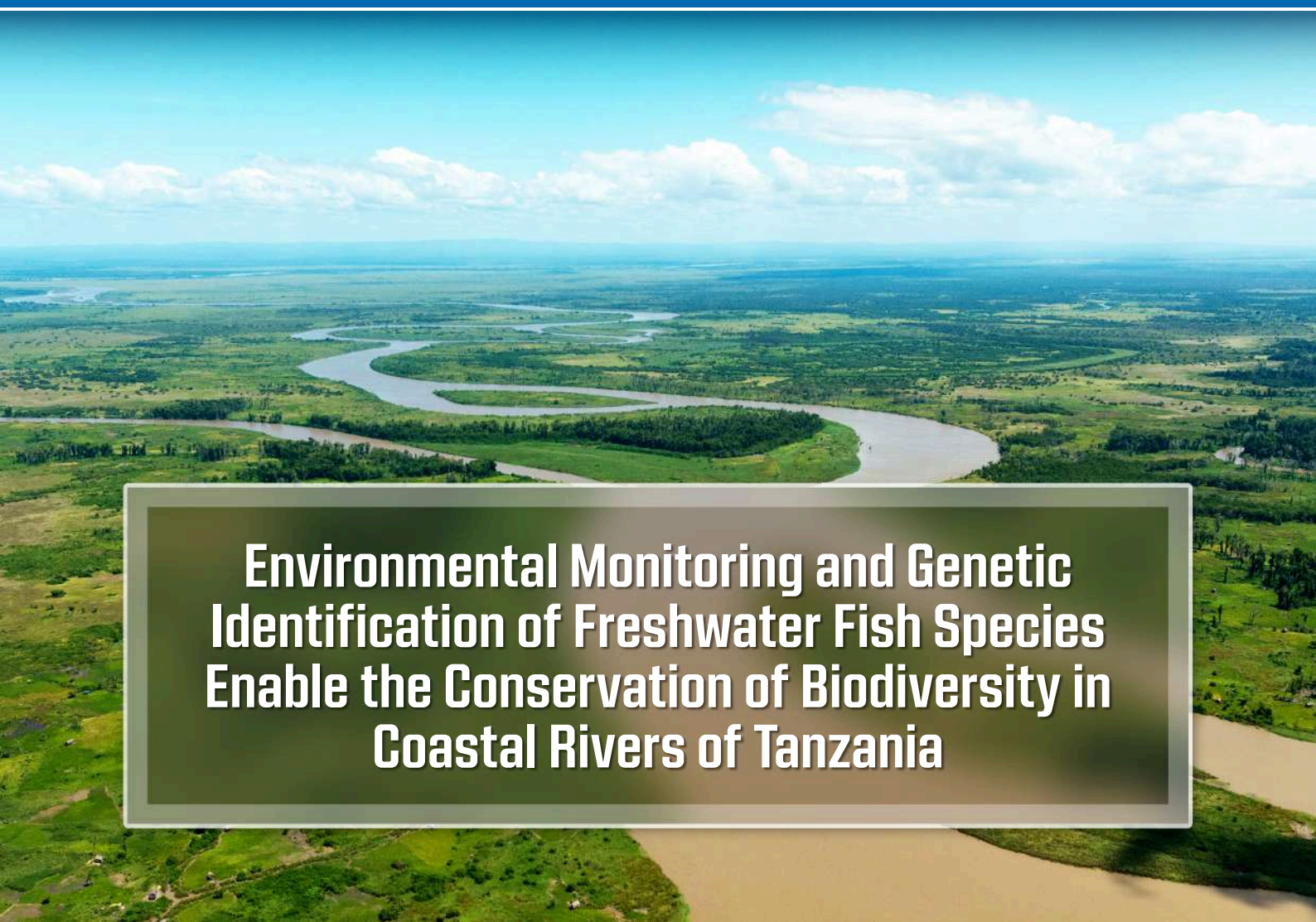


POLICY BRIEF

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**Environmental Monitoring and Genetic
Identification of Freshwater Fish Species
Enable the Conservation of Biodiversity in
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Environmental Monitoring and Genetic Identification of Freshwater Fish Species Enable the Conservation of Biodiversity in Coastal Rivers of Tanzania

