Regional Flyway Initiative · Site Study

May 2026

RFI Priority Site:

Papua New Guinea · Tonda Wildlife Management Area

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Asian Development Bank

General Site Information

Country	Papua New Guinea			
RFI Site Name	Tonda Wildlife Management Area (WMA)			ID0xx
City/ Municipality, Province, Region	Western Province (Westen Provins), South Fly District, Morehead Rural LLG			
Geographical coordinates	08°45'S, 141°23'E		Area (has)	590,000 ha
Key species	At least two EAAF species exceeding 1% thresholds (e.g. Little Curlew, Australian Pratincole), based on published data			
Key habitats (biomes)	coastal mangroves, shallow swamps and lakes, grasslands			
Key ecosystem services	Provisioning services and cultural services (tourism)			
Key drivers of change	Climate change, encroachment and illegal hunting			
Conservation status (mark all that applies)		Protected Area		Flyway Network Site
		Ramsar Site		Others _____
IBA/ KBA name (and number) and other designations	N/A			
Management Stakeholders	Conservation and Environmental Protection Authority (CEPA), Western Province			
With management plan?				
Project concept themes	Site management, tourism, biodiversity protection, rural development			
Length of project	5 years			
Sector/s	Tourism, fisheries			
No. of potential beneficiaries				
Indigenous Peoples		No		Yes, including Morehead people
Anticipated Implementation Risks	Impact of tourism			
Estimated Project Budget (US$)	5,600,000			
Potential Source/s of Financing		Loan (to be identified)		Private Sector
		Grant (to be identified)		Public-Private Partnership

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Abbreviations

ADB	Asian Development Bank
CEPA	Conservation and Environmental Protection Authority
DEC	Department of Environment and Conservation
DMC	Developing member country
EAAF	East Asian-Australasian Flyway
EAAFP	East Asian-Australasian Flyway Partnership
ENSO	El Nino Southern Oscillation
IBA	Important Bird and Biodiversity Area
IUCN	International Union for the Conservation of Nature
KBA	Key Biodiversity Area
LLG	Local level government
NGO	Non-governmental Organization
PA	Protected Area
PNG	Papua New Guinea
PNGTPA	Papua New Guinea Tourism Promotion Authority
UPNG	University of Papua New Guinea
WMA	Wildlife Management Area
TWMA	Tonda Wildlife Management Area

Executive summary

Tonda Wildlife Management Area (WMA) in Papua New Guinea's Western Province is located 575 km to the west of Port Moresby, and 170 km to the west of the closest administrative center at Daru, the capital of South Fly District. Immediately to the west of Tonda is the Wasur National Park in South Papua Province, Indonesia. As part of New Guinea's Trans-Fly ecoregion, Tonda is recognized as a highly important coastal and floodplain wetland landscape, supporting well over 250 species, including at least 10 species of EAAF migratory waterbirds. Tonda WMA supported large congregations of both East Asian migratory shorebirds (such as Little Curlew *Numenius minutus*) until recently, and a suite of waterbird species associated with the wetlands of New Guinea and Australia, for instance, the Magpie Goose *Anseranas semipalmata*.

The Tonda WMA is currently the largest and oldest WMA in Papua New Guinea and was established in 1975 by the then Papua New Guinea Department of Environment and Conservation (DEC) in partnership with local communities. The site is managed by a committee composed of indigenous community members following a by-law created by that committee, and which regulate human activities in the area. Tonda WMA is also recognized as a Ramsar site since 1993 and became one of three wetland landscape under the Tri-national Wetlands Initiative between Australia, Indonesia and Papua New Guinea in 2002. An estimated 1,500 subsistence gardeners and hunters live within the Tonda WMA. Tourism in the Tonda area is at present limited to recreation fishing and the established Bensbach Fishing Lodge draws a stream of recreational specialist (fishing) tourists, and hunters targeting introduced deer.

Key drivers of change affected Tonda WMA are the aggregated impacts of mining (including the Ok Tedi mine), illegal hunting and encroachment, which is gradually degrading wetlands within the landscape, together with the cumulative ecological effects of introduced deer and other invasive species. A lack of funding for site management and conservation activities has also compromised the conservation of Tonda, with a measurable decline in management effectiveness between 2006 and 2017. Part of the challenge arise from conflicts with traditional landowners due to community-owned land overlapping with the boundaries of the protected area.

Improving the management of the Tonda WMA is expected to require stronger community participation, especially from the villages in the Morehead Rural local-level government, and better institutional capacity for site and tourism management, in coordination with the South Fly District and CEPA, which has jurisdiction over Papua New Guinea's protected areas. Local communities in and around Tonda may be more actively engaged and supported through clear benefit-sharing arrangements, conservation education, and possibly livelihood alternatives. At the same time, the management effectiveness of Tonda can benefit from sustained resourcing for ranger patrols, biodiversity monitoring, and limited visitor infrastructure, as well as training in governance, enforcement, and ecological management. Stronger coordination between government agencies, NGOs, and local communities will be needed to ensure the success of any management intervention for Tonda, in alignment with local priorities.

