



# Regional Flyway Initiative · Site Study

January 2026

## **RFI Priority Site · Huai Chorakhe Mak**

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## General Site Information

Country	Thailand		
RFI Site Name	Huai Chorakhe Mak	ID130	
City/ Municipality, Province, Region	Mueang district and Sakae Phrong subdistrict, Buri Ram Province		
Geographical coordinates	14.90 N, 103.03 E	Area (has)	631 ha
Key species	Sarus Crane. Congregations of waterbirds dependant on freshwater wetlands (e.g. Asian Openbill)		
Key habitats (biomes)	Reservoirs, relatively little emergent or aquatic floating vegetation in the reservoirs and some patches of dry dipterocarp woodland		
Key ecosystem services	Provisioning and regulating services (water storage); also, cultural services (for nature-based tourism)		
Key drivers of change	Agricultural intensification, invasive species. Climate change (increased risk of droughts)		
Conservation status (mark all that applies)	<input checked="" type="checkbox"/>	Protected Area	<input type="checkbox"/>
	<input type="checkbox"/>	Ramsar Site	<input type="checkbox"/>
IBA/ KBA name (and number) and other designations	NA		
Management Stakeholders	Department of Wildlife and National Parks, Buri Ram Provincial Government, Mueang Buri Ram district government; agriculture and irrigation departments		
With management plan?			
Project concept themes	Rice agriculture, improved site management		
Length of project	10 years		
Sector/s	Agriculture		
No. of potential beneficiaries			
Indigenous Peoples	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
Anticipated Implementation Risks	Construction of water and ecotourism infrastructure may impact wildlife.		
Estimated Project Budget (US\$)	14,550,000		
Potential Source/s of Financing	<input checked="" type="checkbox"/>	Loan (to be identified)	<input type="checkbox"/>
	<input type="checkbox"/>	Grant	<input type="checkbox"/>

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## Acronyms

ADB	Asian Development Bank
AWC	Asian Waterbird Census
BCST	Bird Conservation Society of Thailand
CSR	Conservation Status Review
DOF	Department of Fisheries
DMC	Developing Member Country
DWNP	Department of Wildlife, National Parks and Plant Resources
DWR	Department of Water Resources
EAAFP	East Asian-Australasian Flyway Partnership
IBA	Important Bird and Biodiversity Area
IUCN	International Union for the Conservation of Nature
MNRE	Ministry of Natural Resources and Environment (Thailand)
NHA	Non-hunting Area
NGO	Non-governmental Organisation
ONEP	Office of Natural Resources and Environmental Policy
RID	Royal Irrigation Department
RFI	Regional Flyway Initiative
TAO	<i>Tambon</i> Administrative Organisation
TESSA	Toolkit for Ecosystem Services Assessment
USD	United States Dollars
ZPOT	Zoological Park Organisation of Thailand

## Executive summary

Huai Chorakhe Mak and Huai Talad are two reservoirs and their associated wetlands created by the damming of several small streams in Buri Ram, northeast Thailand. The sites are situated about 1 km apart and are located about 11 km from the provincial town of Buri Ram (*Mueang* Buri Ram). There is relatively little emergent or aquatic floating vegetation in the reservoirs and limited edge vegetation, and most of the land in the surrounding landscape is under rice cultivation. Both sites are protected and managed by the Department of Wildlife and National Parks (DWNP) as Non-Hunting Areas although this includes only the area up to the reservoir shoreline and does not encompass any adjacent land. The wider landscape around the site is important for waterbirds dependent on freshwater wetlands, with known congregations of the Asian Openbill and the threatened, Yellow-breasted Bunting (CR). Huai Chorakhe Mak and Huai Talad reservoirs, together with Sanam Bin, are the site of a well-known reintroduction programme for the Sarus Crane (ssp. *sharpii*) (VU), a species extirpated in Thailand since the 1980s. This initiative is a collaboration between the Government of Thailand, ZPOT, Nakhon Ratchasima Zoo (Korat Zoo) and several academic institutions. The sites were chosen partly thanks to their natural proliferation of water chestnuts which is a key, natural food resource for the cranes. The headquarters of the Non-Hunting Area is at the Wetland and Sarus Crane Conservation Centre, which coordinates the monitoring of the reintroduced Sarus Crane population and other waterbirds, and organises awareness activities.

Both the Huai Chorakhe Mak and Huai Talad reservoirs inevitably offer critical provisioning, regulating, and cultural ecosystem services, which are all projected to increase in importance in the future with (rice) agricultural intensification in the landscape around the sites. The provisioning services, particularly fresh water and food, primarily benefit communities around the site; they have increased in the past and are expected to continue increasing. Regulating services, particularly flood hazard regulation, also benefit communities within the site. In recent years, the wetlands have drawn increasing volumes of domestic tourists, highlighting the potential of Huai Chorakhe Mak for nature-based tourism.

To improve conservation and management at the site, there is a need for: (1) strengthening management and legal protection of the wider landscape around the Huai Chorakhe Mak wetlands; (2) continued monitoring of Sarus Cranes and wetland biodiversity, and (3) strengthening invasive species management with a focus on Giant Mimosa. Further growth is anticipated in the tourism sector at the reservoirs, including expansion of facilities targeting domestic tourists. To address this, there is scope to (1) improve ecotourism infrastructure at the reservoirs, including signage and viewing structures; and (2) strengthen the capacity of local communities and tourism businesses for nature-based tourism opportunities. Recent studies show that less than 5% of rice cultivation in Buri Ram (for jasmine rice) is organic. There is considerable potential to work with the local government (at the subdistrict or *tambon* level) and local communities to, (1) scale up of organic and biodiversity-friendly rice-farming in the subdistricts surrounding Huai Chorakhe Mak and, (2) improved management of agro-chemical waste in the rice paddies around Huai Chorakhe Mak to address agro-chemical pollution in the wetlands.

## 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). The team further developed ecosystem services profiles for prioritised wetlands using a multi-pronged approach used the TESSA ecosystem services assessment tool, and data-driven modelling of water-based ecosystem services and stored carbon.

