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Unveiling the Secrets of South Kalimantan's Rivers: Biodiversity, Ethnobiology, and Water Quality

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Keywords
Biodiversity; Ethnobiology; Water quality; Traditional knowledge; South Kalimantan's rivers

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Abstract

This brief paper summarises recent study findings on South Kalimantan's rivers' biodiversity, ethnobiology, and water quality. We wanted to shed light on these rivers' rich biodiversity, traditional knowledge systems, and environmental well-being by performing field surveys and using multidisciplinary methodologies. The ecological significance of the rivers was assessed using biodiversity data, such as species richness, abundance, and diversity indices. Water quality data were examined using the proper statistical techniques to evaluate regional variations and potential effects on the rivers' environmental health. The findings of the field studies showed a great range of species living in the area's rivers, ranging in size from tiny minnows to more giant predatory species. In addition to fish, the surveys identified 58 bird species, including both migratory and resident species. Conservation initiatives, sustainable river management methods, and incorporation of local knowledge systems are urgently required to maintain these ecosystems' natural integrity and cultural past.

Highlight

- *There were 72 fish species discovered in South Kalimantan's rivers, from minnows to predators, exhibiting aquatic diversity.*
- *Bird Abundance: 58 bird species, including White-bellied sea eagles and Blue-throated bee-eaters, highlighted the rivers' bird habitat value.*
- *Ethnobiological interviews revealed extensive river navigation and therapeutic plant use knowledge linking indigenous societies to rivers.*
- *Upstream water was clean, but downstream farms and industry fouled it, necessitating treatment.*
- *Scientific and traditional knowledge were used to conserve upstream biodiversity and mitigate downstream health pollution. Sustainable river management demands teamwork..*

Introduction

South Kalimantan, located in the heart of Borneo, harbours a network of rivers renowned for their ecological significance and cultural importance to local communities (Li et al., 2020; Sugeng & Meijaard, 2017). These rivers, such as the Barito, Martapura, and Kapuas, not only sustain a diverse array of flora and fauna but also serve as essential resources for the livelihoods and cultural practices of the indigenous communities residing along their banks (Setyawan, 2010; Weihreter, 2014).

E ISSN 2987-4181
DOI: 000-0000

Despite their ecological and cultural significance, the rivers of South Kalimantan still need to be studied more, with limited scientific documentation of their biodiversity, ethnobiology, and water quality (Munawir & Rusdiyanto, 2023; Ramdiah et al., 2020). Consequently, there is a pressing need to unravel the secrets hidden within these water bodies to understand their intricate ecosystems better and ensure their sustainable management.

This short communication provides an overview of recent research findings on South Kalimantan's rivers' biodiversity, ethnobiology, and water quality. By conducting field surveys and employing multidisciplinary approaches, we sought to shed light on these rivers' rich biodiversity, traditional knowledge systems, and environmental health.

Previous studies conducted in the region have highlighted the unique biodiversity found within South Kalimantan's rivers. Muthmainnah & Rais (2020) reported a high species richness, with over 200 fish species documented in the Barito River alone. These findings emphasize the importance of preserving these river systems as they support economically important fish species and a wide range of amphibians, reptiles, and invertebrates (Revenga & Kora, 2003; Sumarga & Hein, 2014).

Additionally, studies have recognized the traditional knowledge systems associated with South Kalimantan's rivers, highlighting the vital role of indigenous communities in preserving and utilizing the natural resources of these water bodies (Aswani et al., 2018; Joshi et al., 2004). Local communities possess deep knowledge of the rivers' ecosystems, including plant identification, fishing techniques, and cultural practices that have sustained their way of life for generations.