1. Background of the Regional Flyway Initiative

In July 2021, the Asian Development Bank made a commitment to develop a long-term Regional Flyway Initiative (RFI) in the East-Asian Australasian Flyway (EAAF) (Sovereign Project 55056-001) to protect and restore priority wetland ecosystems and the associated ecosystem services they provide in the EAAF, the most threatened migratory bird flyway globally. The Initiative is slated for implementation in nine ADB developing member countries (DMCs) in East, South and Southeast Asia: Mongolia, People's Republic of China (PRC), Bangladesh, Viet Nam, Cambodia, Philippines, Thailand, Malaysia and Indonesia. In 2023, the geographic scope of the RFI was further extended to two DMCs in Southeast Asia and the Pacific respectively, Lao PDR and Papua New Guinea.

The primary aim of the RFI is to enhance and expand the existing efforts in conserving and managing wetlands of the highest priority for migratory birds within the EAAF through innovative loan and grant financing, and at scale. Consultations and analyses over the development period help identify key interventions to strengthen the management of wetlands, enabling the implementation of nature-based solutions while strengthening biodiversity protection. Over time, the RFI seeks to leverage collaborative opportunities by developing partnerships among important stakeholders including national governments, civil society organizations, communities, regional organizations like the East Asian-Australasian Flyway Partnership (EAAFP), development agencies, the private sector, and other relevant entities.

Through the RFI Technical Assistance (TA) implemented over the RFI's development phase from 2021 to 2024, BirdLife International takes the lead in providing and coordinating technical support for development of the RFI. This is carried out in collaboration with the EAAFP and a consortium of international non-governmental organizations including Wetlands International and the Paulson Institute, as well as two universities, namely the University of Southampton, UK and the National University of Singapore. Over the development phase, the TA team undertook a site selection analysis to identify priority wetland sites in all 10 countries based on recent bird data benchmarked against internationally accepted criteria under the Convention on Wetlands of International Importance (or Ramsar Convention), EAAFP Flyway Network Sites and Important Bird and Biodiversity Areas (IBAs). We were able to identify twenty-nine (29) and seven (7) candidate RFI wetland sites for PNG and Lao PDR, respectively. While a high number of candidate sites were identified in PNG, most of them lack recent information, rendering it impossible to define the most important sites purely based on the available waterbird count data (unlike other sites identified for other DMCs). However, we were able to narrow the shortlist of prioritized RFI sites in PNG to at least three wetlands, including the Tonda Wildlife Conservation Area (also prioritized by CEPA), the Fly River lowlands, and the Kikori and Purari River Deltas, all extensive floodplain and estuarine landscapes in southern New Guinea. The next steps to secure these sites for migratory species conservation are expected to involve strengthened engagement with local and indigenous communities, and the development of management and monitoring plans, coupled with stronger enforcement and patrol regimes using approaches consistent with local needs.

2. Site profile of Tonda Wildlife Management Area

Location: Tonda Wildlife Management Area (WMA) in Western Province is located 575 km to the west of Port Moresby, and 170 km to the west of the closest administrative center at Daru town, on Daru Island, the capital of South Fly District. To the north of the site is the proposed Aramba WMA (further details TBC), further north is the Middle Fly District. To the east of Tonda are riparian floodplain landscapes and wetlands similar in character to Tonda WMA. To the west of the site is the Wasur National Park Ramsar site in South Papua Province, Indonesia. A large part of Tonda is defined by the floodplain of the Bensbach River, which rises south of the Fly River until it drains into the Arafura Sea at the border with Indonesia (Milton 1998). The landscape of Tonda for up to 200 kilometers inland lies mostly below 20 m asl while away from the coastal mangrove zone are huge areas of low-lying grassland plains that are seasonally inundated during the monsoons (May-June) (Milton 1998). When flooded, these areas form seasonal, shallow swamps and lakes that are connected with the Bensbach and its channels. Even further inland, the grassland eventually transits into Paperbark *Melaleuca* spp. forest and mixed gallery forests (Milton 1998); Chatterton 2004).

Present, Tonda is recognized as an important wetland, supporting well over 250 species, including easily 10 species of EAAF migratory waterbirds (see Milton 1998; Bishop 2006). A large proportion of the world population of the Little Curlew *Numenius minutus* until recently, is known to stage on the plains in and around Tonda WMA (Milton 1998; Bishop 2006) during their migrations to continental Australia. 63 species of fish are known from the river system within Tonda. An estimated 1,500 subsistence gardeners and hunters live in the area. Tourism in the Tonda area is at present limited to recreation fishing and the well-known Bensbach Fishing Lodge draws a stream of recreational specialist (fishing) tourists, and hunters targeting the introduced Timor Rusa *Rusa timorensis*.

