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INTEGRATING INLAND FISHERIES INTO WATERSHED MANAGEMENT: A COLLABORATIVE MONITORING APPROACH IN THE MIDDLE MAHAKAM WATERSHED, INDONESIA

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ABSTRACT

This research investigates the integration of inland fisheries into the Mahakam Bagian Tengah's (MBT) management in Central Kalimantan, Indonesia. The study aims to develop collaborative monitoring models that considers the socioecological impact of basin management and destructive fishing practices. Findings reveal that the socioecological resilience of inland fisheries are significantly influenced by basin governance and interactions among stakeholders. A lack of integration between fisheries management and basin-wide policies, coupled with limited community participation, hinders any hope of an effective response that can mitigate any negative impact. The research proposes collaborative monitoring frameworks which involve local communities and the relevant agencies. It highlights the need for improved coordination, clear operational guidelines, and equitable distribution of benefits. The findings underscore the importance of incorporating local knowledge and adaptive co-management strategies for sustainable inland fisheries management in the context of multistakeholder watershed governance.

Abbreviations

MBT	• *Mahakam Bagian Tengah (Middle Mahakam Watershed)*
DKP Kukar	• *Dinas Kelautan dan Perikanan Kukar (Kutai Kartanegara Marine and Fisheries Service)*
DKP Provinsi	• *Dinas Kelautan dan Perikanan Provinsi Kalimantan Timur (East Kalimantan Marine and Fisheries Service)*
RASI	• *Rare Aquatic Species of Indonesia*
BPSPL	• *Balai Pengelolaan Sumber Daya Perikanan dan Kelautan (Marine and Fisheries Resources Information Management Centre)*
Pokmaswas	• *Kelompok Masyarakat Pengawas (Community Monitoring Groups)*
Polairud	• *Polisi Air dan Udara (Marine and Air Police Unit)*
DPR	• *Dewan Perwakilan Rakyat (House of Representatives)*
Koramil	• *Komandan Rayon Militer (Military Rayon Commander)*
PSDKP	• *Pengawasan Sumber Daya Kelautan dan Perikanan (Surveillance for Marine and Fisheries Resources)*
PPNS	• *Penyidik Pegawai Negeri Sipil (Civil Servant Investigator)*
Satpol PP	• *Satuan Polisi Pamong Praja (Civil Service Police Unit)*

PLN	• *Perusahaan Listrik Negara (State Electricity Company)*
Poltek	• *Politeknik*
KTH	• *Kelompok Tani Hutan (Forest Farmer Groups)*
BKSDA	• *Balai Konservasi Sumber Daya Alam (Nature Conservation Agency)*
KSOP	• *Kesyahbandaran dan Otoritas Pelabuhan (Harbormaster and Port Authority)*
PTSP	• *Pelayanan Terpadu Satu Pintu (One Stop Service)*
BPDAS	• *Balai Pengelolaan Daerah Aliran Sungai (Central Management of Regional River Flow)*
BWS	• *Balai Wilayah Sungai (River Basin Management Agency)*
Bappeda	• *Badan Perencanaan Pembangunan Daerah (Regional Development Planning Agency)*
DLHK	• *Dinas Lingkungan Hidup dan Kehutanan (Department of Environment and Forestry)*
KPH	• *Kelompok Pemangku Hutan (Forest Management Unit)*
GNKPA	• *Gerakan Nasional Kemitraan Penyelamatan Air (National Water Rescue Partnership Movement)*
RKL/RPL	• *Rencana Pengelolaan Lingkungan/Rencana Pemantauan Lingkungan (Environmental Management Plan/Environmental Monitoring Plan)*

Introduction

The socioecological resilience of inland fisheries in the Mahakam Bagian Tengah (MBT) is influenced by watershed governance and interactions between watershed users. This governance affects the resource system and fisheries resource units which then affects the socioecological resilience of inland fisheries. In general, watershed governance is regulated by way of various central government policies that regulate natural resource conservation, water resource management, spatial planning, environmental protection and management, plantations, mining, forestry, and fisheries at the regional level. Policy implementation is carried out by government institutions at various levels with little participation from the community. There is hardly any interaction between the government and the community and almost no sharing of information on watershed governance, or environmental monitoring programmes in watershed areas (Ningsih *et al*., 2023).

The lack of interaction between the government and the community in watershed management and environmental monitoring is caused by: (1) The lack of integration between watershed management policies and policies for the management of fisheries, (2) the long gap in and the infrequent central government's monitoring of the impact of human activity in watershed zones, and (3) the lack of operational regulations for watershed management and monitoring on site. This has slowed efforts to respond to the harmful impact of unregulated and unhealthy competition between the fisheries sector and other sectors.

For decades, researchers have called for the integration of inland fisheries into watershed management (Rasi, 2018; Taufan & Pratomo, 2022) as a means of resolving issues plaguing inland fisheries. As the resilience and sustainability of inland general fisheries can only be achieved if fisheries are integrated with watershed management (Taufan & Pratomo, 2022; Herraro-Franco *et al*., 2021). The key to this integration lies in a partnership between industry players, the government, and the local communities (Ojeda Leal & Ladron de Guevara, 2022) in maintaining land cover in the upstream areas so that the flow of water from upstream remains stable so that rivers, lakes, and swamps can continue to function as flood exposure areas and forests can continue to support the development of non-timber forest products, including fisheries (Abbas *et al*., 2017).

In the MBT, the Fisheries and Marine Service has partnered with various stakeholders in establishing Marine Conservation Areas (Sanches *et al*., 2014), fish sanctuaries (Rasi, 2018), and opportunities abound in other areas, which include partnerships involving social forestry schemes (Abbas *et al*., 2017) and partnerships with industry players, through social and environmental responsibility.

The socioecological resilience of inland fisheries in the MBT is also influenced by watershed governance and interactions between fishermen. Interactions between fishermen in the MBT are indirectly regulated through Regional Regulation No. 13 No. 2017 which governs Fishing Management in the Kutai Kartanegara Regency which is then parcelled into Village Regulations or agreements between villages which prohibit the use of destructive fishing gear and poisons. Fisheries policy is the only policy that has been rendered down to the village level because the people most affected by these laws are small-scale fishermen who live not far from fishing sites in the MBT. The rules regarding sanctions for the use of destructive fishing gear are clearly outlined but are not adequately enforced, therefore these laws do not provide a deterrent effect. Destructive fishing remains a major issue in fisheries resource management (Ningsih *et al*., 2023).