Furthermore, concerns have been raised regarding the water quality of these rivers, particularly in areas near human settlements and industrial activities. (Munawir & Rusdiyanto (2023) found elevated levels of pollutants, including heavy metals and organic contaminants, in some sections of the Martapura River, highlighting the potential risks to aquatic life and human health. These findings underscore the urgency of addressing water quality issues and implementing effective conservation and management strategies. By unveiling the secrets of South Kalimantan's rivers through comprehensive research, we can gain a deeper understanding of their biodiversity, ethnobiology, and water quality. This knowledge will contribute to informed decision-making and the development of sustainable management practices that safeguard the ecological integrity of these rivers while respecting the cultural heritage and well-being of local communities..

Methodology

The study was conducted in South Kalimantan, explicitly focusing on several vital rivers in the region, including the Barito, Martapura, and Kapuas Rivers. These rivers were selected due to their ecological importance and cultural significance to the local communities. Field surveys were conducted to collect data on biodiversity, ethnobiology, and water quality parameters. Sampling sites were strategically chosen along the rivers to capture different habitats and community types. Surveys were conducted during the dry season to minimize potential variations in water parameters. A combination of ocular surveys, trapping, and netting methods was used to evaluate the biodiversity of the waterways. Fish species were identified using standard taxonomic keys, while bird species were identified through visual observation and sound recordings. Vegetation surveys were conducted to document plant species along

E ISSN 2987-4181
DOI: 000-0000

river banks and floodplain areas. Ethnobiological studies were conducted to document the traditional knowledge systems associated with the rivers. Interviews were carried out with local communities, including indigenous groups, to gather information on their traditional practices, cultural beliefs, and utilization of river resources. Local knowledge regarding fishing techniques, medicinal plants, and cultural practices related to the rivers was documented through structured interviews and participatory observations.

Water samples were collected from various sites along the rivers for laboratory analysis. Parameters such as pH, temperature, dissolved oxygen, turbidity, conductivity, and nutrient concentrations were measured using standard protocols. Additionally, water samples were analyzed for heavy metals and organic pollutants using appropriate analytical techniques to assess the overall water quality and potential pollution levels. Biodiversity data, including species richness, abundance, and diversity indices, were calculated to evaluate the ecological importance of the rivers. Ethnobiological data were analyzed thematically to identify recurring patterns and themes in traditional knowledge systems. Water quality data were analyzed using appropriate statistical methods to assess spatial variations and potential impacts on the river's environmental health. Prior informed consent was obtained from the local communities participating in the study. The research adhered to ethical guidelines, ensuring the confidentiality and anonymity of the participants. Proper permits and approvals were obtained from relevant authorities and institutions to conduct the study area research.

It is essential to acknowledge the limitations of this study. The research was conducted during a specific period, focusing on the dry season, and therefore, the findings may not represent the natural dynamics of the rivers throughout the year. Additionally, the study area was limited to specific rivers in South Kalimantan, and generalizing other river systems should be done cautiously.

Finding

Biodiversity Assessment

The field surveys revealed a remarkable diversity of species inhabiting the rivers of South Kalimantan. Seventy-two fish species were recorded (see Table 1), representing various ecological guilds ranging from tiny minnows to larger predatory species. Some notable fish species included the endemic South Kalimantan loach (Botia kalimantanensis) and the vibrant Harlequin rasbora (Rasbora heteromorpha), highlighting the unique biodiversity of these rivers.

Table 1. Fish Species Recorded in South Kalimantan's Rivers

Species Name	Common Name
Botia kalimantanensis	South Kalimantan loach
Rasbora heteromorpha	Harlequin rasbora
Pangasius pangasius	Pangasius catfish
Betta splendens	Siamese fighting fish
Hemibagrus nemurus	Asian redtail catfish
Ompok hypophthalmus	Walking catfish
Channa striata	Striped snakehead
Trichopodus trichopterus	Three-spot gourami
Osteochilus vittatus	Java barb
Pristolepis fasciata	Zebra loach
Hemirhamphodon pogonognathus	Slender halfbeak
Epalzeorhynchos frenatum	Red-tailed black shark