Area: 590,000 ha

Altitude: 0 – 40 m asl.

Geographical coordinates: centered on 08°45'S, 141°23'E

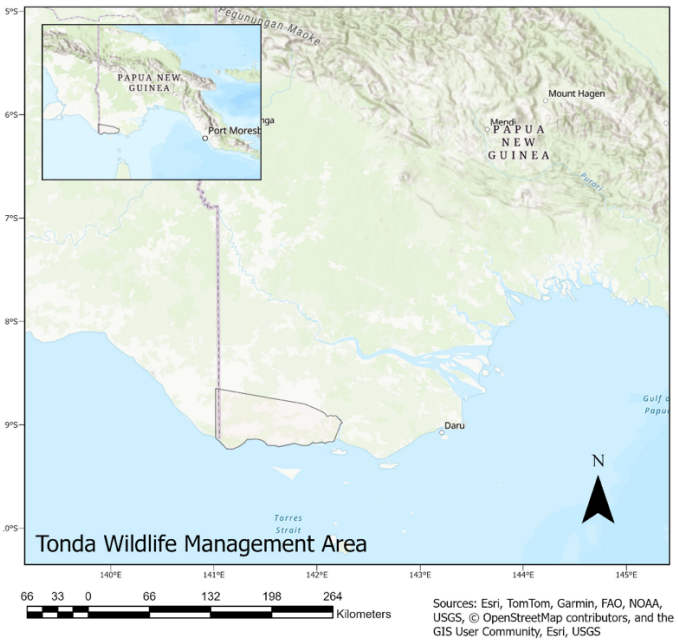

Figure 1. Map of Tonda Wildlife Management Area, with inset map showing the location of Tonda within Papua New Guinea (Map: Yong Ding Li).

Description of site: Tonda WMA is located within the vast Trans-Fly Complex of southern New Guinea which also encompasses Wasur National Park in Indonesia on the Papua New Guinea-Indonesia frontier, and along with Kakadu National Park in Australia are unique floodplain wetland ecosystems in the Asia-Pacific region. As such it was nominated as World Heritage Site in 2006 (UNESCO 2025). The site encompasses a complete range of relatively intact vegetation types from coastal mangroves, through savannas, acacia woodlands, melaleuca swamps and tropical dry forests including all representative types of monsoonal climate vegetation (Chatterton 2021, UNESCO 2025) with a climate that is similar to northern Australia. Overall, the conditions are tropical with a hot humid rainy season from December to March and a slightly cooler dry season from July to October, the area receives 1,500 to 2,000 mm of rain per year with temperatures ranging from high-20s °C to mid-30s °C. The Trans-Fly complex is susceptible to the El Nino and El Nina phenomena, with extreme droughts and flooding experienced periodically.

Site administration, management and land tenure: The Tonda Wildlife Management Area, adjoining the Indonesian border, is the largest and the oldest WMA in Papua New Guinea. Tonda was established in 1975 by the Papua New Guinea Department of Environment and Conservation (DEC) in partnership with local communities (Chatterton 2021). The site is managed by a committee composed of indigenous community members following a by-law created by that committee, and which regulate hunting and other activities in the area. Tonda WMA was declared a Ramsar site in 1993 as it supports significant populations of migratory and resident waterbird species (Milton 1998).

Social and economic values: Tonda WMA is of major cultural significance to indigenous peoples that make their home there. Leverington et al. (2017) noted that, "*Cultural values: There are species that are*

protected – e.g. eagle, kite (associated with initiations) – important bird in the wetlands; tribal groups have local totems (e.g. eagles, plants/trees). Tonda is regarded as part of the family". It is estimated that there are about c. 1,500 subsistence gardeners and hunters living in approximately 12 communities across the Tonda landscape. The Bensbach Fishing Lodge was established in Tonda in 2000, and supports high-end fishing tourism activities for international tourists, and which generate some revenue for local communities.

3. Biodiversity value of Tonda Wildlife Management Area

3.1 Key habitats

The site encompasses a complete range of relatively intact vegetation types from coastal mangroves, through savannas, acacia woodlands, melaleuca swamps and tropical dry forests including all representative types of monsoonal climate vegetation (Chatterton 2021, UNESCO 2025) with a climate that is similar to northern Australia.

The landscape of Tonda for up to 200 kilometers inland lies mostly below 20 m asl while away from the coastal mangrove zone are huge areas of low-lying grassland plains that are seasonally inundated during the monsoons (May-June) (Milton 1998). When flooded, these areas form seasonal, shallow swamps and lakes that are connected with the Bensbach and its channels. Even further inland, the grassland eventually transits into Paperbark *Melaleuca* spp. forest and mixed gallery forests (Milton 1998); Chatterton 2004).