Based on these findings, this study aims to develop a collaborative model to monitor the socioecological impact of management policies on inland fisheries in MBT and to develop collaborative monitoring of destructive fishing in MBT.

One of the co-management concepts that emphasises partnerships between the various actors managing and using natural resources is that of Community-based Natural Resource Management (CBNRM). CBNRM is defined as natural resource governance by multistakeholders where the government decentralises and shares power with communities as these communities are considered capable of managing resources efficiently and sustainably as they are on site and have specialised knowledge of local

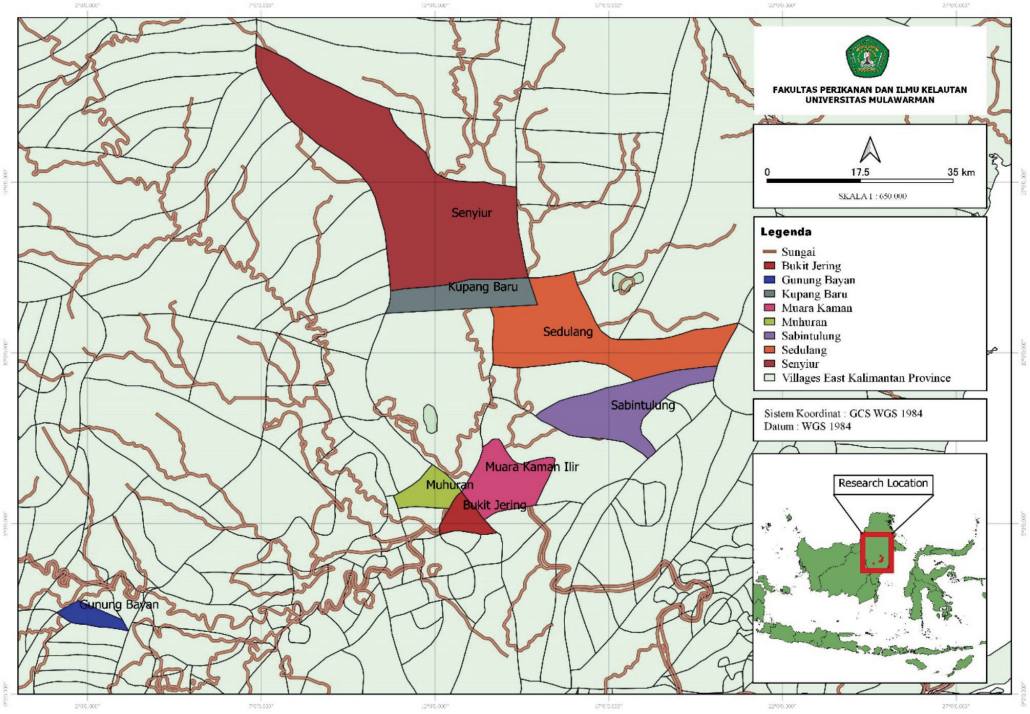

Figure 1: Study location in Middle Mahakam area, East Kalimantan, Indonesia

conditions on the ground. Through the sharing of power, CBNRM is expected to empower marginalised communities, encourage economic development, and ensure the sustainable use of natural resources.

The three main components of CBNRM are local institutions, customary laws or practices, and knowledge systems (Lance *et al*., 2021). CBNRM is primarily concerned with natural resource management, community, and joint management (van Workom, 2015). Institutions built with this concept are generally always built from the bottom-up specifically for joint resource management (Richardson, 2022).

The benefits of CBNRM are that the community has full authority in the decision-making process which is carried out in a participatory manner. The local community also has the authority to determine institutions. In practice, the use of CBNRM for the management of watershed zones faces many threats both internally and externally. External challenges include those from marginalisation, government regulations, as well as global political and economic pressures, while internal challenges include a reduction in social cohesion, an increase in conflicts and reduction in trust (Lance *et al*., 2021; Benyei Petra *et al*., 2022). The main challenge associated with the implementation of a holistic framework integrating inland fisheries and watersheds lies in the lack of knowledge regarding the complexity of human and natural systems in inland fisheries and uncertainty that stems from the natural character of watersheds that does not recognise administrative boundaries. Administrative policies that are based on geographic boundaries can create gaps or result in an overlap between regulations (Taufan & Pratomo, 2022), as well as a lack of synchronisation between regulations and their derivatives (Lestari & Dharmawan, 2011).

The right strategy is to carry out a systematic process in improving management policies and practices continuously, by analysing social-ecological system (SES) (Manuel *et al*., 2013; Sanchez *et al*., 2014; Kura *et al*., 2023), designing management strategies, and integrating local knowledge into policies in a co-management model (Taufan & Pratomo, 2022).

The concept of co-management was introduced and has been widely adopted and adapted over the last few decades, as a result in practice, there are many forms of co-management, which includes the CBNRM model (Berkes, 2009; Sok & Yu, 2021). Co-management practises that have been adapted to socioecological systems and collective learning experiences is known as adaptive co-management (ACM) (Sok & Yu, 2021; Kura *et al*., 2023), while collaborative monitoring (CM) is defined as a process involving resource managers and resource users collaboratively and periodically recording and tracking ecological footprints and human conditions (Mutikumuru *et al*., 2006).

Co-management, ACM and CM at inland capture fisheries management have been associated with positive outcomes, especially with regards to conservation, ecology, and community livelihoods (Manuel *et al*., 2013; Islam *et al*., 2020; Sok & Yu, 2021; Haque *et al*., 2022; Kura *et al*., 2023). However, research on collaborative monitoring of the socioecological impacts of watershed management on inland fisheries and collaborative monitoring of destructive fishing practises that is able to accommodate differences in interests and formulate a legally binding consensus is scarce (Mutikumuru *et al*., 2006; Jhonson *et al*., 2015; Ningsih *et al*., 2023).

Materials and Methods

The development of an institutional model for collaborative monitoring of the socioecological impact of watershed management on inland fisheries and for the collaborative monitoring of destructive fishing is part of a study on the integration of inland fisheries into watershed management that has been carried out for the first time this year.