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Executive summary

This policy brief summarizes the findings of a recent study conducted by the University of Dar es Salaam's School of Aquatic Sciences and Technology, in partnership with the Tanzania Fisheries Research Institute (TAFIRI) and the Thünen Institute of Fisheries Ecology in Germany. The study aimed at assessing and conserving fish biodiversity in two Tanzanian coastal rivers. In addition to a taxonomic analysis of fisheries catches in different parts of the rivers, the distribution and abundance of diadromous freshwater eels of the genus *Anguilla* was used as an indicator for environmental quality. To assess habitat specific fish species composition, distribution, and abundance in the Rufiji and Pangani rivers, the team employed a combination of fishers' ecological knowledge and biological science methods. Two freshwater eel species, *Anguilla bicolor* and *Anguilla bengalensis*, were found in the Rufiji riverine system, while the Pangani River had three species: *A. bicolor*, *A. bengalensis*, and *A. marmorata*. It was the first time that *Anguilla marmorata* was recorded in Tanzania. The taxonomic analysis of fisheries catches revealed gaps and inconsistencies in the knowledge and understanding of the fish fauna in Tanzania. Habitat quality differed considerably along the rivers due to different anthropogenic impacts. The findings underscore the need for long-term environmental monitoring, control of threats such as agriculture and overfishing, diversification of livelihoods, and the implementation of collaborative fisheries management and conservation measures. The study suggests that ecotourism could be a potential solution to these issues.

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Overview of research

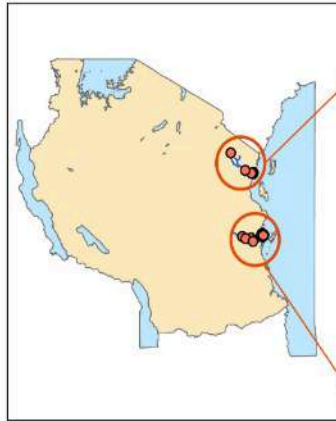
The deterioration of tropical riverine, estuarine, and coastal habitats, primarily due to the negative impact of human activities such as uncontrolled economic development, pollution, and urbanization (Hellar-Kihampa et al. 2013; Shaghude, 2016; Richards et al. 2022; Ciezarek et al. 2023), is an ongoing issue that directly affects fish biodiversity, abundance, and productivity. Freshwater eels are particularly vulnerable to environmental changes due to their complex life cycles, which involve extensive migrations between marine and freshwater habitats and a semelparous reproductive mode, meaning they spawn just once in the open ocean before they die (Tesch 2003). The willow leaf-shaped leptocephalus larvae drift back to the continental shelf areas before they transform into juvenile glass eels. From there, they start their upstream migration into brackish or freshwater environments, where they pigment into yellow eels. After completing their feeding phase for years, they transform into silver eels and begin their once-in-a-lifetime journey back to their spawning areas, where they reproduce and die. Therefore, successful conservation and sustainable management require the protection of diverse habitats, from coastal and estuarine areas to upstream riverine regions.

Freshwater eels play a crucial role in tropical riverine fish communities. However, in East Africa, particularly in Tanzania, eel species have never been in the focus of fisheries science. Currently, tropical eels are facing a growing interest the international live fish trade as seed for aquaculture operations, due to the decline of temperate eel species. A globalized market for glass eels in combination with a general lack of information about their distribution and abundance as well as effects of climate change pose risks of rapid overexploitation and local extinction of stocks potentially even unknown to scientists and policymakers.

Methodology

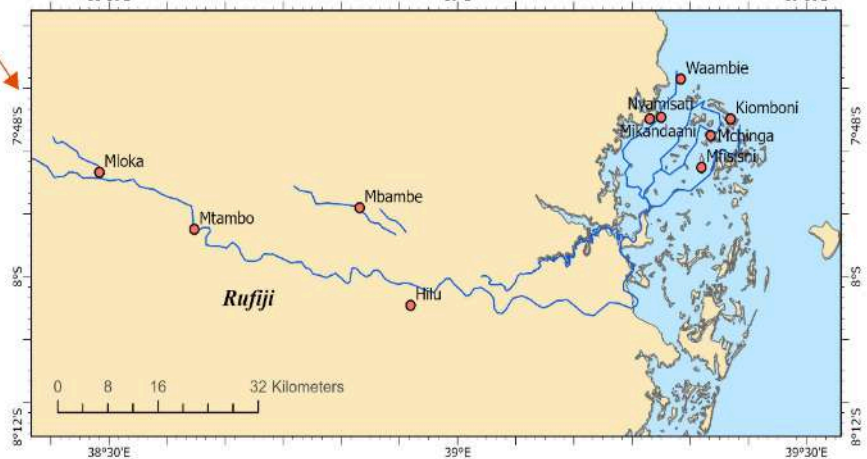
We combined fishers' ecological knowledge and biological science methods to assess species composition, distribution, and abundance of migratory eels and associated fish communities in the two Tanzanian coastal rivers Rufiji and Pangani (Fig. 1). We evaluated socio-cultural and economic factors affecting the sustainability of eel fisheries and habitat quality, and we developed concepts and applications for effective knowledge transfer and capacity building for biodiversity conservation and sustainable use.