3.2. Importance of Tonda Wildlife Management Area for migratory waterbird species

It is estimated that two million migratory shorebirds stage or stopover in New Guinea *enroute* to and from Australia and New Zealand (Bishop 2006) although there has not been any formal field work in the past decade. Scott (1989) noted that Tonda WMA provided an important refuge for waterbirds in the subtropics of northern Australia during major dry periods. Recent data on the congregations of waterbirds using Tonda WMA is however lacking, and therefore expert opinion and other available information has been consulted for prioritizing important wetlands for migratory waterbirds in Papua New Guinea (see Yong & Crosby 2025). The floodplain and savannah habitat in Wasur National Park (Indonesian New Guinea) is contiguous with Tonda WMA and can be broadly used to infer the physiographic and ecological conditions in Tonda.

Tonda WMA is considered by experts to be of high priority for conservation and strengthened management activities on the basis that it, until recently, supported large congregations of both East Asian migratory shorebirds (such as Little Curlew, see Milton 1998) and a suite of waterbird species that breed in New Guinea and Australia during the wet season, for instance, Magpie Goose *Anseranas semipalmata* and Royal Spoonbill *Platalea regia*. Milton (1998) noted that 10,000 Little Curlew staged along the

Bensbach River in 1980 (*viz* Finch 1980) although only 130 individuals were counted during his surveys in 1995. The available data shows that both species undertake local and regional movements across Australia and New Guinea (e.g. Milton 1998; Bishop 2006; Pratt & Beehler 2013).

Table 1. List of migratory species (based on the EAAFP list of species) with globally significant congregations at Tonda WMA.

Species name	IUCN	CSR1 score
Little Curlew *Numenius minutus*	LC	>1%
Australian Pratincole *Stiltia isabella*	LC	>1%

The Sharp-tailed Sandpiper *Calidris acuminata* (VU) has been recorded in numbers close to 1% (850) of regional population, 813 (0.95%) were recorded in 1995 (Milton 1998). In addition, the site is known to support smaller numbers of the following globally threatened or near threatened migratory waterbird species. Red-necked Stint *Calidris ruficollis* (NT), Curlew Sandpiper *Calidris ferruginea* (VU), and Siberian Sand-plover *Anarhynchus mongolus* (EN).

3.3. Other notable biodiversity

In addition to migratory waterbirds, Tonda WMA is known to supports populations of the following Threatened and Near Threatened species; Palm Cockatoo *Probosciger aterrimus* (NT), Fly River Grassbird *Poodytes albolimbatus* (VU). False Water Rat *Xeromys myoides* (VU), Bronze Quoll *Dasyurus spartacus* (NT), Dusky Pademelon *Thylogale brunii* (VU) and Chestnut Dunnart *Sminthopsis archeri* (Data Deficient, only known from N Australia and S Papua New Guinea) are all known to occur.

4. Ecosystem services

4.1. Ecosystem services provided by Tonda WMA

The Tonda Wildlife Management Area (WMA) represents a significant resource for local communities, facilitating livelihoods through the sustainable utilization of its diverse and dynamic ecosystems. Characterized by extensive wetlands, savanna woodlands, rivers, and floodplains, this area is rich in resources. It provides essential goods such as fish, wildlife, and various plant materials that are crucial for subsistence farming, hunting, and gathering. These resources constitute an important component of the local economy and are essential for ensuring food security within the community.

Moreover, the Tonda WMA facilitates regulated commercial enterprises, including the harvest of deer meat, crocodile skins, and an assortment of forest products. Such commodities are available for sale to tourists and local markets, thereby generating significant income for communities that often confront limited economic opportunities. This economic engagement not only sustains family units but also stimulates the broader regional economy.

In addition to its physical resources, the Tonda WMA is rich in cultural and spiritual significance. The conservation of this landscape is integral to safeguarding sacred sites, storytelling locations, and areas rich in cultural heritage, which reinforce traditional practices and foster a robust sense of community identity. The management framework for the area is fundamentally grounded in customary land tenure and indigenous governance structures, thereby empowering local populations to exercise ownership and stewardship over their ancestral lands. The active involvement of communities in the decision-making process and the establishment of management protocols that harmonize conservation objectives with indigenous knowledge further amplify this empowerment.

The Bensbach Tourist Lodge within the WMA has catalyzed additional benefits, contributing to increased employment opportunities, enhanced infrastructure—including airstrips and commercial outlets—and improved access to essential services, such as mail delivery. While the scope of tourism may be relatively modest, it provides a stable source of income, incentivizing the conservation of the area's natural beauty and biodiversity. Additionally, royalties and licensing fees generated from nature-based tourism and regulated hunting are distributed among landowners and community development initiatives, thereby bolstering local welfare and funding community projects.

Ecologically, the WMA plays an essential role in maintaining the health of the region's wetlands and savannas, which support a rich diversity of flora and fauna, including many unique and migratory avian species. The protection of these habitats is critical, as they provide vital ecosystem services, including water regulation, flood mitigation, and fish breeding grounds, all of which are indispensable to the wellbeing of local communities.