Since collaborative institutions usually involve many stakeholders with different goals and interests, this study will use stakeholder

analysis (AS) as a means to identify key actors, specific characteristics and interests, in order to involve them in the participatory process. The AS was carried out in three stages, namely stakeholder identification, individual prioritisation, and stakeholder involvement in decision making. The AS was carried out via surveys and face-to-face interviews (Haji *et al*., 2023). Meanwhile, model development was conducted by identifying the impact of watershed management on fisheries socioecology, conducting stakeholder analysis of monitoring the impact of watershed management on fisheries socioecology and monitoring destructive fishing, and developing an institutional model for supervision.

Identifying the Impact of Watershed Management on Fisheries Socioecology

An identification of the socioecological impact of watershed management policies on inland fisheries was conducted via focus group discussions (FGDs) and in-depth interviews. FGDs were conducted at the research locations in Sabintulung, Gunung Bayan, Kupang Baru, Senyiur, Muara Kaman Ilir, Bukit Jering, Muhuran, and Sedulang. The average number of participants in each group at each village was 20 people representing fishermen [fishermen's groups, Pokmaswas, village heads, Badan Permusyawaratan Desa (BPD), Dinas Kelautan dan Perikanan (DKP) Kukar, DKP Kutim, DKP Kubar, and Balai Pengeloaan Sumber Daya Perairan dan Kelautan (BPSPL)]. The total number of FGD participants was 164 people. Following the FGDs, impact identification was carried out via in-depth interviews with the stakeholders involved in the management of the MBT, namely the Fisheries Service, Dinas Lingkungan Hidup (DLH), Balai Wilayah Sungai (BWS), BPSPL, Balai Konservasi Sumber Daya Alam (BKSDA), Balai Pengelolaan Daerah Aliran Sungai (BPDAS), Rare Aquatic Species of Indonesia (RASI), Biosfer Manusia (Bioma), coal companies, and palm oil companies.

Purposive sampling was employed to select institutions based on their known influence and direct involvement in MBT management and inland fisheries and then the leaders of the institutions delegated their representatives to become informants in FGDs and in-depth interviews. However, each informant was asked to read the informed consent before the FGDs and in-depth interviews began. A total of 13 respondents were involved in the in-depth interviews. In the meantime, the FGDs involved the use of a series of participatory hearing processes so that the relevant stakeholders could contribute towards the design of the joint institutions and come to a consensus on legal institutions and prepare operational procedures for co-management that are test-ready. A rhematic analysis was conducted using a manual open coding approach. Codes were generated inductively from the data, with initial codes refined and grouped into overarching themes through iterative review of the transcript.

Conduct Stakeholder Analysis of Monitoring the Impact of Watershed Management on Fisheries Socioecology and Monitoring Destructive Fishing

An AS was conducted through surveys and face-to-face interviews. The survey was conducted using a questionnaire to measure the level of power, interests, satisfaction, knowledge, and information sharing (Haji *et al*., 2023). The survey was conducted with participants representing fishermen's groups, Pokmaswas, village heads, and BPD from eight villages and stakeholders involved in the management of the MBT, namely the fisheries service, forestry service, DLH, BWS, BPDAS, BPSPL, RASI, Bioma, coal companies, palm oil companies, and industrial forestry [Hutan Tanaman Industri (HTI)]. A total of 43 people participated in the survey. The questionnaire was compiled using a Likert scale with five answer choices, (very low to very high) for each question regarding power, etc., an example of the questions includes, what were the interests of the following stakeholders in monitoring the impact of MBT management on society and the environment? A simple ranking was used, assigning a rank of between

1 and 5 based on the mean Likert scale score. In the case of a tie, an average rank was assigned.

Developing an Institutional Model for Supervision

The institutional model was developed based on the existing conditions of current supervision institutions and based on the results of stakeholder analysis. There are two institutional models developed, namely institutional collaborative monitoring of the socioecological impact of watershed management on inland fisheries and collaborative monitoring of destructive fishing. Institutional collaborative monitoring of the socioecological impacts of watershed management on inland fisheries includes the following elements: (1) Identification and determination of fisheries management working groups in the watershed, (2) determination of impact monitoring plans, (3) determination of supervisors and supervision systems, including rules of thumb for enforcing regulations that have been set at the community level.

A limitation of this study was the potential for bias due to the incomplete participation of all purposively selected institutions. Further research employing a more representative sampling strategy was needed to validate and broaden the applicability of the developed models.

Results

Identification of the Impact of Watershed Management on Fisheries

The key socioecological impacts of watershed management on inland fisheries in the MBT.

Barge Traffic

The operation of large coal barges on the Kedang Kepala River since 2014 has severely disrupted fishing activities and devastated the livelihoods of local fishermen. The 24 hours a day, 7 days a week (24/7) operation of these barges has directly resulted in numerous negative consequences. First, frequent collisions between barges and fishing grounds have severely reduced fish catches. Before barge operations severely disrupted fishing activities, local fishermen were able to net an average of between 43 and 56 kg of fish daily; however, following the start of barge operations the average has plummeted to near zero.

Secondly, significant riverbank erosion caused by barge traffic has made it increasingly difficult to use traditional fishing gear such as gillnets. Thirdly, pontoons operating in conjunction with the barges often collide with fishing gear, damaging the equipment and further reducing the catch of the day. Research by Ningsih (2021) in villages directly impacted by barge traffic reveals a dramatic decrease in the average daily catch during the rainy season, falling from between 60 and 70 kg before barge operations to just 20 kg afterward. The inadequate compensation for damaged gear compounds the economic hardships. In Muara Kaman Ulu, the risk of collisions and potential accusations of entrapment have prevented fishermen from using *rawai* fishing gear, which further limited fishing opportunities.

Decrease in Water Level or Sedimentation

The expansion of palm oil plantations has profoundly altered the hydrology and ecology of the Kupang Baru and Muara Kaman regions, leading to a significant decline in previously frequent flooding events. This change, coupled with an increase in sedimentation, has had severe consequences for farmers and fishermen. In Muhuran, farmers have experienced significant crop failures due to severe drought conditions. This agricultural impact is not simply due to a reduction in the water level but also to an increase in river sedimentation, as a result of intensified erosion upstream. This erosion is exacerbated by deforestation and mining activities, expanding the areas of critical land and degrading the overall environmental condition.