In Thailand, a total of 36 wetland sites, including several Asian Waterbird Census (AWC) count sites, were initially assessed through data analysis and expert consultation, of which 18 were short-listed for assessment. Of this pool of sites, twelve (12) were defined and identified to be RFI priority sites on the basis that they support over 1% the flyway population of at least one EAAF migratory waterbird species. Nine (9) of the RFI sites identified are coastal wetlands, a consequence of the country's long coastline

along the Gulf of Thailand and Peninsular Thailand, with the largest cluster of priority sites concentrated in the Inner Gulf of Thailand (four: Pak Thale-Laem Pak Bia, Khok Kham, Bang Pu, Khlong Tamru). Three inland (freshwater) wetlands are distributed in Nakhon Sawan and Buri Ram provinces, identified for their important to species such as Baer's Pochard (CR) and Sarus Crane (VU). 15 EAAF species exceeded the 1% threshold at the site level in Thailand, with species such as the Spotted Greenshank (EN) exceeding 10% of the estimated population in just one site (Laem Pak Bia) on a regular basis. Other species with important non-breeding populations in Thailand includes Spoon-billed Sandpiper (CR), Great Knot (EN), and Sarus Crane.

## 2. Site profile of Huai Chorakhe Mak Reservoir

*Location:* The Huai Chorakhe Mak and Huai Talad Non-Hunting Areas (NHA) are located 11 km southwest of the town of Buriram, in Mueang Buriram District, Buriram Province, northeastern Thailand (see Figure 1).

*Area:* The Huai Chorakhe Mak Non-Hunting Area covers an area of 631 ha. Huai Talad Non-Hunting Area covers slightly over 700 ha.

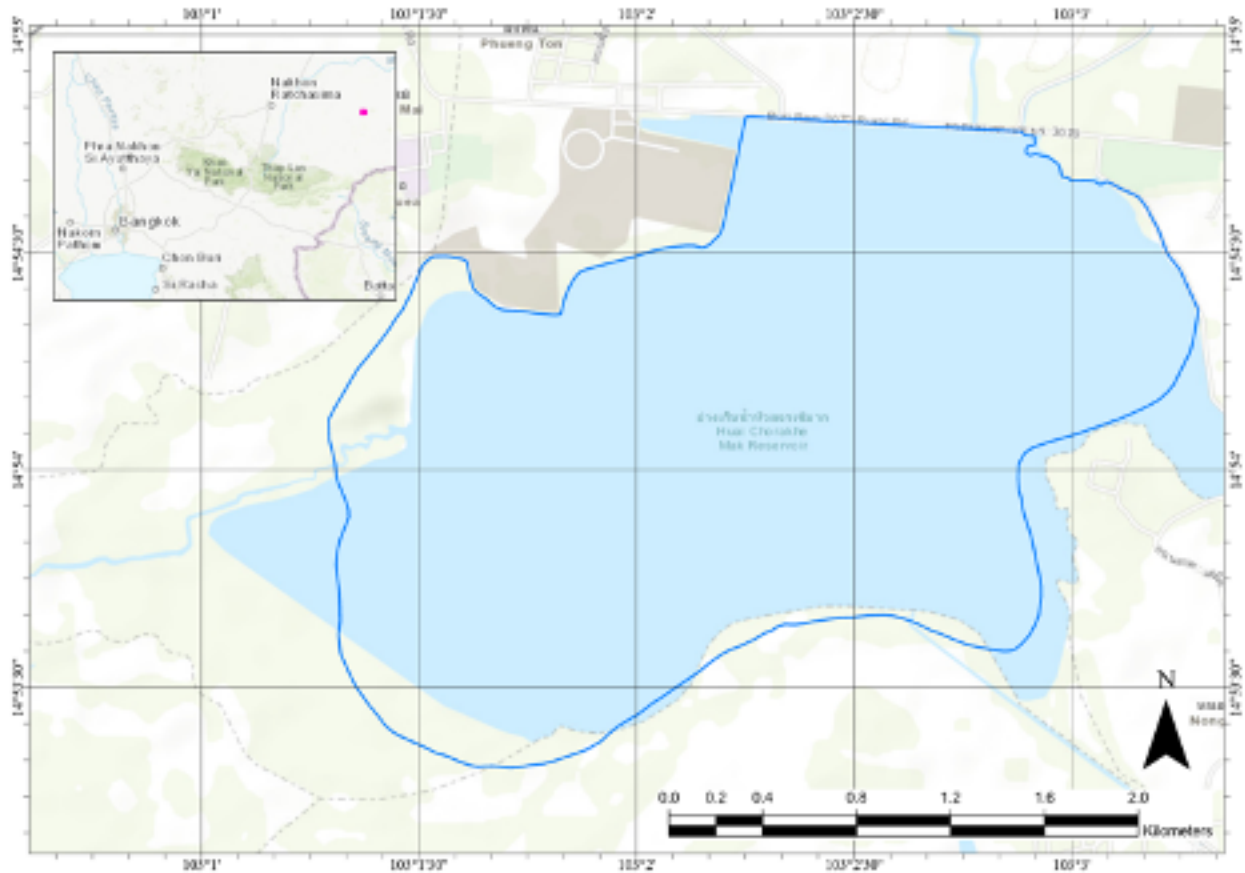
*Altitude:* Approximately 160 m asl.

*Geographical coordinates:* 14.90° N, 103.03° E

*Description of site:* This site includes two reservoirs that were created in about 1975 by the damming of several small streams, which are situated about 1 km apart on an extensive floodplain. The average depth of the water is 5-7 m with a seasonal fluctuation in water level of approximately 2 m, and the area of open water diminishes by approximately 25% during the dry season, when much dense weed and some mud is exposed. There is relatively little emergent or aquatic floating vegetation in the reservoirs and no permanent marshland. There are some patches of dry dipterocarp woodland in surrounding areas, but most of the land is under cultivation, mainly for rice.

*Site administration, management and land tenure:* The two reservoirs are under public ownership and were declared as Non-Hunting Areas in 1980, but this only includes those areas up to the shoreline and does not encompass any adjacent lands. The surrounding areas are privately owned, and smallholdings abut onto the shores of the reservoirs. The headquarters of the Non-Hunting Area are in the Wetland and Sarus Crane Conservation Centre, which is situated at Huai Chorakhe Mak. This centre coordinates the monitoring and study of the introduced Sarus Crane population and organises awareness activities to convey the importance of preserving the cranes and the wetlands through the engagement of the local community.