4.2. Global climate regulating services

The Tonda WMA is distinguished by its wide variety of habitats, encompassing vast savanna woodlands and grasslands, particularly those characterized by Acacia and Melaleuca species. It also features an array of wetland habitats, including extensive swamps, floodplains, seasonal shallow lakes, and permanent freshwater lakes. Additionally, the Tonda WMA contains significant areas of freshwater swamp forests, flooded gallery rainforests, and paperbark woodlands. The area supports intertidal wetlands with mangrove and nipa palm habitats, sandy beaches along the coast, and extensive seagrass beds and coral reefs offshore. This unique assemblage of habitats implies the ecological importance of the Tonda WMA, which provides climate-regulating services to both global and local communities. However, the carbon storage and sequestration in the Tonda WMA are currently not being studied.

4.3. Coastal protection services

The coastal protection services provided by Tonda WMA were assessed using both biophysical indices and monetary values (see Tables A1 and A2, and Annex 1 for details). When compared to the average of all other coastal areas in Papua New Guinea (Table A3 in Annex 1), Tonda WMA shows some partly mixed results in terms of risk level:

1. for the potential exposure to coastal hazards, Tonda WMA is above average (index: 2.77 vs. 2.27 for all other coastal areas);
2. for the contribution to reducing coastal risk as a proportion of population density with 2.5 km of the coast, Tonda WMA is well below average (0.27 vs. 2.84 people/ha for all other coastal areas); but
3. for the contribution to reducing coastal risk as a percentage of the maximum potential exposure, Tonda WMA is again above average (5.1% vs. 4.6% for all other coastal areas).
4.

In monetary terms (Table A4 in Annex 1), Tonda WMA ranks below the national RFI average (142 vs. 257 USD/ha) in terms of total annual benefits per ha of mangroves. Conversely, these benefits for the total area of Tonda WMA are above average (22 thousand vs. 14 thousand USD for all other coastal areas in Papua New Guinea).

5. Drivers of change and their potential impacts on Tonda WMA

5.1. Current drivers of change and their level of impact

Tonda WMA is presently threatened by the aggregated impacts of mining, illegal hunting and encroachment, which is gradually degrading wetlands within the landscape (Leverington et al. 2017). Notably, a lack of funding for management activities has compromised the protection of the site, with a measurable decline in management effectiveness between 2006 and 2017. Leverington et al. (2017) noted that at the point of gazettement of Tonda, the processes lacked consideration for traditional rights and landowners (see also Eaton 1991), and which has since resulted in conflicts with some landowners due to community land overlapping with the boundaries of the protected area. Through interviews with local stakeholders, Leverington et al. (2017) pointed out that some landowners have never supported the WMA in view of their traditional land rights.

Local stakeholders (see Leverington et al. 2017) have also noted experiences of climate change, for instance,

- "The coconuts and sago die and also many other plants. This is affecting the whole area. People are starting to question and say, 'What next". The coconuts are not going into flower.",
- "… Before there were seasons, but now everything is out of season. Storms and flooding can come at any time – unexpectedly."
- the floods "can remove riparian vegetation, which is the roosting site for birds, which then have to find new habitat".
- In Tonda WMA, "the villages on the coast now flood on the high tides".
- "Saltwater is intruding into the wetlands. It is going into new areas, and the saltwater fish are following them. Saltwater now comes six to seven kilometers upstream (in the past it was only two to three kilometers upstream) ... The native fish are almost gone (no prawns) and the birds that eat them are gone – this is due to the change in fresh to saltwater and the change in color of the water. Villages are inundated with salt water"

Poaching and illegal fishing poses another threat to Tonda's wetland, as noted by Leverington et al. (2017) and Eaton (1991). In Tonda, local people reported that, "outsiders from Indonesia take our fish – they come in with large nets that take a diverse array of species". Introduced and invasive species are considered to be problematic for the area, though introduced pigs are seen as less problematic due to their cultural significance. There is also grazing pressure from introduced deer which regularly enter the wetlands and promote seed dispersal and overgrowth of *Melaleuca* scrub. Poachers are also known to reportedly set fires to cover their escape, and this has caused habitat loss and degradation (Leverington et al. 2017).

Local communities reported; unregulated expansion of settlements across Tonda WMA has been taking place, this has resulted in increasing hunting, gardening and deforestation, and has created disputes over land ownership. Some bush camps are reportedly created by poachers from Indonesia and refugees, catching the large female fish was raised as a concern, since it may impact on fishing tourism. Poaching of deer also takes place (Leverington *et al.* 2017).