The widespread conversion of wetlands to palm oil plantations has drastically reduced the traditional fishing grounds utilised by fishermen in Muara Kaman Ulu, impacting their ability to

harvest species such as *betok*, *biawan*, *kerapu*, and *toman*. Ningsih (2021) reported a staggering 19,513.34 ha loss of water bodies and traditional fishing grounds in the Muara Kaman subdistrict by 2015, that is directly attributable to the expansion of mining and plantation activities. This loss of habitat has severely diminished the resource base for the fishing community, contributing to increase unemployment particularly during the dry season.

Abrasion

Riverbank erosion, driven by both natural processes and unsustainable water transport practices, has significantly degraded fish habitats and negatively impacted the livelihoods of many fishermen in the MBT. The resulting loss of soil has led to faster currents and unsuitable conditions for fish microhabitats, particularly those crucial for spawning and juvenile fish development. This habitat degradation has directly caused a loss of fishing grounds for those relying on riverbank areas, particularly fishermen who live far from lakes and reservoirs which serve as alternate fishing grounds.

This problem is exacerbated by water transport vessels that exceed permitted capacities, sizes, depths, and widths. During floods and high tides, these vessels often collide with riverbank trees, causing further erosion and contributing to landslides. These issues highlight a failure in the enforcement of river navigation regulations, as the current regulations are too broad and lack specific guidelines for permitted routes. The loss of these important fishing grounds has resulted in a loss of income for fishermen in the area.

Pollution and Mass Fish Deaths

Pollution from coal and palm oil operations has resulted in widespread mass fish kills and significant challenges for fish farmers in the MBT. In Kedang Kepala Village, mass mortality events have affected farmed *baung* and *patin*, strongly indicating pollution from coal and palm oil operations as the cause. Similar issues have plagued fish farming operations in Muara Kaman Ulu, likely due to pollution from upstream sources in the Kedang Rantau and MBT. Furthermore, altered water quality appears to be stunting the growth of *sepat* fish. These pollution-related fish kills tend to occur during the rainy season, affecting large swathes of the river system. Ningsih (2021) detailed the pattern of fish mortality during such events: Caged fish—*baung* (*Hemibagrus*), lele sangkuriang (*Clarias gariepinus*), striped snakehead (haruan), marble goby (betutu), and shellfish—are the first to perish, followed by smaller wild *Hemibagrus*, while fish with labyrinth organs—climbing perch, kissing gourami (biawan), *kerapu* (*Epinephelus lanceolatus*), and giant snakehead (toman)—show greater resilience.

The impact extend beyond areas immediately near the polluting industries, affecting communities in more distant villages. This contrasts sharply with fish kills caused by illegal fishing, which typically occurs in smaller streams during the dry season and have more limited impact. While companies adhere to minimum water quality standards, mass fish kills are likely caused by the combined effects of industrial pollution, illegal fishing practices (using poison), and other factors such as mining activities, fertilizer runoff, and high sedimentation levels.

Pollution and Water Hyacinth

The uncontrolled proliferation of water hyacinth poses a serious threat to the MBT's ecosystem and significantly impacts fishing activities. The dense mats of water hyacinth obstruct river channels and fishing grounds, rendering them unusable. This has forced villages to expend considerable funds on water hyacinth removal efforts. The excessive growth of water hyacinth is exacerbated by the easy flow of nutrient-rich runoff from surrounding plantations into adjacent wetlands, which are themselves important fishing areas. This runoff accelerates the growth of water hyacinth and further degrades water quality.

Fishermen in villages along the Kedang Rantau River, including Sabintulung, Sedulang, and Liang Buaya, have been directly affected

by the reduced accessibility of fishing grounds. During eutrophication events caused by the uncontrolled growth of water hyacinth, the income of fish folk decreases by more than two-thirds (Zuliarsih, 1996).

Overview of Destructive Fishing in the MBT

The problems faced by fishermen and the fisheries sector are caused by the trend of the palm oil economy and the existence of large-scale palm oil plantations, which trigger the conversion of swamps into palm oil plantations. This narrows the space for fishermen to fish, which in turn can spur destructive fishing practices.

Illegal fishing in the MBT area is often associated with fishermen from other villages who use more dangerous equipment than those used by local villagers. Illegal fishing perpetrators also operate across districts and even provinces, where perpetrators from outside the region often act recklessly and dispute with local communities. Electrofishing has become a source of jealousy among fishermen, with divisions between traditional fishermen who obey the prohibition on electrofishing and those who violate it, including tensions between fishermen from villages that do not prohibit electrofishing. The non-applicability of village regulations to residents of other villages allows fishermen to carry out illegal fishing in neighbouring villages, even though they would not resort to such fishing practises in their own villages.

The impact of these activities is significant; local fish populations are not only reduced, but in many cases, can disappear completely. Fishermen who fish across villages are also aware that the decline in fish numbers is not only occurring in their village but is also felt by neighbouring villages. Only a few villages such as Muara Siran, Pela, and Muara Kaman Ilir, have community monitoring groups (Pokmaswas) to monitor illegal fishing practices. However, these groups do not yet have clear operational costs and incentives, which can reduce the effectiveness of their duties. In addition, illegal fishing patrols carried out by PSDKP and DKP Kukar are rarely carried out and are limited to the MBT, which leaves other rivers such as the Belayan River and its tributaries unmonitored, even though the community considers these patrols to be very effective.

Electrofishing activities are carried out in two locations, namely swamps and rivers, with electrocution in swamps not being strictly prohibited. Supervision by Pokmaswas has proven to be ineffective, and may even be prejudicial and cause conflicts between local residents. Common forms of illegal fishing include electrocution, poisoning, and the use of destructive fishing gear such as a *sawaran*. Several villages are only able to provide warnings because they do not yet have village regulations [Peraturan Desa (Perdes)] that support the prohibition of illegal fishing. Communication at the subdistrict level is also not effective, which has allowed this problem to continue without a concrete solution.