*Social and economic values:* The principal economic activity Huai Chorakhe Mak and Huai Talad are the cultivation of rice, with one crop of wet-season (rainfed) rice produced per year. Wet rice cultivation is the dominant crop across Northeast Thailand, and the extent of land under rice cultivation in Buri Ram in 2019 is estimated at 501,000 ha, or slightly half the area of the province; about 3.59% of Buri Ram’s rice production is certified as organic (Faculty of Economics, Khon Kaen University 2022). Some plots of vegetables are grown on areas of the shoreline which are exposed by receding waters in the early dry season. Other activities there are the raising of ducks and the collection of aquatic plants to feed pigs. The Wetland and Sarus Crane Conservation Centre create economic opportunities for the local people through nature-based tourism.



*Figure 1. Map of Huai Chorakhe Mak Reservoir, showing its boundary (in blue) and location within Thailand (in pink) (data from EAAFP Site Information Sheet; map: Evelyn Pina Covarrubias).*

### 3. Biodiversity value of Huai Chorakhe Mak Reservoir

#### 3.1. Key habitats

Huai Chorakhe Mak Reservoir has been created in about 1975 by the damming of several small streams, which are situated about 1 km apart on an extensive floodplain. There is relatively little emergent or aquatic floating vegetation in the reservoirs and no permanent marshland. There are some patches of dry dipterocarp woodland in the surrounding areas, but most of the land is under cultivation, mainly for rice.

#### 3.2. Importance of Huai Chorakhe Mak Reservoir for migratory waterbird species

Huai Chorakhe Mak and the adjacent Huai Talad Non-Hunting Areas are the sites for a reintroduction programme for the globally threatened eastern population of Sarus Crane (see Sankhom et al. 2018), a species until recently extirpated from the wild in Thailand. This programme is a collaboration between the Government of Thailand, Nakhon Ratchasima Zoo (Khorat Zoo) and several academic institutions, which began in 1989 and made the first crane reintroduction in 2011. Both reservoirs were chosen partly thanks to their natural proliferation of water chestnuts *Eleocharis* spp., which provide a stable food source for the cranes.

*Table 1. List of migratory species (based on the EAAFP list of species) with globally significant congregations in Huai Chorakhe Mak Reservoir.*

Scientific name	IUCN	Average count	CSR1	CSR1 score
Sarus Crane <i>Antigone antigone sharpii</i>	VU	10	2	5.0

Data from a single AWC count (BCST-AWC-2018) was available for the RFI analysis of Huai Chorakhe Mak Reservoir. The Sarus Crane was the only migratory waterbird species found to regularly exceed the 1% population estimate, and the CSR1 score for this species provided the overall site score. Other data sources suggested that the site also support large congregations of the Asian Openbill *Anastomus oscitans*, although counts do not meet the 1% threshold of that species' population.

### 3.3 Other notable biodiversity

The site supports small numbers of Yellow-breasted Bunting *Emberiza aureola* (CR) during the winter period, and regular congregations of several migratory birds-of-prey, especially Harriers *Circus* spp. There is little information on the mammal and reptile fauna of the site, but there have been several studies assessing the aquatic invertebrate fauna of both reservoirs (e.g. Rodmongkoldee et al. 2009).

## 4. Ecosystem services

### 4.1. Ecosystem services provided by Huai Chorakhe Mak Reservoir

The Huai Chorakhe Mak Reservoir supports diverse freshwater habitats that provide valuable provisioning, regulating, and cultural ecosystem services (Figure 2). The results from the RFI workshop<sup>1</sup> highlights the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Provisioning services, such as fresh water and food (fish and prawns harvested from the reservoir), primarily benefit communities within the site, especially artisanal fishermen. Both services have experienced an increase in the past and are expected to continue increasing in the future, indicating their growing importance for local populations. Regulating services, particularly flood hazard regulation, benefit communities within the site. This service has seen an increase in the past and is projected to keep increasing, reinforcing its crucial role in mitigating environmental risks. Cultural services, including recreation ecotourism and knowledge systems and education, provide significant benefits. Recreation and ecotourism primarily benefit adjacent communities and have shown an increase in the past, with further growth anticipated. Knowledge systems and education benefit communities within the site, with increases in both the past and expected future, highlighting the site's importance for local learning and development.

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<sup>1</sup> Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. <https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop>