The pollutive effects of the OK Tedi mine upstream from Tonda WMA are still being felt. Local people noted that, the "Ok Tedi mine has effluent that enters the WMA. This causes health complications (e.g. birth defects and deformities and skin growths). There is a gas that comes up through the river (it bubbles) – it smells and kills prawns – we don't know what it is". There needs to be a water management plan in place to minimize the impacts." (Tonda WMA in Leverington *et al.* 2017). Overall, community members at Tonda WMA considered it the wetland to be in a 'fair' condition (Leverington et al. 2017), with vegetation land cover having declined from 99.8% in 1996 to 87% in 2013.

5.2. Expected changes in the ecosystem services of Tonda WMA

Papua New Guinea is one of the most vulnerable countries to the effects of climate change (UNDP 2025) and Tonda WMA is no exception. Much of the area is low lying, sea-level rise and saline intrusion will increase in the future. The area is also likely to experience the effects of increasingly strong El Nino Southern Oscillation (ENSO) cycles through floods and drought.

6. Capacity needs in Tonda WMA

At least four stakeholder groups were identified as important to the management of the Tonda WMA wetland ecosystems. Of immediate importance are stakeholders in the national and stakeholders who have jurisdiction over the management of the WMA (e.g. local and district governments; LLGs) and local communities who directly benefit from the site.

Table 2. Expected capacity needs for the management of Tonda Wildlife Management Area.

Stakeholder group	Current role in wetland management	Possible future role in wetland management	Current capacity for sustainable wetland management	Capacity development needed to improve wetland management	Form of capacity development (e.g. training, organizational strengthening etc.)
Local communities	Establish local community groups of end-users (villages within Tonda) to strengthen the management process.	Expand the user network and better understand their needs.	Limited, but there is potential for larger roles in natural resource management, biodiversity monitoring and site protection.	Coordinate the sharing of information between across stakeholders. Use technology to help establish feedback systems on natural resource usage.	Training and awareness programmed to understand natural resource usage across stakeholders
Tourism operators (e.g. fishing lodges)	Attracting high-end tourists, which generates income for the local economy.	Set up cooperatives to organize and regulate local tourism and involve local communities.	Limited.	Support to develop tourism itineraries around existing resources, that expand beyond fishing.	Provide knowledge training for tour guides and operators.
Government: local administrative offices of Western Province.	Oversee the improvement of public infrastructure to access site.	Manage complementary development projects for the site	Capacity to work closely with the local community to seek mandate for managing conflicted areas	Better appreciation of wetland ecosystems	Strengthen the capacity of personnel working with local communities Develop land use and resource use rules (in line with traditional rights) for the local communities.

Stakeholder group	Current role in wetland management	Possible future role in wetland management	Current capacity for sustainable wetland management	Capacity development needed to improve wetland management	Form of capacity development (e.g. training, organizational strengthening etc.)
Government: management of Tonda WMA and CEPA	Protect and monitor the site; enforce regulations.	Enhanced protection for the site through enforcement and local community engagement	Lack of ecological data to inform site management.	Data management to guide site-based management. Local engagement and development of local rules in light with traditional rights.	Strengthen work and collaborations with other stakeholders. Support development of resource use rules with local communities.

7. Opportunities for RFI interventions

7.1. Recommended Interventions

Interventions at the site focus on strengthening site management and protection of Tonda WMA, wildlife research and monitoring, and establishing nature-based tourism.

Table 3. List of proposed interventions for Tonda WMA and possible project indicators

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
Component 1. Strengthening site management and protection of Tonda WMA					
Undertake scoping study of existing interventions and threats at Tonda WMA and adjacent landscapes.	Assessment and scoping guidance to provide basis for proposed management interventions. Threats faced by Tonda WMA and its indigenous people better understood, and potential interventions identified.	Assessment report with key threats identified and recommendations for improved management published and disseminated to key stakeholders. Number of stakeholder meetings	100,000	2 years	CEPA Western Province (Westen Provins) government South Fly District (and Morehead Rural LLG)

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		conducted in the scoping study. Number of stakeholder groups engaged in the scoping study, ensuring a participatory assessment of existing interventions and threats.			Tonda WMA management authority Research institutions ADB
Strengthen site management through the development of a community led management plan.	Tonda WMA is better managed through the development of the site management.	Site management plan over short to medium-term developed and finalized for implementation, in consultation with key stakeholders, including communities inside the site. Number of stakeholder consultation workshops organized with local communities (at least 100 households engaged)	200,000	3 years	CEPA Western Province (Westen Provins) government South Fly District (and Morehead Rural LLG) Tonda WMA management authority Community groups Conservation organizations
	Tonda WMA is better protected through local community ranger groups.	Local by-laws linked to the site management plan regularly updated in consultation with local communities (75%). Conservation and ranger groups established in each community, and effectively functioning	500,000	3 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		Number of people engaged in the protection of Tonda WMA			
Component 2. Wildlife research, monitoring and management					
Strengthen knowledge on biodiversity, with a focus on waterbirds, large mammals.	Biodiversity in Tonda WMA is better protected through improved understanding of biodiversity, particularly on waterbirds and large mammals.	Number of locally led (rapid) field surveys (including boat-based and land-based surveys) of waterbirds populations. Number of local researchers and stakeholder groups engaged in field research and reports on status of biodiversity. Awareness-raising program on nature protection, with a focus on waterbirds and large mammals. Number of awareness activities (including workshops and WMBD activities) on importance of nature protection, with a focus on charismatic bird species. Number of people engaged in the awareness-raising activities	100,000	2 years	Western Province (administration) South Fly District (and Morehead Rural LLG) Tonda WMA management authority Research institutions (University of Papua New Guinea)
Strengthen biodiversity and wetland	Better monitoring of biodiversity and wetland ecosystems in	Biodiversity monitoring framework and	100,000	5 years	Western Province (administration)

