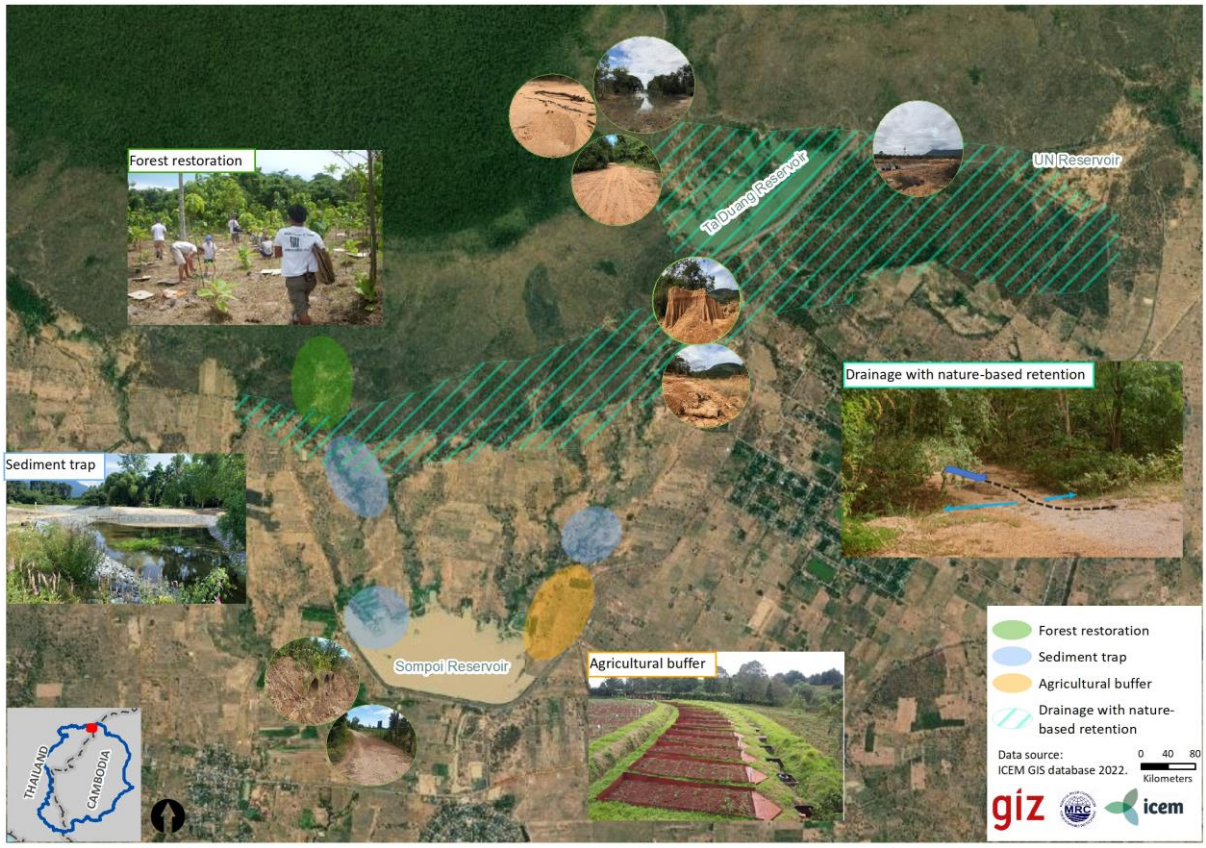
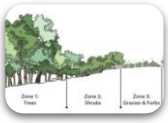
PROJECT 3: HEADWATERS AND PROTECTED AREAS – SOMPOI, TADUANG AND UN RESERVOIRS, THAILAND

1. Project Overview





1. Riparian buffer

3. Catchment water management

4. Drainage in combination with nature-based retention

5. Sediment trap

6. Forest restoration and rehabilitation

13. Sustainable irrigation measures

15. Agricultural buufer

Project 3 is in a key landscape suffering headwater protected area encroachment, drought, erosion and sedimentation and reduced water quality. The project objectives for this area address those concerns by:

- implementing measures for reservoir and watershed rehabilitation and management, including introducing riparian buffers, sediment traps, reforestation, agricultural allotment buffers and water quality management; and
- working with the lead and supporting agencies, as well as local and provincial stakeholders to ensure an integrated approach to protected area, drought and erosion management, aligning with the 9C-9T Masterplan and Action Plan.