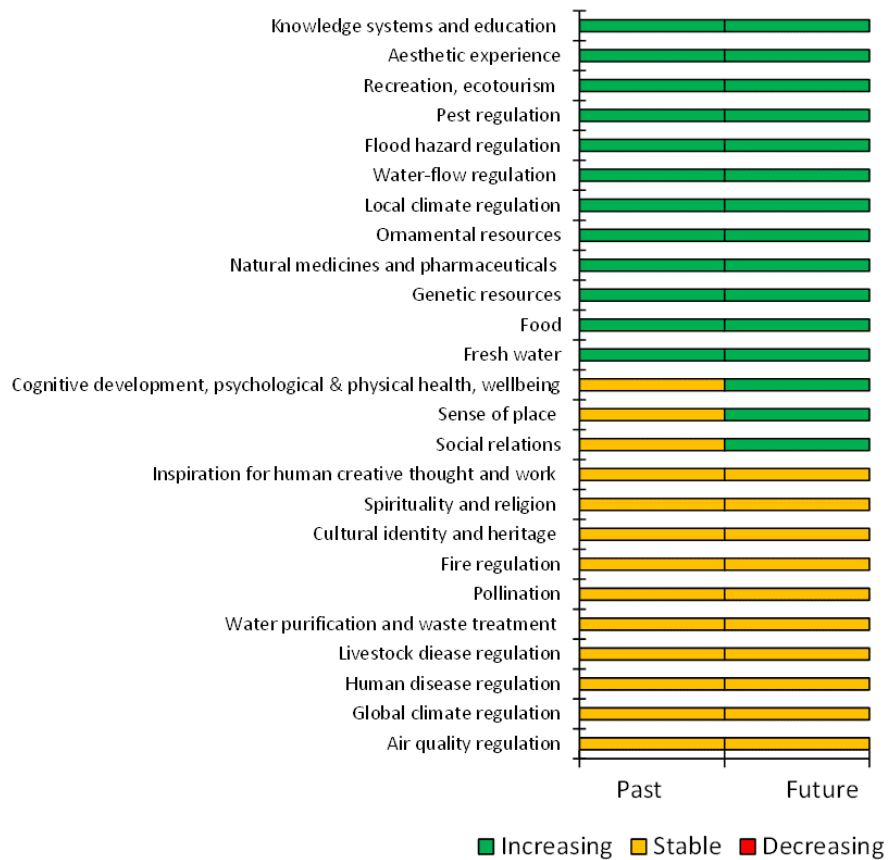


Figure 2. List of ecosystem services provided by Huai Chorakhe Mak Reservoir, as identified through stakeholder consultation at the Regional Flyway Initiative workshop in 2023.

Table 2. List of top ecosystem services provided by Huai Chorakhe Mak Reservoir.

Ecosystem services	Essential or non-substitutable	Benefits to communities			Change	
		Within the site	Adjacent to the site	Distant to the site	Past	Future
<i>Provisioning services</i>						
Fresh water	Yes	✓			Increase	Increase
Food	Yes	✓			Increase	Increase
<i>Regulating services</i>						
Flood hazard regulation	Yes	✓			Increase	Increase
<i>Cultural services</i>						
Recreation, ecotourism	Yes		✓		Increase	Increase

Knowledge systems and education	Yes	✓			Increase	Increase
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#### 4.2. Flood mitigation services

The flood mitigation services provided by Huai Chorakhe Mak Reservoir were assessed using biophysical values only (see Table A1 and Annex 1 for details). When compared to both the average of the three RFI inland sites and the average of all other inland wetlands in Thailand (Table A2 in Annex 1), Huai Chorakhe Mak Reservoir shows some consistent results in terms of benefits and beneficiaries:

- (1) for the average green storage capacity per sq. km of wetland, Huai Chorakhe Mak Reservoir is below average (95 Giga Litres or GL of water per km<sup>2</sup> vs. 226 GL/km<sup>2</sup> for RFI inland sites and 216 GL/km<sup>2</sup> for all other inland wetlands);
- (2) for the average population uniquely benefitting from influential green storage upstream per sq. km of wetland, Huai Chorakhe Mak Reservoir is also below average (24 vs. 251 people/km<sup>2</sup> RFI inland sites and 202 people/km<sup>2</sup> for all other inland wetlands); and
- (3) for the average built-up area uniquely benefitting from influential green storage upstream per sq. km of wetland, Huai Chorakhe Mak Reservoir is again well below average (0.99 ha/km<sup>2</sup> vs. 12.42 ha/km<sup>2</sup> for RFI inland sites and 11.30 ha/km<sup>2</sup> for all other inland wetlands).

### 5. Drivers of change and their potential impacts on Huai Chorakhe Mak Reservoir

#### 5.1. Current drivers of change and their level of impact

Stakeholders at the RFI workshop<sup>2</sup> identified several drivers of change impacting Huai Chorakhe Mak. Table 3 highlights these key drivers and their corresponding levels of impact on the wetland site. Medium-impact drivers include annual and perennial non-timber crop production, which alters land use and affects habitat quality. Droughts pose a significant threat to water availability and the overall health of the ecosystem. Biological resource use, such as fishing, killing, and harvesting of aquatic resources, contributes to a moderate impact on biodiversity. Recreational activities, tourism, and the development

<sup>2</sup> Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. <https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop>

of related infrastructure further modify the site. Other medium-impact factors include storm and flooding events, temperature extremes, and research, education, and other work-related activities.

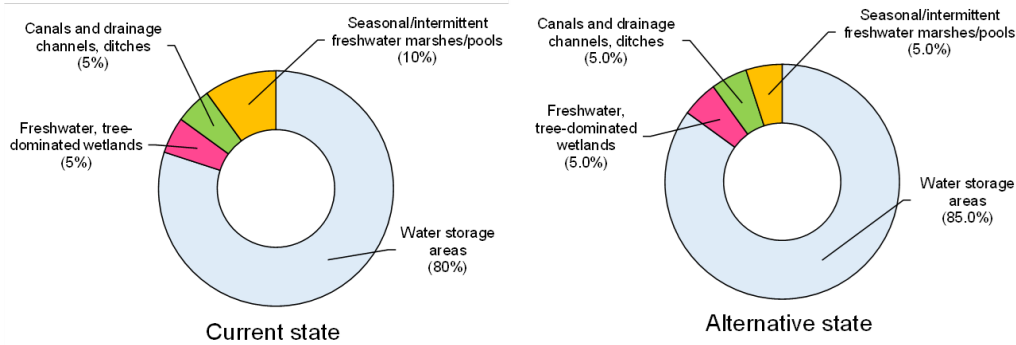
**Table 3. Drivers of change and their potential impact on the integrity of Huai Chorakhe Mak Reservoir based on consultations with stakeholders.**

Driver of change	Impact
Annual and perennial non-timber crop production	<b>Medium</b>
Droughts	
Fishing, killing and harvesting of aquatic resources	
Recreational activities and tourism	
Research, education and other work-related activities	
Storm and flooding	
Temperature extremes	
Tourism and recreation infrastructure	
Agricultural and forestry effluents	<b>Low</b>
Collecting terrestrial plants or plant products (non-timber)	
Drought conditions	
Erosion and siltation/deposition	
Excess ponding of water onsite	
Garbage and solid waste	
Habitat clearing	
Hunting, killing and collecting of terrestrial animals	
Invasive plant species	
Livestock farming and grazing	
Marine and freshwater aquaculture	
Roads and railroads	
Utility and service lines	
Water extraction/diversion within the wetland site or catchment	

## 5.2. Potential alternative state of Huai Chorakhe Mak Reservoir under current drivers of change

Stakeholders at the RFI workshop<sup>3</sup> defined the most plausible future alternative state (to 2035), and how this will translate to a net change in the cover of different types of wetland habitat types within this site (current habitat cover vs future alternative cover; Figure 3). The alternative state of the site assumes there will be no changes in the current drivers of change impacting the site, and the current management regime.