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
monitoring, with a focus on waterbirds, through community-led initiatives	the landscape through biodiversity monitoring mechanisms.	mechanism established. Biodiversity monitoring programmes developed and implemented. Number of monitoring activities conducted using the established biodiversity and wetland monitoring scheme. A locally led conservation group organized			South Fly District (and Morehead Rural LLG) Tonda WMA management authority Research institutions (University of Papua New Guinea) Local community groups.
Strengthen wildlife protection and enforcement at Tonda WMA. (see also component 1)	Improved wildlife protection and enforcement at Tonda WMA through co-management framework with greater involvement of local stakeholders, increased patrol and enforcement efforts for landscape, wildlife protection and encroachment activities, and increased capacity of local rangers	Co-management framework with local communities developed. Number of households (target of at least 50% households in site) engaged and actively participating in co-management activities. Training program and modules on patrol and enforcement developed Number of training activities conducted Number of local rangers trained on patrolling and enforcement.	200,000	5 years	Western Province (administration) South Fly District (and Morehead Rural LLG) Tonda WMA management authority Community groups

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
Component 3. Strengthen tourism infrastructure and local capacity for specialized, nature-based tourism					
Assess the potential for ecotourism (or nature-based tourism) expansion at Tonda WMA	Assessment and scoping guidance to provide basis for expanding ecotourism (or nature-based tourism) at Tonda WMA.	Assessment report of developing additional tourism infrastructure in Tonda WMA developed, published, and disseminated with key stakeholders Number of stakeholder meetings with local community groups conducted. Number of stakeholder groups engaged in the scoping study, ensuring a participatory assessment.	100,000	1 year	CEPA PNGTPA Western Province (administration) South Fly District (and Morehead Rural LLG)
Strengthen the capacity of local communities (in key villages) and businesses for nature-based tourism (i.e. fishing lodges)	Impact of habitat degradation caused by tourism activities in the landscape reduced through the local strategies on nature-based tourism and strengthened capacity of local communities. Nature-based tourism as a source of livelihood strengthened, benefiting at least XX households.	Provincial-level tourism plans and strategies updated with relevant tourism stakeholders. Number of training activities implemented to strengthen local capacity and tourism management skills of households to support domestic and international tourists (e.g. local nature guides) Training program on nature-based	300,000	5 years	PNGTPA South Fly District (and Morehead Rural LLG) Tonda WMA management authority Local community groups Conservation organizations Research institutions (UPNG)

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		tourism/ ecotourism developed Number of stakeholders trained on tourism management Framework for benefits-sharing from nature-based tourism enhanced for local households. Number of stakeholder groups engaged in the framework development for nature-based tourism/ ecotourism Ecotourism strategy and business plans and packages on specialized wildlife/nature tourism and tested with tourism operators (including international bird and wildlife tour companies) developed Number of packages on specialized wildlife/ nature tourism tested with tourism operators. Number of key stakeholders engaged in tourism-related activities engaged.			

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
Total investment for 5 years			5,600,000		

7.2. Potential Financing

The estimated project cost is USD 5,600,000 over a 5-year period. This project budget supports local assessments and scoping studies, development of plans on site management, tourism, and a co-management framework, capacity-building activities on wetland research, nature-based tourism, and biodiversity awareness, and patrolling, upgrading tourism infrastructure, and biodiversity monitoring.

7.3. Proposed Institutional Arrangements

The proposed project is expected to be implemented over a period of at least five (5) years, with the main project components focusing on improving community-led management of Tonda WMA, biodiversity conservation and tourism enhancement.

7.4. Project Beneficiaries

This proposed project is expected to undertake activities to promote gender inclusion and participation in community development activities, with a particular focus on the Morehead People, the main tribal group in the Tonda landscape.

7.5. Anticipated Implementation Risks

Environment: Nature-based tourism has been identified as a key project concept theme. The proposed interventions include assessing and upgrading infrastructure that would improve tourism experience in Tonda WMA. Building these infrastructures, however, would induce noise that may disturb the wildlife in the area. Moreover, increasing tourism activities bring other human-induced impact, especially in the Bensbach Lodge. Planning with the stakeholders is critical before any infrastructure development and tourism management.