Stakeholder Analysis of the Impact of MBT Management on Fisheries

This study employs a mixed-methods approach to analyse stakeholder influence on the management of the MBT and its impact on inland fisheries. We first assessed stakeholder power and influence using a quantitative matrix (Table 1), which considered six key dimensions: Power, interest, knowledge, participation, information-sharing ability, and monitoring performance satisfaction. RASI and DKP Kukar consistently scored highest across all dimensions, reflecting their significant influence on decision-making in watershed management and fisheries monitoring.

The high scores for RASI and DKP Kukar are not surprising, given their respective mandates and resources. DKP Kukar, as the formal authority for fisheries management in Kutai Kartanegara, possesses significant legitimacy, substantial human and financial resources, effective communication channels, and a demonstrated capacity for conflict

resolution. RASI, an NGO with a long history of Mahakam Dolphins conservation, has built strong community trust and possesses considerable knowledge on Mahakam Dolphins and their habitats.

In contrast, BPDAS and BWS received the lowest scores, indicating a more limited capacity to influence decision-making. BPDAS's focus on consultative services related to forest rehabilitation, with limited direct involvement in fisheries monitoring, accounts for its lower score. Similarly, BWS, concentrating its efforts on the lower MBT, has less direct involvement in the MBT's upper reaches where many of the negative impacts studied originate. This does not, however, suggest a power imbalance that is indicative of a conflict in decision-making with regards to the impact of watershed management on fisheries. The final decisions are made by Penyidik Pegawai Negeri Sipil (PPNS) [according to Rencana Pengelolaan/Rencana Pemantauan (RKL/RPL)], based on evidence and not just stakeholder pressure.

To further illuminate stakeholder interrelationships, a Social Network Analysis (SNA) was conducted (Table 2). This analysis reveals the high centrality of DKP Kukar within the network, implying a significant role in coordinating interactions and information flow among various stakeholders. While DKP Kukar is most central, the network demonstrates a relatively high level of connectivity, signifying substantial collaboration and information sharing. The high density of connections suggests that communications and collaborations are relatively well-established amongst this group of stakeholders.

However, the SNA analysis also suggests potential conflict points. The network reveals a distinct division between conservationist stakeholders (RASI, BPSPL, and Bioma) and more pragmatically oriented stakeholders (palm oil and coal companies). This difference in values and priorities creates the potential for conflict, particularly regarding resource allocation and environmental protection measures. Specifically, conflicts involving the use and operation of coal barges. While the government plays a mediating role, the higher resource capacity of the pragmatist stakeholders increases the likelihood that their interests may hold more sway over decision-making processes. This highlights the need for improved mechanisms to ensure equitable representation and facilitate consensus-building amongst these groups.

The integrated stakeholder analysis revealed a complex interplay of power dynamics, collaborations, and conflicts shaping decision-making in the MBT. While the formal authority structures and resources empower some stakeholders, fostering collaboration between diverse groups is crucial for effective and equitable watershed management and sustainable inland fisheries practices.

Stakeholder Analysis of Destructive Fishing Surveillance

Based on stakeholder analysis (Table 3), the DKP Provinsi and DKP Kukar have the highest scores in terms of power, interest, knowledge, participation, information sharing ability, and supervision. This shows that the DKP Provinsi and DKP Kukar have significant influence in decision-making with regards to the monitoring and control on destructive fishing practises. In contrast, BPDAS and BWS recorded the lowest scores, indicating their lack of influence or power with regards to this issue. Meanwhile, RASI (3.10) and Pokmaswas (2.91) maintained relatively high-power levels. RASI and Pokmaswas also showed relatively high interest levels in efforts to supervise dangerous fishing practices.

The role of the DKP Provinsi is crucial because the role of enforcement can only be carried out by seven PPNS based at the DKP Provinsi and serve not only East Kalimantan but North Kalimantan and South Kalimantan. Incidental supervision carried out by the DKP Provinsi is considered effective because there is action, the suspect is arrested and processed legally which has a deterrent effect on other fishermen who are or plan to use destructive or

Table 1: Stakeholder analysis of watershed management impact monitoring

No.	Stakeholder Analysis	RASI	DKP Kukar	DKP Provinsi	BP SPL	BLH Kukar	BIO MA	Palm Oil Company	Coal Company	BWS	BP DAS
1	Power	3.46	3.50	3.33	3.06	2.88	2.81	2.94	3.06	2.53	2.63
2	Interest	3.44	3.44	3.17	3.07	2.94	2.81	2.76	2.76	2.47	2.60
3	Knowledge	3.38	3.50	3.05	3.13	2.94	3.00	2.89	2.82	2.80	2.63
4	Participation	3.31	3.44	2.94	2.57	2.78	2.47	2.41	2.31	2.31	2.27
5	Ability to share information	3.38	3.14	2.87	2.93	2.73	2.69	2.53	2.50	2.54	2.46
6	Supervisory performance satisfaction	3.38	3.20	2.87	2.92	2.64	2.54	2.53	2.50	2.46	2.46
Total		**20.3**	**20.2**	**18.2**	**17.7**	**16.9**	**16.3**	**16.1**	**15.9**	**15.1**	**15.0**
Ranking		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

Table 2: Social network analysis of monitoring the impact of watershed management

	DKP Provinsi	DKP Kukar	BPSPL	BLH Kukar	BWS	BPDAS	RASI	BIOMA	Palm Oil Company	Coal Company
DKP Provinsi		11	6	4	2	3	5	3	3	3
DKP Kukar	11		7	4	2	3	5	3	4	4
BPSPL	6	7		4	4	4	3	5	3	4
BLH Kukar	4	4	4		3	2	3	3	3	5
BWS	2	2	4	3		5	5	3	3	2
BPDAS	3	3	4	2	5		4	3	3	3
RASI	5	5	3	3	5	4		4	3	3
BIOMA	3	3	5	3	3	3	4		3	4
Palm oil company	3	4	3	3	3	3	3	3		4
Coal company	3	4	4	5	2	3	3	4	4	
Total	**40**	**43**	**40**	**31**	**29**	**30**	**35**	**31**	**29**	**32**