<sup>3</sup> Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. <https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop>



**Figure 3. The proportional change in the extent of different habitat types between the current and alternative states of Huai Chorakhe Mak Reservoir.**

### 5.3. Expected changes in the ecosystem services of Huai Chorakhe Mak Reservoir

Stakeholders at the RFI workshop<sup>4</sup> documented the future trends in the provision of ecosystem services in Huai Chorakhe Mak Reservoir, indicating if the ecosystem services provided by this site (to 2035) will increase, decrease, or will remain stable if the current drivers of change impacting this site will continue in their present condition, with the intervention remains unchanged.

Provisioning services, particularly food provision, are expected to increase in the long term (see Figure 2 and Table 2), with the intensification of rice production. However, there is concern that regulating services, such as air quality and global climate regulation, as well as flood and storm hazard regulations may decrease in the long term, while cultural services, particularly recreation and tourism, remain stable.

Huai Chorakhe Mak Reservoir includes diverse habitats that provide valuable provisioning, regulating, and cultural ecosystem services (Figure 2). The results from the RFI workshop<sup>5</sup> highlights the top ecosystem services provided by the site, emphasising their essential and non-substitutable nature (Table 2). Provisioning services, such as fresh water and food, primarily benefit communities within the site. Both services have experienced an increase in the past and are expected to continue increasing in the future, indicating their growing importance for local populations. Regulating services, particularly flood hazard regulation, benefit communities within the site. This service has seen an increase in the past and is projected to keep increasing, reinforcing its crucial role in mitigating environmental risks. Cultural services, including recreation ecotourism and knowledge systems and education, provide significant benefits. Recreation and ecotourism primarily benefit adjacent communities and have shown an increase in the past, with further growth anticipated. Knowledge systems and education benefit communities

<sup>4</sup> Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. <https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop>

<sup>5</sup> Asian Development Bank. (2023, November 27-29). Thailand: Wetland Ecosystem Services Workshop [Workshop]. Thailand. <https://events.development.asia/learning-events/thailand-wetland-ecosystem-services-workshop>

within the site, with increases in both the past and expected future, highlighting the site's importance for local learning and development.

A net loss of 31.5 hectares of green water habitats (Table A5) due to conversion to reservoir area, specifically from seasonal/intermittent freshwater marshes/pools, is expected to result in an effective reduction of 25.1% or 23.9 Giga Litres of green storage capacity per km<sup>2</sup>. This loss, calculated relative to the core green water habitat area, may amount to nearly 6.1 people and 0.25 hectares of built-up areas losing flood mitigation benefits per km<sup>2</sup> of wetland.

## 6. Capacity needs in Huai Chorakhe Mak Reservoir

The stakeholder consultation and analyses with government and civil society stakeholders identified at least three stakeholder groups with clear roles in the long-term sustainable management of Huai Chorakhe Mak wetlands. Table 4 summarizes the current and potential roles of these stakeholder groups in relation to the management of the Huai Chorakhe Mak wetlands. There are opportunities to strengthen tourism, water quality monitoring, and others to be identified with local communities.

*Table 4. Capacity needs for the management of Huai Chorakhe Mak, based on RFI stakeholder consultations.*

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, organisational strengthening etc.)
Government: Department of National Parks, Wildlife and Plant Conservation (DWNP)	Conserve, restore, protect, and maintain site.	Support and manage the expansion of tourism (and levies)	Management and oversight for:  Nature-based tourism (e.g. for Sarus Crane)	Improve facilities for tourism.  Training to improve the water basin quantity/quality monitoring system.	Provide training for the communities/ and educational bodies in the proximity.
Government: Department of Fisheries	Fish stocking of reservoir (for local communities)	Continued work to stock fish in the reservoirs.	Agriculture (e.g. organic rice production)		RPR Ambassador programme.  Training programmes and workshops on nature-based tourism, and storytelling.
Government: Royal Irrigation Department (RID)	Management water storage. (too little water may cause ecosystem degradation)	Undertake expansion and dredging works to expand water storage capacity.  Stronger management of water supply in the area of irrigated land.			
Government: Provincial Waterworks Authority.	Clean water production.	Improve management on water production, and	-	-	-

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, organisational strengthening etc.)
		supply of water to surrounding communities			
Local communities (end users)	Support organic farming.  Unrestrained use of water supply.	Work to reduce the use of agro-chemicals to address water pollution.  Work with stakeholders to improve guidelines for water use.	-	-	-
Zoological Park Organization of Thailand (ZPOT).	Sarus crane conservation and breeding program.	No change	-	-	-

## 7. Opportunities for RFI interventions

### 7.1. Recommended Interventions

Huai Chorakhe Mak and Huai Talad Non-Hunting Areas, together with Sanam Bin, are among two sites chosen for the reintroduction of the Sarus Crane in Thailand, facilitated by the DWNP and the ZPOT. The reintroduction programme has now established a population of over 100 individuals at both sites. A Wetland and Sarus Crane Conservation Centre have been established at Huai Chorakhe Mak reservoir, which coordinates the monitoring and study of the introduced Sarus Crane population and organises awareness activities to convey the importance of preserving the cranes and the wetlands. To improve the conservation and management of Huai Chorakhe Mak and Huai Talad, there is a need for, (1)

strengthening legal protection and management of both sites, and (2) continuation monitoring of Sarus Crane population and raising awareness of the cranes and wetland ecosystems.

Following the reintroduction of Sarus Crane, Huai Chorakhe Mak has become an important tourist attraction. A Wetland and Sarus Crane Conservation Centre have been established there, which coordinates the monitoring and study of the Sarus Crane population and organises awareness activities to convey to local people and tourists the importance of preserving the cranes and the wetlands. Nasa & Hassan (2016) rated Huai Chorakhe Mak and Huai Talad as a natural site of ‘moderate’ importance for ecotourism in Buri Ram. It is anticipated that there will be further growth in recreation, tourism and educational activities at the reservoirs in the future, including provision of accommodation for visitors and small-scale tourism operations run by local people. Future ecotourism activities are anticipated to include (1) Improvement of ecotourism infrastructure at Huai Chorakhe Mak, including boardwalks, signages and viewing structures; and (2) Building capacity of local communities and businesses to develop small-scale tourism operations.

