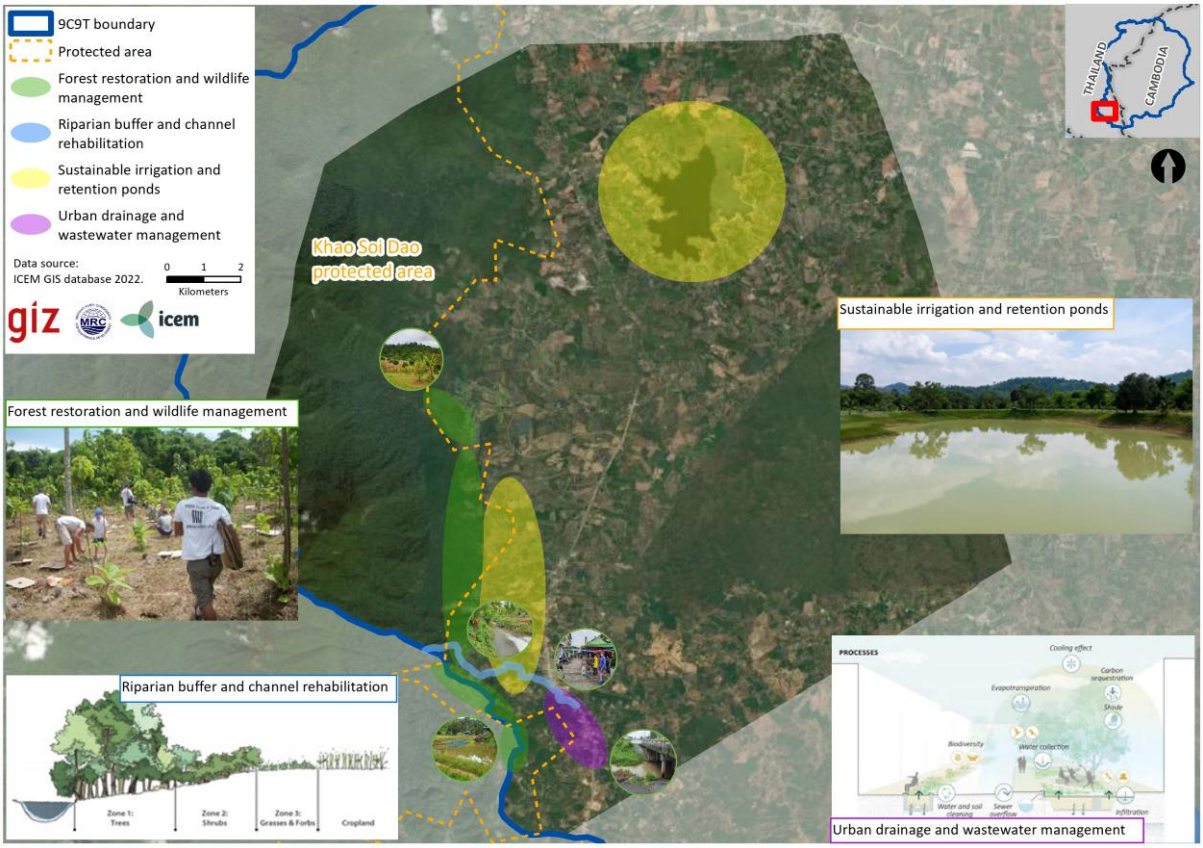
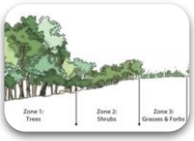
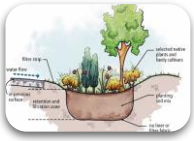
# PROJECT 2: HEADWATERS AND PROTECTED AREA – KHAO SOI DAO WILDLIFE SANCTUARY, PONG NAM RON AND PLANTATIONS, THAILAND

## 1. Project Overview





1. Riparian buffer


6. Forest restoration and rehabilitation


9. Retention and infiltration of surface runoff


12. River bank stabilization and rehabilitation


13. Sustainable irrigation measures


14. Urban greening

Project 2 is identified as a key landscape, in particular in relation to protected area encroachment, drought and water retention, urban risk and watershed and forest degradation with downstream impacts on farms, urban areas and transport corridors. The project objectives for this area are focused on:

- Defining opportunities for the establishment of measures to foster watershed rehabilitation, forest restoration, protected area and buffer zone ecological restoration, and road and urban drainage interventions;
- Working with the lead and supporting agencies, as well as local and provincial stakeholders to ensure an integrated and transboundary approach to watershed rehabilitation and forest restoration is implemented within the PA, that aligns with the 9C-9T Masterplan and Action Plan.