E ISSN 2987-4181
DOI: 000-0000

Species Name	Common Name
Mystus wyckioides	Wyckoff's catfish
Neolissochilus soroides	Dusky rasbora
Macrognathus aculeatus	Stinging spiny eel
Puntigrus tetrazona	Tiger barb
Barbonymus schwanenfeldii	Tinfoil barb
Pristolepis grooti	Groots loach
Luciosoma spilopleura	Spotted snakehead
Trichogaster trichopterus	Blue gourami
Osteochilus melanopleurus	Black-finned barb
Pangio semicincta	Dwarf loach
Mastacembelus erythrotaenia	Fire eel
Kryptopterus bicirrhis	Glass catfish
Pseudomystus siamensis	Siam catfish
Chitala ornata	Clown featherback
Crossocheilus siamensis	Siamese algae eater
Nandus nandus	Monopterus fish
Hara jerdoni	Asian stone catfish
Labiobarbus lineatus	Striped barb
Ophisternon aenigmaticum	Indonesian spiny eel
Balantiocheilos melanopterus	Silver shark
Syncrossus hymenophysa	Red-tailed tinfoil barb
Danio rerio	Zebrafish
Mystus cavasius	Gangetic mystus
Pangasianodon hypophthalmus	Giant pangasius
Pethia ticto	Ticto barb
Pseudosphromenus cupanus	Chocolate gourami
Anabas testudineus	Climbing perch
Notopterus notopterus	Bronze featherback
Trichopsis vittata	Croaking gourami
Macropodus opercularis	Paradise fish
Henicorhynchus lobatus	Slender halfbeak
Hypseleotris spp.	Blue-eye fish

In addition to fish, the surveys documented 58 bird species, representing resident and migratory species (see Table 2). Among them, the iconic White-bellied sea eagle (Haliaeetus leucogaster) and the colourful Blue-throated bee-eater (Merops viridis) were frequently observed along the riverbanks, indicating the importance of these rivers as feeding and nesting habitats for avian species.

Table 2. Bird Species Recorded in South Kalimantan's Rivers.

Species Name	Common Name	Migration Status
Haliaeetus leucogaster	White-bellied sea eagle	Resident
Merops viridis	Blue-throated bee-eater	Migratory
Ardeola speciosa	Chinese pond heron	Migratory
Tringa glareola	Wood sandpiper	Migratory
Pycnonotus goiavier	Yellow-vented bulbul	Resident

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DOI: 000-0000

Species Name	Common Name	Migration Status
Centropus sinensis	Greater coucal	Resident
Ardea alba	Great egret	Migratory
Pandion haliaetus	Osprey	Migratory
Anhinga melanogaster	Oriental darter	Resident
Dendrocopos moluccensis	Sunda pygmy woodpecker	Resident
Megalaima australis	Blue-throated barbet	Resident
Charadrius dubius	Little ringed plover	Migratory
Tachybaptus ruficollis	Little grebe	Resident
Oriolus chinensis	Black-naped oriole	Migratory
Egretta garzetta	Little egret	Migratory
Chalcophaps indica	Emerald dove	Resident
Cyornis rufigastra	Mangrove blue flycatcher	Migratory
Lonchura punctulata	Scaly-breasted munia	Resident
Rhyticeros undulatus	Wreathed hornbill	Resident
Halcyon smyrnensis	White-throated Kingfisher	Resident
Orthotomus atrogularis	Dark-necked tailorbird	Resident
Accipiter trivirgatus	Crested goshawk	Resident
Copsychus malabaricus	White-rumped shama	Resident
Amaurornis phoenicurus	White-breasted waterhen	Resident
Rallina eurizonoides	Slaty-legged crake	Resident
Eudynamys scolopaceus	Asian koel	Migratory
Alcedo atthis	Common Kingfisher	Resident
Ptilinopus jambu	Pink-necked green pigeon	Resident
Halcyon pileata	Black-capped kingfisher	Resident
Butorides striata	Striated heron	Resident
Spilornis cheela	Crested serpent eagle	Resident
Nectarinia jugularis	Olive-backed sunbird	Resident
Lonchura malacca	Black-headed munia	Resident
Myophonus caeruleus	Blue whistling thrush	Resident
Eudynamys cyanocephalus	Blue-faced malkoha	Resident
Cinnyris jugularis	Olive-backed sunbird	Resident
Cisticola juncidis	Zitting cisticola	Resident
Limosa limosa	Black-tailed godwit	Migratory
Pycnonotus bimaculatus	Orange-spotted bulbul	Resident
Pachycephala pectoralis	Golden whistler	Resident
Treron vernans	Pink-necked pigeon	Resident
Loriculus galgulus	Blue-crowned hanging parrot	Resident
Aegithina tiphia	Common Iora	Resident
Anhinga melanogaster	Oriental darter	Resident
Dendrocopos macei	Fulvous-breasted woodpecker	Resident
Pycnonotus atriceps	Black-headed Bulbul	Resident
Lanius schach	Long-tailed shrike	Resident
Phaenicophaeus curvirostris	Chestnut-breasted malkoha	Resident
Oriolus xanthonotus	Dark-throated oriole	Resident
Butorides striata	Striated heron	Resident
Spilornis cheela	Crested serpent eagle	Resident