The principal land-use activity in the landscape surrounding Huai Chorakhe Mak is (wet season, rainfed) rice cultivation, and the scale of rice production is anticipated to intensify. The farmers at this site currently use agro-chemicals on their rice crops, leading to an inflow of chemical waste into the wetland. There is considerable potential to work with the local communities to (1) scale up organic and/or biodiversity-friendly rice-farming in the rice paddies that surround the sites using wildlife-friendly approaches; and (2) Improved management of agro-chemical waste in the rice paddies around Huai Chorakhe Mak.

**Table 5. Summary of key RFI interventions proposed for Huai Chorakhe Mak Reservoir**

<b>Intervention</b>	<b>Outcome</b>	<b>Indicators</b>	<b>Cost (USD)</b>	<b>Timeframe</b>	<b>Potential Stakeholders</b>
<i>Component 1. Strengthening site management and protection of Huai Chorakhe Mak and Huai Talad.</i>					
Conduct a scoping study of existing interventions and threats and disturbance at Huai Chorakhe Mak, including targeted work on long-term threats (from climate change and invasive species management).	Best practices, guidelines, and standards for proposed RFI interventions	Assessment report with key threats identified and recommendations for improved management published and disseminated to key stakeholders.  Number of consultations conducted with	50,000	1 year	DWNP and management board of NHA  Buri Ram provincial government  Mueang Buri Ram government, Sakae Phrong TAO  Consultancy companies

<b>Intervention</b>	<b>Outcome</b>	<b>Indicators</b>	<b>Cost (USD)</b>	<b>Timeframe</b>	<b>Potential Stakeholders</b>
Identify, successes failures, gaps and lessons for RFI interventions.		<p>local stakeholders for a participatory process in the scoping study</p> <p>Number of stakeholder groups engaged in the scoping study</p>			
Strengthen and expand site management and zonation of the Huai Chorakhe Mak and Huai Talad landscape (including the NHA and surrounding landscapes).	Improved management and conservation of the Huai Chorakhe Mak and Huai Talad landscape through site management planning, and co-management.	<p>Site management and zonation plan over short- to medium-term for Huai Chorakhe Mak and Huai Talad developed, agreed with key stakeholders and endorsed by the management authority (Huai Chorakhe Mak NHA)</p> <p>Number of consultations conducted with key stakeholders for participatory process in the development of the site management and zonation plans, and co-management framework.</p> <p>Number of stakeholder groups engaged in the development of the site management and zonation plans and co-management framework.</p> <p>Number of identified activities in the site</p>	100,000	2 years	<p>DWNP and management board of NHA</p> <p>Buri Ram provincial government</p> <p>Mueang Buri Ram government, Sakae Phrong TAO</p> <p>ZPOT</p> <p>BCST and local conservation groups</p>

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		<p>management plan implemented.</p> <p>A co- management framework developed with key stakeholders and piloted.</p>			
<p>Improve water management infrastructure to ensure water supply to Huai Chorakhe Mak.</p>	<p>Improved wetland management through better water management.</p> <p>Reservoirs adequately stocked with fish.</p>	<p>Number of water management infrastructure (including canals, reservoir expansion, clearance of vegetation) established and repaired.</p> <p>Number of localized dredging works to address siltation of Huai Chorakhe Mak.</p> <p>Number of people benefitting from improved water infrastructure</p> <p>Number of consultations conducted with key stakeholders, ensuring a participatory process.</p>	1,500,000	2-3 years	<p>Department of Water Resources</p> <p>RID</p> <p>Department of Fisheries</p> <p>DWNP</p> <p>Agricultural and fishing cooperatives.</p>
<p>Strengthen the management of site fisheries, with a focus on</p>	<p>Fishing activities in the reservoirs better managed and conserved.</p>	<p>Licensing framework for fishers established.</p>	100,000	3 years	<p>Department of Water Resources</p>

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
small-scale artisanal fishers.	Improved site management through the shift to sustainable fishing practices and increased participation of fisherfolks	<p>Number of consultations conducted in the development of the licensing framework, ensuring a participatory process.</p> <p>Number of local fishers from local communities engaged in the good practices in the use of nets.</p>			<p>Department of Fisheries</p> <p>DWNP</p> <p>Conservation organisations</p>
Strengthen the invasive species management with a focus on Giant Mimosa in Huai Chorakhe Mak, Huai Talad and surrounding rice farming land	Improved site management and biodiversity conservation through an effective invasive species management for the Giant Mimosa at Huai Chorakhe Mak, especially critical areas for cranes.	<p>Area (target of at least 20 has of wetlands) with controlled management of the invasive species including Giant Mimosa</p> <p>An invasive species monitoring plan developed, consulted with key stakeholders and implemented by NHA management.</p> <p>Number of experimental plot (target of at least 1) for Mimosa removal.</p> <p>Number of consultations conducted in the development of the</p>	100,000	5 years	<p>DWNP and management board of NHA</p> <p>Buri Ram provincial government</p> <p>Mueang Buri Ram government, Sakae Phrong TAO</p> <p>Research institutions (Khon Kaen University)</p>

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		<p>invasive species monitoring plan, ensuring a participatory process</p> <p>Number of identified activities in the invasive species monitoring plan implemented.</p> <p>Number of people engaged in invasive species management.</p>			
<i>Component 2. Stronger wildlife protection and monitoring, with a focus on the Sarus Crane.</i>					
Strengthen the legal protection of Huai Chorakhe Mak and Huai Talad	Improved wetland protection through higher level of legal status for Huai Chorakhe Mak and Huai Talad, with boundaries of the protected area precisely delineated, co-management, and increased patrol and enforcement efforts for wildlife protection and encroachment activities	<p>Number of local and/or international designation facilitated for Huai Chorakhe Mak and Huai Talad</p> <p>Number of activities implemented to advocate for a higher legal status for Huai Chorakhe Mak and Huai Talad</p> <p>A co-management framework, with patrol and enforcement, co-development with key stakeholders.</p> <p>Number of patrol and enforcement</p>	200,000	3 years	<p>DWNP and management board of NHA</p> <p>Buri Ram provincial government</p> <p>Mueang Buri Ram government, Sakae Phrong TAO</p> <p>ZPOT</p> <p>Nakhon Ratchasima (Korat) Zoo</p> <p>Conservation and academic organisations (including bird and community-focused NGOs)</p>