**Table 1: Project 2 – Master Plan implementation factors**

| Item | Description |
|---|---|
| **Alignment to 9C-9T Masterplan** | • **Focal Area 2**: Manage urban and rural flood and drought to reduce risk<br>**Rural**<br>• **Outcome 2.3**: Rehabilitated basin headwaters and wetlands, to improve water security and climate resilience through ecosystem-based adaptation interventions<br>• **Output 2.3.1**: Develop and implement at least six (3 in each country) interventions for rehabilitation and effective management of protected areas and upper watersheds in river basin headwaters – to improve and maintain the delivery of ecosystem services, with an emphasis on safeguarding transboundary biodiversity of international importance<br>**Urban**<br>• **Outcome 2.1**: Strengthened urban flood and drought resilience through innovative climate-sensitive and ecosystem-based planning tools and adaptation interventions<br>• **Output 2.1.4**: Develop and implement protective, hybrid (green and grey) infrastructures to reduce urban flood risks (e.g. urban river channel improvement, bank stabilization and natural flood retention areas) and enhance water quality in two target towns (one in each country) |
| **Implementing stakeholders** | **Rural**<br>• **Lead agency (Thailand):** Department of National Park, Wildlife and Plant Conservation (DNP)<br>• ***Supporting agency (Thailand)*:** Office of the National Water Resources (ONWR), the Ministry of Agriculture and Cooperatives, the Ministry of Natural Resources and Environment (MoNRE) and provincial government<br>**Urban**<br>• ***Lead agency (Thailand)*:** Ministry of Interior, Department of Public Works and Town and Country Planning<br>• ***Supporting agency (Thailand)*:** National Water Resources (ONWR), the Ministry of Agriculture and Cooperatives, the Ministry of Natural Resources and Environment (MoNRE) and provincial government |
| **Alignment to agency priorities** | DNP, an agency of the Ministry of Natural Resources and Environment in Thailand, has a mission towards the conservation, protection, restoration and sustainable management of forest resources and wildlife. Khao Soi Dao is one of the national parks under its remit The Ministry of Interior is responsible for core areas including local administration, disaster management, road safety, land management and public works |

## 1.1. Site description

The landscape covers the area surrounding Pong Nam Ron urban development and the Khao Soi Dao Wildlife Sanctuary, located in the S0517 and SO576 sub-catchments, near the Thai-Cambodian border at the south-eastern boundary of the 9C-9T sub-basin. The landscape is located in the Pong Nam Ron District, Chanthaburi Province, and comprises a combined protected area and rural headwater, and urban environment. The headwater area is located within the protected area at maximum elevations of 1500 m above sea level (asl). To the east of Khao Soi Dao, the catchment levels off into a plain with agricultural land, a number of small reservoirs, urban settlements and scattered villages. The area naturally drains down from steeper elevations within the protected area into flatter terrain, which has been extensively developed into agricultural land. The landscape is transected by the national 317 highway, from north to south. A large vegetated military zone of approximately 55 $km^2$, as well as the larger Khlong Phra Phut Reservoir are also situated in the catchment. Pong Nam Ron urban area,

providing for an estimated 10,000 people (2019[1]), is also located in the conduit between the military zone and the PA. The area is a critical headwater for four sub-basins in eastern Thailand, with water also flowing to Tonlé Sap Lake in Cambodia. The catchment is important for downstream ecosystems and water users.

Khao Soi Dao is contiguous with Khao Khitchakut National Park to the south and to the west, and contiguous with Khao Ang Ru Nai Wildlife Sanctuary. The topography of the protected area is made up of two distinct landscapes, with a smaller, low-lying area to the north and a larger mountainous region with perennial streams and waterfalls in the south. Vegetation is dominated by semi-evergreen and evergreen forest at higher elevations, as well as a few pockets of deciduous forest and bamboo. Khao Soi Dao Wildlife Sanctuary supports several endangered species and is the only Important Bird and Biodiversity Area (IBA) in Thailand that supports the globally endangered Chestnut-headed Partridge *Arborophila cambodiana*, a restricted-range species.[2]

## 1.2. Flood and drought drivers and impacts

### *1.2.1. Drivers*

#### *Agricultural development and protected area encroachment*

Forest areas at the eastern boundary of Khao Soi Dao act as a protective barrier against erosion, flood/drought and biodiversity loss. Increasingly however forest areas are being destroyed and replaced with orchard plantations. Site visits combined with remote sensing analysis indicates encroachment into the foothills of the PA, associated with the establishment of small to medium-scale plantations, sprinkler systems and the installation of small reservoirs. The main agricultural product in the Pong Nam Ron area is durian, exported overland to China (through Cambodia and Vietnam). Durian, mangosteen, banana and other crops require the application pesticides and broad-spectrum herbicides that pollute local retention ponds and streams.

Many encroached areas were initially established by local communities, comprising dwellings, orchard plantations or cropland before such locations were declared part of the Khao Soi Dao Wildlife Sanctuary. Such areas are therefore recognised and not illegal.