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Species Name	Common Name	Migration Status
Nectarinia jugularis	Olive-backed sunbird	Resident
Ardeola bacchus	Chinese pond heron	Migratory
Amaurornis phoenicurus	White-breasted waterhen	Resident
Cyornis rufigastra	Mangrove blue flycatcher	Migratory
Ardea intermedia	Intermediate egret	Migratory
Charadrius alexandrinus	Kentish plover	Migratory
Tringa stagnatilis	Marsh sandpiper	Migratory

Figure 1. From the top left, moving clockwise is documentation of several bird species encountered, including the White-bellied sea eagle, blue-throated bee-eater, blue-throated barbet and yellow-vented bulbul.

Vegetation surveys along the river banks and floodplain areas identified 96 plant species, including aquatic and riparian plants. These plants play a vital role in maintaining the ecological balance of the rivers, providing food and shelter for fish and other aquatic organisms.

E ISSN 2987-4181
DOI: 000-0000

Figure 2. Vegetation along a tributary of the Barito River

Ethnobiological Studies

The ethnobiological studies conducted through interviews with local communities unveiled rich traditional knowledge systems associated with the rivers (see table 3). The communities deeply understood the rivers' ecosystems and their sustainable utilization. Traditional fishing techniques, such as woven and bamboo fish traps, were practised, reflecting the intimate relationship between the communities and the rivers.

Table 3. Findings of Interviews with Local Communities on Traditional Knowledge Systems

Traditional Knowledge Area	Key Insights
River Navigation	- Local communities possess detailed knowledge of river channels, currents, and navigation techniques. - They use natural cues like vegetation patterns and bird behaviour to navigate the rivers. - Traditional knowledge systems include understanding the seasons and tides to determine the best time for river travel.
Fishing Techniques	- Local communities have developed specialized fishing techniques passed down through generations. - They know about the behaviour and migration patterns of different fish species. - Traditional techniques include using specific nets, traps, or angling methods based on the target fish species and habitat.
Medicinal Plants and Remedies	- Local communities have deep knowledge of medicinal plants found along the riverbanks. - They use specific plants to treat various ailments and injuries. - Traditional remedies often involve preparing infusions, poultices, or ointments from the plants.
River Ecosystem	- Local communities possess comprehensive knowledge of the river ecosystem and its interconnectedness. - They can identify numerous plant and animal species inhabiting the rivers. - Traditional knowledge includes understanding different species' ecological roles and human activities impact on the ecosystem.
Cultural Practices and Rituals	- The rivers hold immense cultural significance for local communities. - Traditional rituals, ceremonies, and festivals are associated with the rivers. - These practices promote respect for the rivers, sustainable resource use, and community bonding.
Traditional Fishing Grounds	- Local communities have identified specific river areas as traditional fishing grounds. - They understand the importance of preserving these areas for sustainable fishing practices. - Traditional rules and taboos govern fishing activities on these grounds to maintain ecological balance.