Sampling Sites for Pangani and Rufiji Riverine Systems.



Legend

- Sampling Sites
- Rivers
- Water_bodies



Sources: Esri, HERE, Garmin, FAO, NOAA, USGS, ©

Figure 1: A map showing study areas and sites where fish samples were caught. The lower and upper panels represent the Rufiji and Pangani river systems, respectively.

RESULTS

For the assessment of the diversity of the fish community, 70 species from 59 genera and 40 families were detected in 334 genetic samples. In some cases, morphological and genetic species determination were not in agreement. In these cases, further investigations are necessary. During the project, the presence of *A. bicolor*, *A. bengalensis* and *A. marmorata* in the studied rivers was documented, which show a distinct distribution pattern along the rivers (Fig. 2). Whereas *A. bicolor* was found in all sampled river sections with a clear tendency towards the lower stretches, *A. marmorata* and *A. bengalensis* were only caught upstream. This distribution pattern has management implications regarding migration barriers.

Interviews with local fishers revealed that eels in the lower river stretches and the estuaries are mainly caught as bycatch in longline and trap fisheries. Conversely, larger eels (*A. bengalensis* and *A. marmorata*) further upstream are valued for human consumption and are rather high-priced. On the other hand, anguilliform estuarine species like the slender giant moray (*Strophidon sathete*) are mostly utilized as baits for crab fisheries. While time series investigations and therefore reconstructions of historical catches are missing, local fishers are perceiving a decline in eel stocks which they explain to increased fishing