Table 3: Stakeholder analysis of destructive fishing supervision

Stakeholder Analysis	DKP Kukar	DKP Provinsi	RASI	Pokmaswas	BPSPL	Fishers Group	Polairud	BIOMA	BPDAS	BWS
Power	3.82	3.91	3.10	2.91	2.82	2.82	2.90	1.91	2.10	2.10
Interest	3.73	3.64	3.30	3.18	3.33	3.18	3.18	2.50	2.40	2.40
Knowledge	3.83	3.67	3.33	3.25	3.00	3.25	3.08	2.73	2.40	2.27
Participation	3.58	3.42	3.18	3.25	3.10	3.25	2.92	2.17	2.10	2.10
Ability to share information	3.83	3.58	3.55	3.25	3.10	3.00	3.18	2.36	2.20	2.20
Supervisory performance satisfaction	3.64	3.55	3.30	3.09	3.10	2.82	2.82	2.18	2.00	2.00
Total	**22.43**	**21.76**	**19.76**	**18.93**	**18.45**	**18.32**	**18.08**	**13.85**	**13.20**	**13.07**
Ranking	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

poisonous fishing gear. Meanwhile, in routine supervision where the DKP Provinsi is not involved, the police only provide a warning which does not have a deterrent effect. The role of DKP Kukar is very crucial in coordinating other stakeholders both in incidental supervision and routine supervision. At every stage of supervision, DKP Kukar is always involved. In terms of independent supervision carried out by RASI, BPSPL, Polairud, and Pokmaswas, they continue to coordinate with DKP Kukar.

The crucial role of the DKP Provinsi and DKP Kukar in eradicating destructive fishing is evident in the interactions and interdependence between the two institutions. The supervisory authority lies with the DKP Provinsi, but DKP Kukar has the authority to coordinate with related parties which means that the DKP Provinsi must always coordinate with DKP Kukar.

RASI, BPSPL, and Pokmaswas has an important role in routine supervision in the Marine Conservation Area. In carrying out routine supervision, RASI, BPSPL and Pokmaswas always coordinate with DKP Kukar. Therefore, the level of interaction and information sharing between them is also quite high. The lower interaction levels between several stakeholders such as Polairud and Pokmaswas shows that coordination between these agencies for the supervision of destructive fishing practises needs to be improved as both of these agencies are key stakeholders.

Based on the network analysis table above, the DKP Kukar interacts the most with other stakeholders followed by the DKP Provinsi and Pokmaswas and fishermen groups. The high levels of interaction with the DKP Kukar for the supervision of destructive fishing practices is because the DKP Kukar acts as a node for the coordination of supervisory efforts, from the top-down by the DKP Provinsi through incidental supervision and from the bottom-up by the Pokmaswas.

Table 4: Social network analysis of destructive fishing

	DKP Provinsi	DKP Kukar	BPSPL	BWS	BP DAS	RASI	BIOMA	Polairud	Pokmaswas	Fisher Group
DKP Provinsi		9	5	0	3	5	1	4	7	7
DKP Kukar	9		7	1	2	6	3	5	7	7
BPSPL	5	7		1	1	4	2	1	4	4
BWS	0	1	1		2	1	2	1	0	1
BPDAS	3	2	1	2		1	2	1	1	0
RASI	5	6	4	1	1		3	2	3	3
BIOMA	1	3	2	2	2	3		2	3	3
Polairut	4	5	1	1	1	2	2		2	2
Pokmaswas	7	7	4	0	1	3	3	2		4
Fisher group	7	7	4	1	0	3	3	2	4	1
Total	**41**	**47**	**29**	**9**	**13**	**28**	**21**	**20**	**31**	**31**

Collaborative Monitoring Model for Monitoring the Impact of Watershed Management on Fisheries

Development activities carried out by the government, private sector, and communities in the watershed will certainly have negative and positive impact. Some of these impacts have been predicted and some have not been in the RKL/RPL Amdal or Renstra of government institutions. Any negative impact that has not been predicted has the opportunity to be submitted via Environmental Impact Assessments (EIA) updates or Strategic Planning (Renstra) updates. In order for the impacts that has not been predicted to be submitted to the EIA or Renstra, the general watershed management impact monitoring model is made to resemble the environmental impact management and monitoring pattern consisting of five elements, namely RKL/RPL, monitoring, reporting, action or resolution, then updating the RKL/RPL or Renstra.

RKL/RPL is an environmental management and monitoring plan in the watershed which is prepared based on an environmental impact analysis by watershed users, both by the community, companies, government, and NGOs. Monitoring is an activity to examine the impact of environmental management in the watershed carried out by watershed users and observers. Reporting is a mechanism for detailing the results of monitoring to the authorities. Action is the steps of process taken to resolve serious environmental problems through mediation, punishment, and sanctions. Resolution is an effort to find an effective solution for mild environmental problems for the community.

The crucial thing in this model lies in the monitoring stage to resolution because if the regulation monitoring is carried out by the governor or regent without any obligation to involve the community. This is different from the RKL/RPL preparation stage where the community must be involved. Although in reality the community is involved in monitoring, the absence of an obligation to involve the community in the monitoring process causes

unrest, while on an institutional level, it is often cause for miscommunication and poor coordination. The process that involves resource managers and users collaboratively and periodically recording and monitoring ecological conditions and human welfare is known as collaborative monitoring. Collaborative monitoring (CM) helps to maintain a sense of justice and environmental sustainability. In the CM system, a platform for sharing via feedback meetings, general community meetings and workshops, which allows decision makers to reflect and learn from the results of monitoring sessions is a control panel that helps to inform the decision-making process (Mutikumuru, 2006).

In general, the collaborative supervision model consists of the object of supervision, the supervision process, the coordinator of supervisors, the partner supervisor, the coordination line of the coordinator supervisor and the partner supervisor, and the supervision strategy. The object being supervised is the fishery resources that are negatively impacted by non-fishery activities in the MBT consisting of fishing equipment hit by barges, mass fish deaths, water hyacinth outbreaks, decreasing water levels, and riverbank abrasion.

The supervision process begins with identification of the company's RKL/RPL or the Institution's Renstra, supervision, reporting, reporting follow-up, action, and resolution. Based on Law No. 32 of 2009, reporting follow-up refers to a series of steps taken by the authorised agency after receiving reports of environmental violations from the community or other sources. Reporting follow-up focuses on investigation and information gathering to determine whether violations have occurred and who the perpetrators are. This stage does not necessarily lead directly to punishment or sanctions.