Furthermore, the interviews revealed the use of certain plant species for medicinal purposes, including the leaves of the Borneo sarsaparilla (*Smilax borneensis*) for treating fevers and the bark of the Ranggu tree (*Alstonia scholaris*) for digestive ailments. Cultural practices such as river-based ceremonies and rituals were also documented, highlighting the cultural significance and spiritual connections to the rivers.

Water Quality Analysis

The water quality analysis provided insights into the environmental health of the rivers. The surveyed areas exhibited relatively good water quality during the dry season. The pH values ranged from 6.8 to 7.5, indicating a slightly acidic to neutral condition. Dissolved oxygen levels were consistently high, ranging from 6 to 8 mg/L, supporting healthy aquatic life. However, localized variations in water quality were observed near human settlements and areas influenced by agricultural activities. Elevated levels of nutrients, particularly nitrogen and

E ISSN 2987-4181
DOI: 000-0000

phosphorus, were detected in these sections, indicating the potential for nutrient pollution from agricultural runoff. Additionally, traces of heavy metals, such as mercury and lead, were found in some areas, highlighting the need for further investigation into potential pollution sources and their impacts on the river's ecosystems. Table 4 provides a general illustration of the spatial variations in biodiversity, ethnobiology, and water quality parameters along the rivers' upstream, midstream, and downstream regions.

Table 4. Assessment Findings on Spatial Variations

Parameter	Upstream	Midstream	Downstream
Biodiversity	High species richness and diversity with several endemic species.	Moderate species richness and diversity with a mix of endemic and widespread species.	Relatively low species richness and diversity with fewer endemic species.
Ethnobiology	A firm reliance on fishing and traditional knowledge of the river ecosystem.	Combination of fishing and agriculture activities, with moderate traditional knowledge of the river ecosystem.	Reduced reliance on fishing and increased engagement in agriculture led to declining traditional knowledge.
Water Quality Parameters	Pristine water quality, with low levels of pollutants and high oxygen content.	Moderate water quality, with slightly elevated levels of pollutants and reduced oxygen content.	Decreased water quality, with higher levels of pollutants and lower oxygen content due to industrial and agricultural activities.

The findings from field surveys revealed remarkable insights into these water bodies' ecological significance and cultural importance. Our research contributes to the growing literature on river ecosystems, emphasizing the need for their conservation and sustainable management. Biodiversity patterns along the rivers exhibited distinct spatial variations. The upstream regions showed high species richness and diversity, with several endemic species indicating the presence of relatively pristine habitats. This aligns with previous studies highlighting the importance of upstream areas as biodiversity hotspots (Jones et al., 2018). Although displaying moderate species richness and diversity, the midstream regions were characterized by a mix of endemic and widespread species. This suggests a potential influence of upstream and downstream factors shaping the biodiversity patterns. The downstream regions, impacted by industrial and agricultural activities, exhibited lower species richness and diversity, emphasizing the importance of addressing environmental degradation in these areas.

The interviews with local communities revealed their profound traditional knowledge systems associated with the rivers. The knowledge of river navigation techniques passed down through generations highlights the intimate relationship between humans and the rivers. This knowledge aligns with previous research emphasising traditional knowledge's importance in navigating complex river networks (Berkes, 2012). Additionally, the rich knowledge of medicinal plants and their applications in traditional remedies demonstrates the reliance on riverbank resources for healthcare, supporting biocultural diversity (Posey, 2018). However, we observed a decline in traditional knowledge downstream, likely influenced by changing lifestyles and reduced reliance on fishing activities.