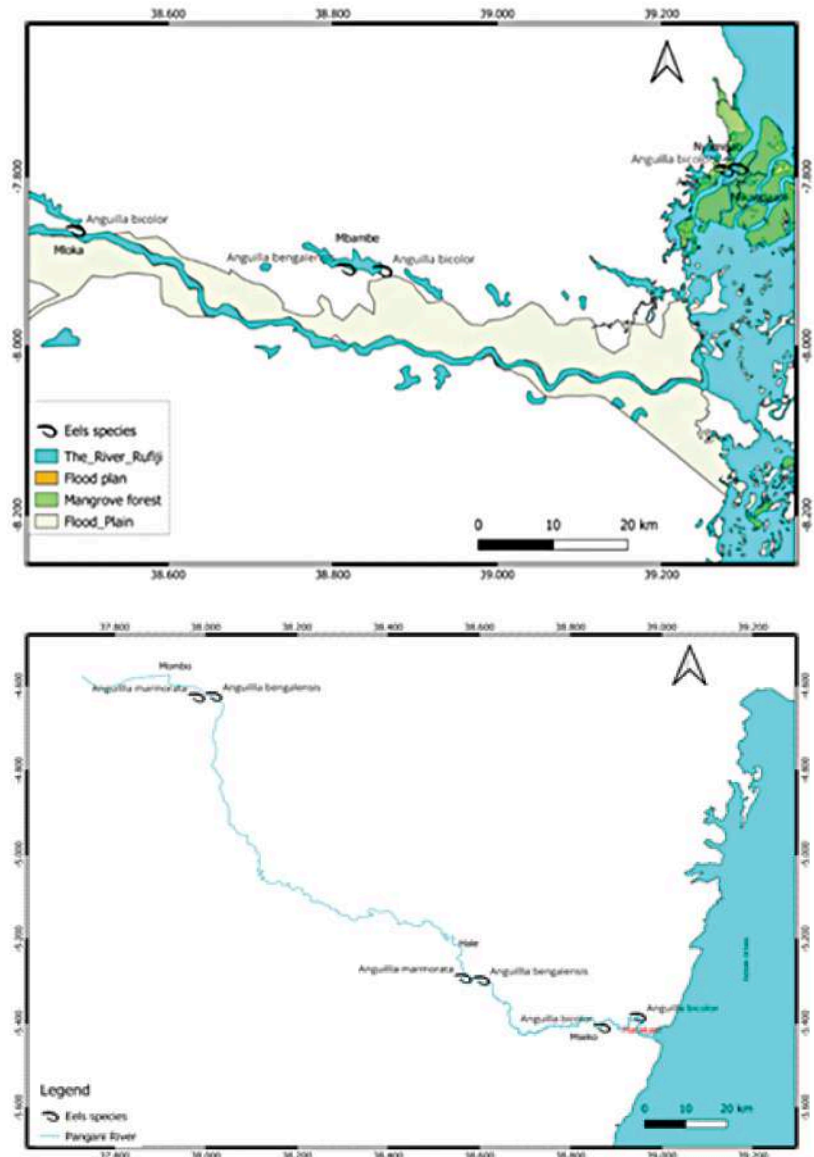


Figure 2: Map showing anguillid eel species distribution in Rufiji (A) and Pangani (B) riverine systems

pressure, reduced water flow (low rainfall), and high level of sedimentation. A first assessment of the respective value chain indicates that eels are sold locally or in neighboring regions either whole (TZS 2000¹ – 5000 per kg) or processed (sundried = TZS 1000 – 5000; fried = 500 – 4000; or smoked = 2000 – 6000). An analysis of the management framework revealed a lack of specific rules and regulations guiding the utilization of eel resources in terms of minimum size, catch volume, and trade modalities which pose risks of overexploitation. The general rules and regulation governing fishing practices in terms of prohibition and marketing are currently applied. Also, on statistics records eels are recorded on the category of other fish species thus becomes difficult to trace their catch trends. Therefore, the existing legal and institutional framework is largely sectoral and has encountered instances of contradicting impacts that need to be addressed to effectively manage this resource.

¹ 1 USD = 2380 TZS

CONCLUSIONS

- A combination of morphological species identification and DNA barcoding proved essential for assessing species diversity in the Rufiji and Pangani riverine systems and revealed gaps and inconsistencies in the knowledge of the Tanzanian fish fauna.
- Together with regular biodiversity assessments, monitoring schemes should include basic environmental parameters and ecomorphological mappings (Kern et al 2002). also showing the integrity of riparian vegetation and land use along the rivers.
- The occurrence and abundance of freshwater eels can be used as a simple indicator for habitat quality and river continuity in Tanzanian coastal rivers.
- Fishers' knowledge provided initial information about the development of local stocks that needs to be considered for the design of sustainable management approaches.
- Data on the trade of eel products and especially live eels are scarce. More emphasis should be placed on the value chain of fisheries products in Tanzania
- Increasing public awareness about the ecological importance of anguillid eels and their role as indicator species can foster a sense of responsibility and support efforts for river conservation.





POLICY RECOMMENDATIONS

For successful conservation of biodiversity in coastal rivers of Tanzania, this policy brief recommends the following:

- Tanzanian coastal rivers are highly productive but sensitive ecosystems. Despite their importance, a proper assessment of their biodiversity and ecological status is missing and should be urgently initiated.
- For an effective fisheries management of Tanzania's coastal rivers a continuous monitoring of fish diversity and abundance together with fisheries landings is urgently needed.
- Damming and water diversion by hydroelectric power plants and other users lead to river fragmentation and are among the most severe impacts on ecosystem health of coastal rivers, directly affecting the existence of migratory species. Their potential effects on aquatic genetic resources needs to be assessed already in the planning phase and should be mitigated by technical installations that allow river continuity.
- Agricultural activities such as rice and coconut farming, livestock keeping, deforestation, and human settlements together with climate change can also significantly contribute to the deterioration of Tanzanian rivers and need to be monitored and controlled.
- Most of the communities residing near rivers have limited economic activities and are not adequately included in the development of new management strategies. Therefore, poverty eradication and diversification of livelihoods should be an integral part of any new conservation measures.
- Alternative sources of livelihood for local fishing communities, such as aquaculture, preferably with native species, and tourism, need to be tested in specifically targeted case studies. Awareness creation in local communities (indigenous people) for biodiversity conservation issues and existing new policies is key for better implementation.
- The creation of collaborative fisheries management areas and better integration of the different institutions by a clear legal framework are among the measures that urgently need to be implemented.
- New guidelines and legal frameworks for species-specific fisheries management (especially for eels and other migratory species), controlled water diversion from rivers for the different activities, and the permanent demarcation of a 60 m buffer zone from river banks need to be decided and enforced.
- Protected areas, seasonal closures, and gear restrictions should be considered among different management scenarios to protect critical habitats and enigmatic species.
- If properly communicated with the local communities, ecotourism in coastal and riverine areas could aid in relieving natural resources from overuse and create employment opportunities.