#### *Drainage structure, irrigation and reservoirs*

A key issue in Pong Nam Ron district is drought, so the priority is to retain as much water as possible for the dry season. Water demand and consumption associated with urbanisation, agricultural land (including plantations) and recreational use has risen along with waste water and water abstraction for irrigation. These drivers contribute to the construction of reservoirs, occasionally at the expense of degrading and disappearing natural drainage channels.

The Khlong Ta Liu dam and reservoir, situated within the forested area of PA, was proposed for flood regulation purposes and supports water provision in the region (without the undertaking of an environmental impact assessment). A number of further reservoirs are situated in the lowlands, outside the protected area boundary, to provide agricultural and recreational water resources. Satellite imagery highlights the continuous construction of such artificial waterbodies. Natural drainage channels and streams have been developed over, constraining the natural drainage structure and flood/drainage control of the lowland area, including the expanding Pong Nam Ron urban development.

#### *Urbanization and road infrastructure*

Although there are no large urban areas situated within Pong Nam Ron District, development along the road that borders the easter boundary of Khao Soi Dao has resulted in increased hard surfaces and a reduction in natural areas. The increase of small to moderately sized urban areas such as Pong

[1] Source: https://www.citypopulation.de/en/thailand/eastern/chanthaburi/2289__pong_nam_ron/

[2] BirdLife International, 2022. Important Bird Areas (IBA) factsheet: Khao Soi Dao, Thailand. http://datazone.birdlife.org/site/factsheet/khao-soi-dao-iba-thailand

Nam Rong have acted as a hub for urbanization, road infrastructure and industrial expansion in the area. Waste management and wastewater treatment facilities have not been able to keep up with the increasing commercial and residential demands. Road infrastructure and paths are located in the transition from the plain into the hilly area. Many lack a drainage structure which would divert water into channels, fields or natural retention areas.

**Figure 1: Hardening of the landscape at Pong Nam Ron**

### 1.2.2. Impacts

*Increased runoff and loss of water storage in the reservoirs and drainage channel*

The expansion of urban areas has reduced nature-based water management and retention opportunities, in turn reducing water infiltration and increasing runoff from the upland watershed in the PA. The area also experiences damaging seasonal flooding.

Insufficient water during the dry season impacts both the agricultural sector and the use of water for consumption. During the dry season, the Pong Nam Ron municipality water source has reduced flow for approximately two months, resulting in competition for water among farmers and local municipalities. Drinking water is supplied for 3 months by trucks.

*Wastewater discharge*

The lack of waste management and water treatment facilities result in untreated wastewater discharge entering drainage channels and streams within the catchment, passing into downstream areas in Cambodia. Hard standing and grey infrastructure dominates the built-up environment, which also increases wastewater disbursement and potential flash flooding.

*Forest loss, fragmentation and biodiversity loss*

The increase in urbanization and agricultural development around the Khao Soi Dao protected area has resulted in a reduction in forest cover in the landscape area. In addition, development within the protected area, including the Khlong Ta Liu dam, has reduced vegetative cover and impacted on biodiversity. This loss of forested areas (including in elevated areas) increases soil degradation, erosion and landslide risk, as well as water retention and flood risk in an area that already experiences flooding. Changes to the drainage system has resulted in elephants and other wildlife coming down into the foothills to drink and feed in agricultural areas (Figure 2).

**Figure 2: (L) Water retention/irrigation pond (0.21 Ha) and (R) evidence of elephant presence**

The national 317-highway road is a significant constraint to ecological connectivity within the landscape – it has been constructed with little concern to maintenance of natural drainage channels as important ecosystem service and amenity assets for the area. On the border of the 9C-9T sub-basin to the south, the buffer zone between Khao Soi Dao and Khlong Kreua Wai Chaleum National Park is severely fragmented by the road and the associated linear urbanisation. This prevents prospects for a connecting wildlife corridor between the two PA's. Opportunities for developing ecological buffer zones or wildlife crossings for roads and highways may exist to reconnect the landscape area.

## 1.3. Nature based and hybrid solutions project concept

### *1.3.1. Concept design of NbS*

*Measure 1: Drainage buffer strip and Measure 12: River bank stabilization and rehabilitation*

The degradation of drainage corridors within the landscape is a concern for flood and drought resilience. The rehabilitation of natural drainage channels (and artificial canals linked to reservoirs in the area, including the Khlong Phra Phut Reservoir) is required to reconnect the hydrological landscape and provide effective soil retention, water quality and drainage from the watershed into the agricultural-focused plains below. Figure 3 presents the Ta Ni stream and weir complex near Pong Nam Ron.

**Figure 3: Drainage channel from Khao Soi Dao to Pong Nam Ron**


NbS rehabilitation of the stream through buffer strips in combination with bank stabilization measures provide an opportunity to improve water retention, water quality and reduce sedimentation.