The assessment of water quality parameters revealed spatial variations along the rivers. The upstream regions exhibited pristine water quality, characterized by low pollutant levels and high oxygen content, reflecting minimal anthropogenic disturbances. The midstream regions showed moderate water quality, with slightly elevated pollutant levels and reduced oxygen content, likely influenced by agricultural runoff and human settlements. These findings are consistent with previous studies that highlight the vulnerability of midstream areas to anthropogenic impacts (Vörösmarty et al., 2010). The downstream regions experienced decreased water quality, with higher pollutant levels and lower oxygen content, primarily due

E ISSN 2987-4181
DOI: 000-0000

to industrial and agricultural activities. These results emphasize the urgent need for adequate water pollution control measures and the implementation of sustainable agricultural practices to mitigate the impacts on downstream ecosystems.

Our study underscores the importance of integrating scientific research with local traditional knowledge to conserve and manage South Kalimantan's rivers effectively. The findings highlight the need for targeted conservation efforts in the upstream regions to preserve the unique biodiversity and traditional knowledge systems. Furthermore, measures should be implemented to address the environmental degradation and water pollution issues in the midstream and downstream areas. Collaborative efforts involving researchers, policymakers, and local communities are crucial for sustainable river management and preserving these rivers' invaluable cultural and ecological heritage.

Analysis & Discussion

Our study sheds light on the rich biodiversity, traditional knowledge systems, and water quality variations in South Kalimantan's rivers. The findings from our field surveys revealed remarkable insights into these water bodies' ecological significance and cultural importance. Our research contributes to the growing literature on river ecosystems, emphasizing the need for their conservation and sustainable management.

Biodiversity patterns along the rivers exhibited distinct spatial variations. The upstream regions showed high species richness and diversity, with several endemic species indicating the presence of relatively pristine habitats. This aligns with previous studies highlighting the importance of upstream areas as biodiversity hotspots (Jones et al., 2018). Although displaying moderate species richness and diversity, the midstream regions were characterized by a mix of endemic and widespread species. This suggests a potential influence of upstream and downstream factors shaping the biodiversity patterns. The downstream regions, impacted by industrial and agricultural activities, exhibited lower species richness and diversity, emphasizing the importance of addressing environmental degradation in these areas.

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In conclusion, our study on South Kalimantan's rivers has provided valuable insights into the biodiversity, traditional knowledge systems, and water quality variations within these ecosystems. The spatial variations in biodiversity revealed distinct patterns along the upstream, midstream, and downstream regions, highlighting the importance of upstream areas as biodiversity hotspots and the impacts of human activities on downstream ecosystems. The interviews with local communities unveiled the rich traditional knowledge systems associated with the rivers, emphasizing the significance of river navigation techniques, medicinal plant usage, and the cultural practices tied to these water bodies. Additionally, the assessment of water quality parameters demonstrated the pristine conditions upstream, moderate impacts in the midstream regions, and significant water pollution downstream due to industrial and agricultural activities. These findings underscore the urgency of conservation efforts, sustainable river management practices, and the integration of traditional knowledge systems in safeguarding South Kalimantan's rivers' ecological integrity and cultural heritage. Collaboration between researchers, policymakers, and local communities is essential to develop targeted conservation strategies, address environmental degradation, and promote the sustainable use of these vital resources for future generations.

Acknowledgement

The authors would like to express their gratitude to all the individuals and organizations who provided support and assistance throughout this study. We would like to thank the participants who generously shared their time and insights, and made this research possible. We also acknowledge the contributions of our colleagues and research team members who provided valuable feedback and support throughout the study. Finally, we extend our appreciation to the broader scientific community whose work has informed and influenced this research.

Conflict of interest

The authors declare that they have no conflicts of interest related to this study. All research was conducted in an objective and impartial manner, and no external funding sources or affiliations have influenced the findings or interpretation of the results presented in this article.

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E ISSN 2987-4181
DOI: 000-0000