Acknowledgment

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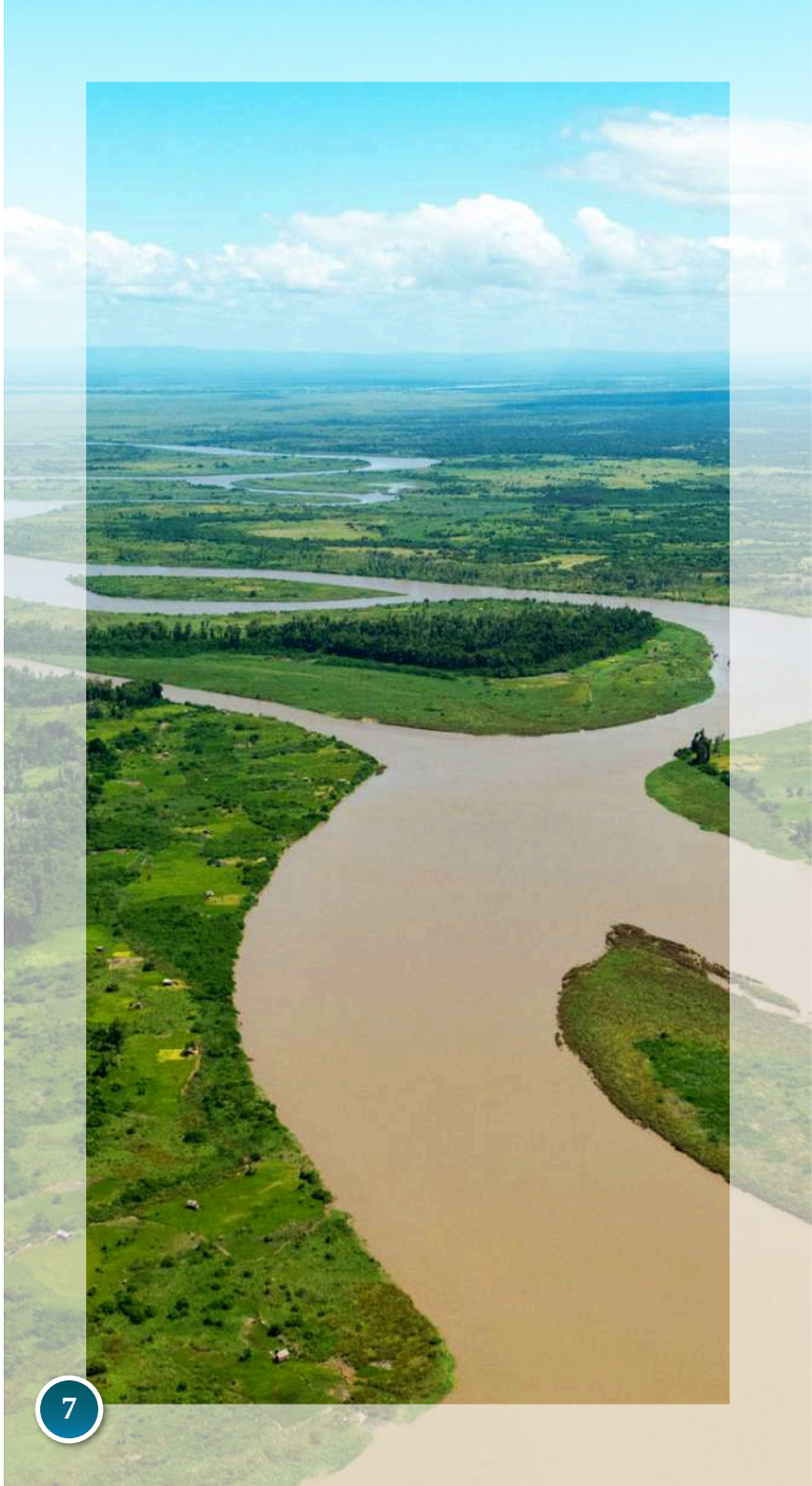
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