The supervisory coordinator is a stakeholder who plays a role in coordinating the supervision obtained based on stakeholder analysis, namely the DKP Kukar, RASI together with supervisory groups at the village level, namely Pokmaswas, Pokdarwis (Tourism Awareness Group), Pokdakan (Fish Farmer Group), KUBE (Joint Business Group), KTNA (Kelompok Tani Nelayan Andalan), KTH (Forest Farmer Group), and KUPS (Social Forestry Business Group). In carrying out supervision, the main supervisor coordinates with partner supervisors consisting of the government, companies, and NGOs.

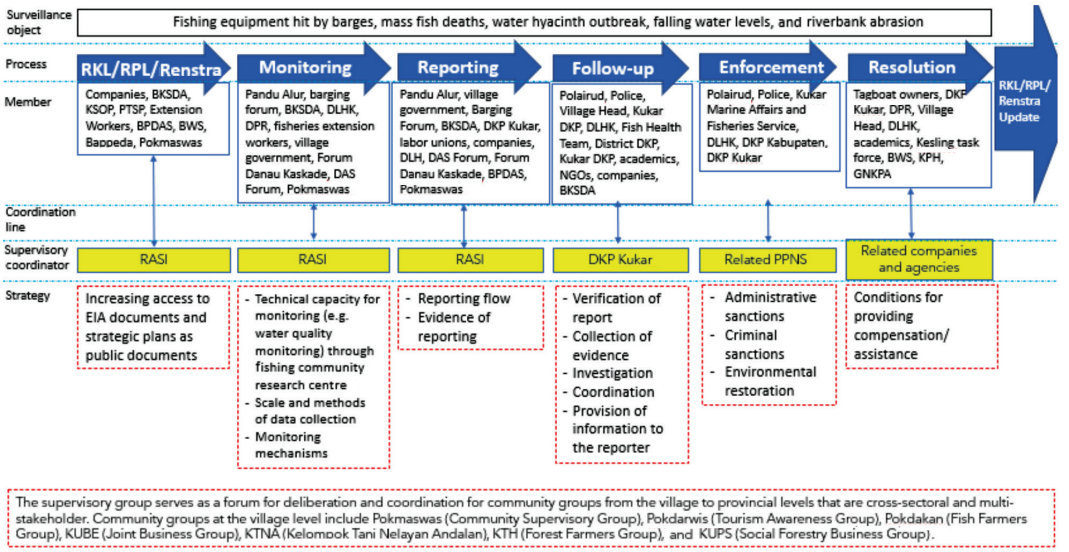

Figure 2: Collaborative model for monitoring the impact of watershed management on fisheries

The supervision strategy is in the form of increasing community participation in each supervision process, revitalising related institutions at various levels, increasing the role of key stakeholders, clarifying the coordination flow in each process and between processes, the scale and method of data collection, the function of supervision and legal action is clear, evidence, supervision mechanisms and reporting flows are clear, legal protection for supervisors, involvement of village heads in supervision and dispute resolution, and reports and evidence must be appropriate because reports without evidence can be slander for the company. The involvement of village heads in supervision and dispute resolution is the easiest way because the company does not have to gather the community. This assumption was made because the village head is responsible to his community.

Collaborative Monitoring Model of Destructive Fishing Monitoring

The monitoring of destructive fishing practises is an effort to supervise and enforce the law against the use of such fishing activities. Supervision includes monitoring and identification, law enforcement and coordination between institutions. The key to effective supervision is comprehensive regulation and coordination between institutions and Pokmaswas (Nasution, 2024). Monitoring is an activity aimed at identifying detecting and tracking destructive fishing activities, including perpetrators, types of equipment, and methods used as well as the time and place. In accordance with law No. 31 of 2004, monitoring is carried out to ensure compliance with fisheries regulations which include supervision of fishing gear, fishing activities, and protection of protected areas by focusing on efforts to prevent violations through regular monitoring. Meanwhile, based on law No. 45 of 2009, monitoring uses an ecosystem approach that includes ecological and socioeconomic aspects. Law No. 45 of 2009 requires the relevant institutions to carry out systematic and sustainable monitoring, including using technology and fisheries statistical data by emphasising the preparation of plans that include monitoring and evaluation activities to ensure the sustainability of fishery resources.

Enforcement or law enforcement is the application of administrative and/or criminal sanctions to perpetrators of destructive fishing. Based on law No. 31 of 2004, enforcement is carried out against violations that have been identified with administrative and criminal sanctions. Enforcement is reactive, based on the monitoring carried out. In law No. 45 of 2009, enforcement is not only reactive but includes preventive measures to stop violations from occurring again in the future. The monitoring of destructive fishing practises is a collaborative effort involving various parties. Collaborative supervision is also known as joint supervision, in the context of fisheries management, it is a strategy in which responsibility is shared equally between local fishermen and the government.

Collaboration between the government and the community in fisheries monitoring is regulated through the Decree of the Minister of Marine Affairs and Fisheries No. 58 of 2001 concerning Procedures for Implementing the Community Monitoring System in the Management and Utilisation of Marine and Fisheries Resources (SISMASWAS). This system emphasises community participation, with local fishermen at the core of the Pokmaswas. The main role of Pokmaswas is to report any violations of fisheries and coastal resource regulations. This includes illegal fishing activities, environmental damage, and pollution. However, they are not authorised to enforce the regulations themselves; their role is only to report violations to the appropriate authorities. The role of the government is primarily to provide support, training, and equipment, not to conduct direct supervision. Pokmaswas can report illegal fishing to several authorised agencies, depending on the situation and jurisdiction of the receiving officer.

The things to take note of when monitoring destructive fishing practises include the use of fishing gear that is not environmentally friendly, bombs, electric shocks, poisons, and *sawaran*.

From a management perspective, the supervision process begins by studying the supervisory strategic plan followed by close monitoring, reporting, patrols, action, and resolution. The term "action" refers to the application of legal sanctions as a consequence of violations. "Follow-up reporting" is more specific and refers to the process that occurs after the reporting of alleged violations. The supervisory coordinator is a stakeholder who has an important role in supervision which is determined by the results of the stakeholder analysis. The coordinator is the DKP Kukar, the DKP Provinsi together with Pokmaswas. The supervisory coordinator plays a role in coordinating other stakeholders.