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		<p>activities implemented.</p> <p>Number of consultations conducted for the co-management framework development.</p>			
<p>Strengthen biodiversity monitoring, with a focus on the Sarus Crane population.</p>	<p>Improved biodiversity conservation through increased awareness of Sarus Crane and wetland conservation amongst local people and tourists, and biodiversity monitoring</p>	<p>Number of awareness activities on importance of preserving the cranes and the wetlands implemented.</p> <p>Number of stakeholder groups engaged in the awareness-raising and biodiversity monitoring activities.</p> <p>A biodiversity monitoring program is developed and implemented.</p> <p>Number of people engaged in biodiversity monitoring.</p> <p>A biodiversity monitoring group established.</p>	<p>100,000</p>	<p>3 years</p>	
<p><i>Component 3. Upscaling tourism infrastructure and strengthening sustainable ecotourism</i></p>					

<b>Intervention</b>	<b>Outcome</b>	<b>Indicators</b>	<b>Cost (USD)</b>	<b>Timeframe</b>	<b>Potential Stakeholders</b>
Improve and expand tourism infrastructure at Huai Chorakhe Mak, including signage and viewing structures	Improved site management and protected through nature-based tourism benefits, increased capacity of local stakeholders on nature-based tourism, and enhanced appreciation for	Number of nature-based tourism infrastructure (i.e. signage and viewing structures) established and improved.  Number of people benefitting from nature-based tourism activities.	500,000	2 years	LGUs  Department of National Parks, Wildlife and Plant Conservation  Nakhon Ratchasima (Korat) Zoo  Conservation and academic organisations (including bird and community-focused NGOs)
Strengthen the capacity of local communities and businesses for nature-based tourism.	Sarus Cranes, migratory waterbirds, and wetland habitats.	A nature-based tourism strategy with a focus on Sarus Crane developed and implemented with local tourist operators and communities.  Number of business plans and packages co-developed with local stakeholders for nature-based tourism.  Number of stakeholder groups engaged in the development of the business plans, packages, and nature-based tourism strategy.  Number of consultations	200,000	3 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
		<p>conducted with key stakeholders in the development of nature-based tourism strategy and business plans, ensuring a participatory process.</p> <p>Training programme established for nature-based tourism</p> <p>Number of training activities implemented to target participants</p> <p>Number of people trained from target participants.</p>			
<b>Component 4. Strengthening sustainable and organic rice farming (on Jasmine rice)</b>					
Scale up sustainable and regenerative rice-farming in the rice farming landscape that surround Huai Chorakhe Mak, using organic and/or wildlife-friendly approaches.	Improved site management through the practice of organic and biodiversity-friendly rice farming in landscapes around Huai Chorakhe Mak, and financing mechanism support and incentive for biodiversity –	<p>Percentage (target of 30%) of rice fields around Huai Chorakhe Mak under organic/ biodiversity-friendly cultivation.</p> <p>Number of rice farmers shifting to biodiversity-friendly farming as a source of local livelihood (target of 50% increased compared to the baselines)</p>	500,000	10 years	<p>Ministry of Agriculture and Cooperatives</p> <p>DWR</p> <p>Buri Ram provincial government</p> <p>Mueang Buri Ram government, Sakae Phrong TAO</p> <p>Conservation organisations (including bird and</p>

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
	friendly farming practices.	<p>A capacity building (and training) program for organic and biodiversity-friendly rice farming and financial management developed and implemented.</p> <p>Number of capacity-building activities conducted for target participants.</p> <p>Number of people trained on biodiversity-friendly farming and financial management in target stakeholders.</p> <p>A financing mechanism (for local loans and grants) created for local communities and supported by key lending institutions for farmers.</p> <p>Number of farmers benefitting from the established financing mechanism</p>			<p>community-focused NGOs)</p> <p>Agricultural banks</p>
Improve the management of	Improved site management and	Agro-chemical management and	500,000	3 years	

Intervention	Outcome	Indicators	Cost (USD)	Timeframe	Potential Stakeholders
agro-chemical waste in the rice paddies around Huai Chorakhe Mak.	biodiversity conservation through the reduction of agrochemical waste inflow into the wetlands	<p>disposal protocols established and strengthened for all relevant <i>tambons</i>.</p> <p>Number of stakeholder groups engaged in the development of the agrochemical management and disposal protocols.</p> <p>Number of people engaged in monitoring agrochemical waste inflow in the rice paddies around Huai Chorakhe Mak.</p> <p>Baseline metrics for measuring agrochemical flows established.</p> <p>Monitoring data shows reduced inflow of agro-chemicals into Huai Chorakhe Mak wetlands against baselines, using established metrics.</p>			
<b>Total investment for 10 years</b>			<b>14,550,000 USD</b>		

## 7.2. Potential Financing

The estimated project cost is USD 14,550,000 over 10 years. This budget supports the development of site management and co-management framework, the promotion of biodiversity-friendly farming and agrochemical waste management for rice paddies around the Huai Chorakhe Mak, sustainable fishing practices, invasive species management, increased legal protection for the Huai Chorakhe Mak Reservoir through local and/or international designations, nature-based tourism infrastructure, establishment of a financing mechanism, and capacity-building for local stakeholders on biodiversity monitoring, patrolling, enforcement, nature-based tourism, and financial management. Table 5 summarizes the projected budget distribution across the proposed project components.

## 7.3. Proposed Institutional Arrangements

The proposed project is expected to be implemented over a period of ten years, with main project components focusing on improved site management for both Huai Chorakhe Mak and Huai Talad non-hunting areas (led by the Department of National Parks, Department of Water Resources) and expanding organic and/or biodiversity-friendly rice agriculture (with the Ministry of Agriculture and Cooperatives).