Riparian buffer strips are linear vegetated areas located alongside streams and other water courses. They provide several ecosystem services and are beneficial for improving water retention, water

quality, biodiversity, and reducing pollutant and sediment delivery into drainage channels. The buffer strip either side of the drainage channels are proposed at a width of 30m, in line with good practice design, to ensure the ecological integrity linked to the adjacent protected area (see Measure 1, Annex 1). This would yield improved habitat provision and sediment and pollution trapping potential in comparison to a more restricted 15m buffer.

Potential conflicts associated with necessary land take from adjacent private agricultural land are acknowledged. Extensive stakeholder consultation is required prior to planning and implementation. The establishment and development of the natural buffer strip should complement the existing vegetation present in the drainage areas and comprise a mix of native species with exotic trees beneficial to local livelihoods. This will ensure buffer integrity, maximise ecological resilience and prevent the spread of alien invasive species (AIS).

### *Measure 4: Drainage in combination with nature-based retention*

Surface runoff from haphazard drainage needs to be diverted (and where possible treated) into swales, natural depressions, and drainage channels through NbS measures. The surface of the diversion structures must be adopted to expected traffic and small enough to avoid accidents with pedestrians, cyclists and vehicles. Stormwater runoff conveyance systems (e.g. bioswales) comprising linear ditches collect, infiltrate and treat stormwater runoff before releasing it to the watershed. Vegetation reduces water velocity, allowing it to accumulate in a bioswale, and filters suspended sediments.

There is one location (Thap Sai School) where soil erosion is present, requiring NbS measures to connect a new culvert to the manhole of Highway 317 (Figure 4, L). A vegetative buffer would provide appropriate protection from erosion. Such interventions would require engagement and consultation with the Department of Highways and local authorities. The drainage system of 3193 highway road comprises a combined system (water including rainfall, commercial wastewater and public wastewater). NbS interventions for this area comprise wetland rehabilitation at the Ta Ni drainage channel outlet, with effective natural water treatment prior to discharge downstream (Figure 4, R).

**Figure 4: Examples of required drainage improvements (Highway 317 (L), Highway 3193 (R))**

### *Measure 6: Forest restoration*

Forest restoration in the landscape within protected areas and across agricultural and urban areas is critical to ensuring the recovery of degraded and fragmented areas and should be planned at the landscape scale, with the objective of re-establishing ecological integrity and connectivity. This measure is linked to Measure 1 - restoring drainage buffers.

Potential locations have been identified for restoration, particularly in areas where there is encroachment into the protected area along its eastern boundary and in the foothills of Pong Nam Ron. Land ownership of these areas typically comprises private land or land managed by Department of National Parks, Wildlife and Plant Conservation. These areas currently comprise dwellings, orchard plantations and water retention ponds. Measures in each location would share similar objectives (Measure 7, Annex 1).

**Figure 5: (left) protected area forest buffer corridor (right) potential forest restoration sites**


*Measure 13: Sustainable Irrigation*

The establishment of water retention measures, including a network of ponds (Figure 2) in the foothills of Khao Soi Dao Wildlife Sanctuary where orchards are widespread, will support irrigation in the dry season (Measure 13, Annex 1). This should be implemented in tandem with the rehabilitation of drainage channels, reservoirs (including the Khlong Phra Phut Reservoir) and wetland areas, to reconnect the hydrological landscape. Planning and designing such ponds via a network approach can enhance water retention and infiltration benefits. Appropriate wildlife-friendly mitigation/security measures should also be in place to avoid and reduce wildlife conflicts – a challenge already present in the landscape. The creation of ponds for wildlife within the protected area would reduce the need for animals to enter agricultural areas during periods of drought.

*Measure 14: Urban greening*

In combination with nature-based retention, urban green spaces should be established in Pong Nam Ron in strategic locations to capture, reduce and store urban runoff. These can be implemented at different scales in both public and private spaces, including the central market. Existing extensive areas of open hardstanding and degraded industrial open spaces should be converted to green spaces. Ultimately the ambition should be to have 30% coverage of green infrastructure in the urban environment, through a range of interventions including parks, gardens, play areas, landscaped areas and tree pits. New green spaces may require changes in land use, resulting in a loss of productive land and impacting local livelihoods.

### *1.3.2. Project benefits*

- Restoration of 100 ha of forest areas;
- 30% coverage of green infrastructure in Pong Nam Ron, benefiting 10,000 people;
- Rehabilitation of 4 km of the Ta Ni stream and weir complex;
- Reduced human/wildlife conflict in the buffer zone of the protected area;
- Increased water retention;
- Increased water quality, reduced soil loss and sedimentation; and
- Enhanced habitat for biodiversity.