The strategy for monitoring destructive fishing includes strategies to increase access to monitoring strategic plan documents, monitoring between villages, strategies to obtain funds and budgets at each monitoring stage, integration of monitoring operational budgets into village budgets, socialisation regarding the requirements and mechanisms for forming monitoring groups, reporting flow, evidence of destructive fishing, sharing information on monitoring results, patrol mechanisms, empowerment of fishermen, and legal and customary law-based enforcement mechanisms.

Discussions

In the institutional strategic plan and RKL/RPL documents, fisheries are indirectly recognised as a sector affected by development activities in the watershed, both those carried out by the government and the private sector. As a party that is indirectly impacted, fisheries do not receive direct attention from development stakeholders. Conversely, if this perspective is reversed, namely if the impact analysis is viewed from the perspective of fisheries, then fisheries would be seen as the group most inversely affected by development activities in the watershed area. This study is focused on the perspective of fisheries as the most adversely affected party. As the group most negatively affected, fisheries are the main actors for the supervision and accumulation of data on the impact of infections originating from other sectors, both those that have been predicted in the EIA or strategic plan and impacts that have not been predicted.

Likewise, with Pokmaswas as mandated by the Sismaswas Law, Pokmaswas is also tasked with supervising environmental damage and pollution at the village level. So, there is no need to form a new supervisory group. Pokmaswas also plays a role in supervising cross-border pollution and evaluating environmental

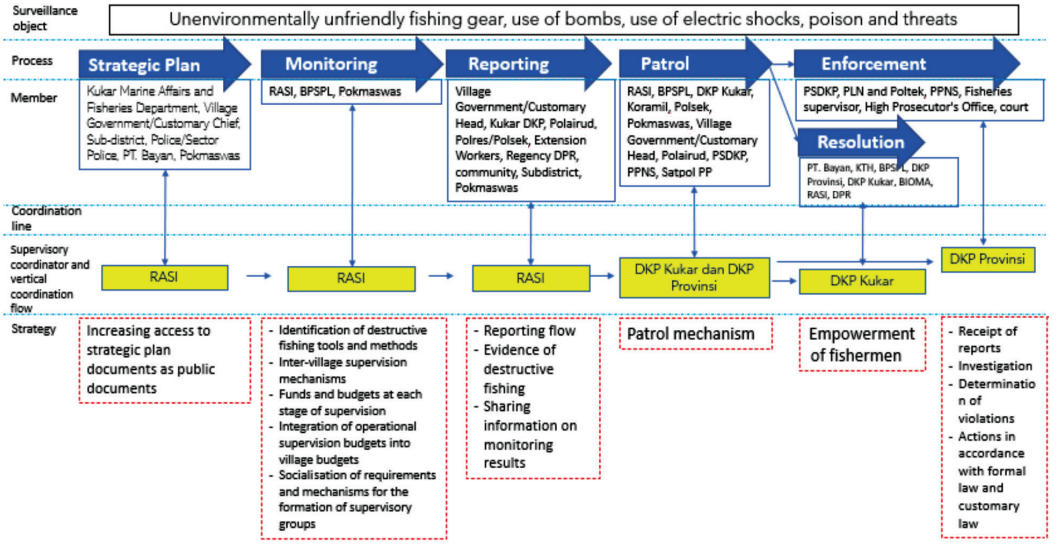

Figure 3: Destructive fishing monitoring model

conditions independently. Members of the monitoring group can consist of key actors and fisheries business actors, communities, and other groups at the village level so that Pokmaswas is a collaborative group between the DKP, DLHK, etc.

The trained monitoring group needs to draw up a cooperation agreement with the facilitator and funder for water quality testing, and to conduct pollution monitoring based on established procedures. Pollution problem solving must be done collaboratively between the company and the community, with facilitation by the Regional Government, considering the many sources of pollution and transboundary impact. Monitoring tasks include observing, recording, and reporting.

To improve the effectiveness of supervision, research needs to be carried out by the monitoring community continuously every year so that series data are available that can be used as a comparison to the data provided by the company. In addition, it is important to form a monitoring institution whose funding is supported by the company, while avoiding the formation of new groups that can lead to overlapping interests at the site level. Therefore, the existing groups should be re-coordinated to map out the responsibilities of each group.

The main problem with collaborative monitoring is the attitudes of the stakeholders who routinely underestimate the knowledge of lay people. The solution to this problem is to improve the scientific capacity of the community or increase the recognition of local knowledge. Improving the scientific capacity of the community can be done by establishing a Fishing Community Research Center (FCRC). FCRC is important for long-term monitoring of cumulative impacts, originating from many sources of pollution and impacts that cross administrative boundaries. FCRC activities include:

(1) Capacitation of local researchers (fishermen) in:
    - Examining evidence of the effects of overfishing and or overharvesting, the impact of climate change and changes in land use to change pragmatic behaviour.
    - Examining procedures for community involvement in watershed management to improve participatory decision-making and knowledge co-production.
    - Examining evidence of the impact of palm oil and coal on fisheries to obtain fair compensation for fishermen.
    - Planning fisheries development programs at the village and watershed levels.
(2) Finding and developing the capacity of local leaders to lead fishermen's organisations.
(3) Strengthening community capacity in citizen journalism.

Additionally, it is necessary to think about funding and the budget at each step, it is necessary to socialise the requirements and mechanisms for forming a monitoring group, because the monitoring group is formed by the village, so the Pokmaswas operational program and budget must be integrated with the village budget. Therefore, technical instructions for the Pokmaswas operational budget at the village level are needed. Monitoring groups can also be created outside the village to independently supervise fisheries so that village heads and companies are not easily or wrongfully accused of mismanagement or malpractice.

Conclusions

This study's integrated stakeholder analysis reveals a complex interplay of power dynamics, collaborations, and conflicts significantly influencing the management of the MBT and its impact on inland fisheries. The findings highlight the disproportionate influence of DKP Kukar and RASI, stemming from their strong legitimacy, substantial resources, and established communication networks. While this high centrality fosters coordination and information sharing, it also underscores the potential for marginalisation of less powerful

stakeholders like BPDAS and BWS, whose limited influence reflects their narrower mandates and resource constraints. The SNA analysis further reveals a potential for conflict between conservation-focused and pragmatically-oriented stakeholders, stemming from differing values and priorities. This conflict is most apparent in the management of barge traffic and pollution control.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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