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Annex 1. Supplementary information on coastal protection services

To further validate the identification of the top ecosystem services by means of stakeholder consultation, an expectedly essential or non-substitutable regulating service across all RFI sites, namely coastal protection and flood mitigation (i.e., storm and flood hazard regulation), was assessed based on a combination of globally available datasets supplemented by web-based tool Co$tingNature (Mulligan, 2022). Estimates for coastal protection by mangroves (after the effects of coral reefs) were spatially inferred in QGIS from a selection of metrics expressing different biophysical and monetary values modelled by Chaplin-Kramer et al. (2023) and Menéndez et al. (2020), respectively.

The key metrics selected for biophysical values (Table A1) were current maximum potential exposure to coastal hazards, which is a vulnerability risk index calculated in InVEST[1] for several hazard variables (i.e., wind, waves, sea level rise, geomorphology, and bathymetry) in the hypothetical absence of current mangrove extent, and nature's (i.e., the mangroves') contribution to reducing this coastal risk, both as an absolute value multiplied by the local population affected and a percentage of the maximum potential exposure.

Table A1. Contribution of mangroves to coastal protection as a critical natural asset in Tonda WMA based on site-level (biophysical) values inferred from Chaplin-Kramer et al. (2023) and expressed as ranges to represent the resulting uncertainty. Key metrics are in italics.

Critical contribution of mangroves to coastal protection (metrics)	Risk levels
Current population density within 2.5 km of the coast (number of people per hectare)	1.1 – 2.7
Current maximum coastal risk to be mitigated, or potential exposure to coastal hazards (unitless index)	*2.29 - 2.64*
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #1 'Sustainability' (unitless index)	2.57 - 2.97
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #3 'Regional Rivalry' (unitless index)	2.75- 3.17
Maximum coastal risk to be mitigated, or potential exposure to coastal hazards in 2050 according to IPCC's Shared Socioeconomic Pathway #5 'Fossil-fueled Development' (unitless index)	3.00 - 3.45
Current proportional risk reduction, nature's contribution to reducing coastal risk as a proportion of maximum coastal risk (unitless index)	0.15 - 0.17
Nature's contribution to reducing coastal risk as a proportion of population density within 2.5 km of the coast (# of people per hectare)	*3 - 9*
Nature's contribution to reducing coastal risk as a percentage of the maximum potential exposure (%)	*0.06 - 0.07*

The key metrics selected for economic values (Table A2) were the annual expected flood protection benefits to total stock, which is the monetary value of the averted damages to the industrial and residential stocks (i.e., property) in 2015 US$, the same total annual benefits expressed per hectare of mangroves, and the total benefits in the event

of a 100-year return period storm, which are the rarest of cyclonic conditions but cause the most flood damages to property (i.e., maximum level of coastal protection by mangroves).

Table A2. Coastal protection benefits offered by mangroves in Tonda WMA based on site-level (monetary) values inferred from Menéndez et al. (2020) and expressed as ranges to represent the resulting uncertainty. Key metrics are in italics.

Benefits of mangroves in terms of coastal protection (metrics)	Avoided costs (US$)
Mangrove extent (hectares)[2]	8,242 – 23,318
Annual expected flood protection benefits to people (number of people)	(7) – 13
Annual expected flood protection benefits to Industrial Stock (US$)	(25,613) – 47,056
Annual expected flood protection benefits to Residential Stock (US$)	(28,329) – 52,046
Annual expected flood protection benefits to Total Stock (US$)	*(52,518) – 96,485*
Annual expected flood protection benefits to Industrial Stock per hectare of mangroves (US$ per hectare)	*(1*82) - 335
1-in-100-year return period damage in terms of area flooded (number of hectares)	(9) – 22
Total expected flood protection benefits of mangroves per 100-year return period storms (US$)	*(68,264) – 158,113*

Table A3. Biophysical benefits from RFI coastal wetland sites (expressed as ranges to represent the resulting uncertainty) and at the national level.

Site name	Max pot exp (index)	Risk reduction (index * pop)	Risk reduction (% max pot exp)
Tonda WMA	2.77	0.27	5.07
Papua New Guinea RFI average	2.77	0.27	5.07
Papua New Guinea national average	2.27	2.84	4.61

Table A4. Monetary benefits from RFI coastal wetland sites (expressed as ranges to represent the resulting uncertainty) and at the national level.

Site name	Total annual benefits (US$)	Per mangrove area (US$/ha)	For 100-yr return period storms (US$)
Tonda WMA	21,984 (±74,502)	142 (±481)	44,924 (±113,189)
Papua New Guinea RFI average	21,984	142	44,924
Papua New Guinea RFI total	21,984	Not Applicable	44,924
PNG national average	14,392	257	77,353