## 7.4. Project Beneficiaries

This proposed project is expected to undertake activities promote gender inclusion and participation in livelihood activities, through capacity building activities for organic rice farming agriculture and nature-based tourism.

There are no indigenous communities in the project landscape.

## 7.5. Anticipated Implementation Risks

*Stakeholder engagement:* Proposed interventions rely on support from local communities, particularly in adopting sustainable fishing practices, biodiversity-friendly rice farming, and co-management. Establishing strong stakeholder buy-in from local leaders and community engagement will facilitate better implementation of the proposed interventions.

*Environment:* Most proposed interventions are relatively soft and have a low environmental impact, but it may be necessary to consider the effects of expanding tourism in Huai Chorakhe Mak, which could increase anthropogenic pressures and lead to greater disturbance of wildlife. Planning with stakeholders to reduce noise pollution during the construction of ecotourism facilities and ongoing ecotourism activities, as well as managing waste pollution from increased tourist traffic, is essential.

## References

- Asian Waterbird Census (AWC): Thailand data for 2018. See <https://eaaflyway.net/asian-waterbird-census>
- Faculty of Economics, Khon Kaen University. (2022). *Integrating the value of ecosystems and biodiversity in rice systems in Thailand. An analysis of alternative rice cultivation methods in northeast Thailand*. UNEP TEEB Agri-food Initiative.
- IUCN Red List of Threatened Species. Available at: [www.iucnredlist.org](http://www.iucnredlist.org)
- Mundkur, T. & Langendoen, T. (2022) *Report on the Conservation Status of Migratory Waterbirds of the East Asian – Australasian Flyway Partnership*. First Edition. Draft Report to the East Asian – Australasian Flyway Partnership. Wetlands International, Ede, The Netherlands. Available at: <https://www.wetlands.org/publication/eaaf-conservation-status-review1/>
- Nasa, M., & Hassan, F. B. (2016). Assessment of tourism resource potential at Buriram Province, Thailand. *Asian Social Science*, 12(10), 27-34.
- Rodmongkoldee, P., Salaklang, P., & Rodmongkoldee, C. (2009). Species Diversity of Freshwater Prawns, Crabs, and Mollusks in Huai Chorakhe Mak Reservoir, Muang District, Buriram Province. *Journal of Humanities and Social Sciences, Buriram Rajabhat University*, 1(1), 48-57.
- Sankhom, R., Warrit, N., & Wiwegweaw, A. (2018). Screening and application of microsatellite markers for genetic diversity analysis of captive eastern sarus crane *Grus antigone sharpii* Blanford, 1895 in Thailand. *Zoo Biology* 37(5), 310-319.
- Scott, D.A. (1989) *A Directory of Asian Wetlands*. IUCN: Gland, Switzerland & Cambridge, U.K. Available at: <https://portals.iucn.org/library/node/5933>
- The Jakarta Post: Fly away home: rare Eastern Sarus cranes released in Thailand. Available at: <https://www.thejakartapost.com/culture/2022/12/27/fly-away-home-rare-eastern-sarus-cranes-released-in-thailand.html>.
- Tourism Thailand: The Wetland and Eastern Sarus Crane Conservation Center, Buri Ram. Available at: <https://www.tourismthailand.org/Attraction/the-wetland-and-eastern-sarus-crane-conservation-center-buri-ram>

## Annex 1. Supplementary information on flood mitigation 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 flood mitigation were spatially inferred in QGIS from a selection of metrics expressing different biophysical values modelled online by the Water World component of this tool. Equivalent data to assess monetary values similarly to coastal protection were not available for the RFI region.

The key metrics selected for biophysical values (Table A1) were the average green storage capacity, which is the volume of water stored by each square kilometre of wetland itself as well as its soil and vegetation, and the direct influence of this storage capacity on beneficiaries found downstream of the wetland, both as the average number of people and the average built-up area that are uniquely benefitting from the resulting flood mitigation (and not from other green storage found upstream).

**Table A1.** Contribution of the wetland habitats to flood mitigation in Huai Chorakhe Mak reservoir based on site-level (biophysical) values inferred from Mulligan (2022) and expressed as ranges to represent the resulting uncertainty.

Influence of the wetland on flood mitigation (metrics)	Benefit/Beneficiaries
Average green storage capacity per sq. km of wetland in million cubic metres (GigaLitres/km <sup>2</sup> )	27 – 163
Average population uniquely benefitting from influential green storage upstream per sq. km of wetland (n/km <sup>2</sup> )	7 – 40
Average built-up area uniquely benefitting from influential green storage upstream per sq. km of wetland (ha/km <sup>2</sup> )	0.28 – 1.70

**Table A2.** Biophysical benefits from and beneficiaries of RFI inland wetland sites (expressed as ranges to represent the resulting uncertainty) and at the national level.

Site name	Green storage capacity (GigaLitres/km <sup>2</sup> )	Downstream population (n /km <sup>2</sup> )	Downstream built-up area (ha /km <sup>2</sup> )
Bueng Boraphet	228 (±21)	647 (±170)	32.90 (±3.01)
Huai Chorakhe Mak reservoir	95 (±68)	24 (±26)	0.99 (±0.71)
Sanam Bin reservoir	356 (±56)	81 (±27)	3.38 (±0.53)
Thailand RFI average	226	251	12.42
Thailand national average	216	202	11.30

**Table A5.** Key habitat types in Huai Chorakhe Mak Reservoir based on stakeholder-based assessment at the Regional Flyway Initiative workshop in November 2023.

Habitat type	Current state		Alternative state (2035)	
	Area (ha)	Cover (%)	Area (ha)	Cover (%)
Water storage areas	503.1	80.0	534.5	85.0
Freshwater, tree-dominated wetlands	31.4	5.0	31.4	5.0
Canals and drainage channels, ditches	31.4	5.0	31.4	5.0
Seasonal/intermittent freshwater marshes/pools	62.9	10.0	31.4	5.0
Total	628.9	100.0	628.9	100.0