal the MAS problems. The collected data from group discussions after the systemization can provide comprehensive information for the MAS management. Our study has similar results to that previously stated by Nguyen et al.\(^4\) and in contrast provides more details of roles of two key stakeholders of the FD and the farmers. This study also confirmed the common gaps between the FD and the farmers in terms of responsibilities and benefits which was similarly mentioned previously in Ca Mau study of Ha et al.\(^2\) and Ha et al.\(^15\). Moreover, the detailed problems from this study can be combined with the common advantages of the MAS (with shrimp) such as low capital need, livelihood diversification, provision of regular income, and a chance to obtain organic farming practice previously claimed by Bosma et al.\(^16\) to provide the entire picture with pros and cons of the MAS. Besides confirming risks for the farmers as Ha et al.\(^17\) reported, we emphasize the need of the FD supports in the MAS changes. Particularly, our results agree with those of Nguyen et al.\(^4\) on the necessity of providing technical supports to the farmers for the MAS sustainability.

4. CONCLUSION

SSM performed well in this study to reveal MAS problems. This systemization process can reveal the farmers and the FD as the key stakeholders for sustainable management of the MAS. We reported that technical challenges of the farmers in the MAS as a constraint for MAS management. Further improvement of the current MAS needs provide technical trainings for this group. In addition, we noted that SSM outcomes may have uncertainties due to data, study methods, and current knowledge. For this reason, the SSM application should be pre-assessed of its applicability to study contexts.
Fig. 3 Soft System Methodology (adapted from Nguyen et al.\textsuperscript{8} and Checkland\textsuperscript{14})

Fig. 4 Current situation of the mangrove-aquaculture system
Fig. 5 Feasible solutions for improving the current mangrove-aquacultural system.

Table 1 CATWOE analysis of the mangrove-aquaculture system

| CATWOE                     | Contents                                                                 |
|---------------------------|--------------------------------------------------------------------------|
| Customers (T)             | Government: Forest protection                                             |
|                           | Farmers: Benefit from the farming for livelihood development             |
|                           | Scientist: Research interest                                             |
| Actors (A)                | Farmers: Aqua-fauna selection for aquaculture, water quality control     |
|                           | Forest Department: Rule and regulation enforcement                      |
| Transformation (T)        | More understanding of MAS to better enhance livelihood and mangrove      |
|                           | protection                                                               |
| Weltanschauung (world-views) (W) | MAS is well-managed and sustainable                                      |
| Owners (O)                | The owner is Forest Department managing forest land while farmers are    |
|                           | the short-term owners of water body.                                     |
| Environmental constraints (E) | Water pollution and saline intrusion                                     |
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