Table 1: Project 3 – Master Plan implementation factors

Item	Description
Alignment to 9C-9T Masterplan	• **Focal Area 2**: Manage urban and rural flood and drought to reduce risk • **Outcome 2.3**: Rehabilitated basin headwaters and wetlands, to improve water security and climate resilience through ecosystem-based adaptation interventions • **Output 2.3.2**: Develop and implement at least four (2 in each country) interventions to rehabilitate and manage wetlands in the multiple use areas to strengthen protected area buffer zones and improve ecological integrity for the delivery of ecosystem services (water storage/treatment/habitat)
Implementing stakeholders	• *Lead agency (Thailand)*: Ministry of Agriculture and Cooperatives (MOAC) • *Supporting agency (Thailand)*: Office of the National Water Resources (ONWR), the Department of National Park, Wildlife and Plant Conservation (DNP), the Ministry of Natural Resources and Environment (MoNRE) and provincial government
Alignment to agency priorities	MOAC is responsible for the administration of agricultural policies, forestry, water resources, irrigation and the development of farmers and cooperative systems

1.1. Site description

Project 3 is located in Sa Keo Province, Amphoe Taphaya district and covers the Tambons Thap Thai in the north and Thap Sadet in the south. It is the utmost northern part of the 9C-9T basin. The headwater area is hilly and forested within the Tapraya national park located close to Pang Sida national park, and part of the Phnom Dong Rak mountain range. The hills fade out to the south where agricultural land prevails. The location is home to many reservoirs, which provide domestic water and irrigation. Countless small rivulets drain the area from north to south and become the source for the reservoirs. They continue to form the drainage corridor that finally flows through the Svay Check river to Sisophon in Cambodia.

The striking feature of this area is dispersive soil, which is sandy in nature and thus highly erodible. Rain can easily infiltrate and mobilise the loose sand particles. This causes high sediment loads in all rivers in the catchment. Erosion and thus sedimentation is strongest where vegetation has become sparse or entirely removed which is often the case along river-banks and in the buffer to the park following logging and temporary settlements. In addition, although satellite images suggest rather dense vegetation in the hills, the field mission found that the remaining trees and bushes do not have a dense canopy structure and erosion prone areas are common (Figure 1).

Figure 1: Landscape upstream of reservoirs on the southern border of Tapraya national park

The landscape condition determines water supply and condition for all downstream reservoirs and irrigation systems. Three larger reservoirs (UN, Taduan and Sompoi reservoirs) and countless small ponds provide water storage for domestic use and irrigation. From a biodiversity perspective, the national park and forested areas following the mountain ridge from west to east, are a natural wildlife corridor of international importance and an essential upper catchment for Sa Keo Province downstream to Cambodia. However, the Joint Project's GIS analysis from 1990 to 2020 shows a progressive loss of forest, especially in the past 10 years. Forested areas to the north of the reservoirs are managed by the Department of National Park, Wildlife and Plant Conservation.

An in-depth field mission was undertaken to the Sompoi Reservoir (see Annex 3 for further details) to identify potential demonstration sites for building flood and drought resilience, incorporating hybrid and nature-based solutions. The following sections provide more detailed focus on this reservoir.

1.2. Flood and drought drivers and impacts

1.2.1. Drivers

Erosion and thus sediment local in drainage corridors and reservoirs in this area is largely attributable to the specific soil structure combined with extensive loss of vegetative cover. Other drivers were identified during the field missions and the expert exchange. They are listed in the order of their significance.

Natural features - erodible soil and vegetation with less pronounced canopies

The dispersive soil in this area is the main reason for high erosion and sedimentation rates. In addition, the vegetation does not form dense canopies and overall, the immediate upstream landscape is degraded.

A number of individual sites, including Lalu, a popular tourist destination in the region, also contributes to erosion. Lalu is managed by the National Park authority comprises an extensive, bare area of sandy soil and spectacular dissected earth formations formed through steady erosion. Significant sediment build-up and localised erosion occurs dispersing through a system of small ephemeral stream near the National Forest of Thailand office. This results in the transfer of sediment during periods of discharge into the Khlong Sompoi reservoir.

Inadequate drainage structures and vegetated buffers for roads and paths

Roads and paths are located in the transition from the plain into the hilly area. The current system of unsealed roads and paths are a significant part of the erosion and sedimentation problem in the landscape. They all lack adequate drainage structures and vegetated buffers which would divert and filter water into channels, fields or natural retention areas. The presence of small streams and drainage pipes on the roadside of the National Park facilitate the transfer of sediment during periods of discharge towards downstream agricultural areas and then into the Sompoi reservoir.

Missing drainage buffer strips

Vegetated buffer strips have been removed along most streams and drainage channels in favour of gaining more agricultural land, or where present, have been degraded. The benefit of more cultivated land comes with the cost of increasing erosion into rivers and reservoirs. Agricultural practices like furrows in direction of drainage also exacerbates erosion and sedimentation.

Drainage channels were examined during the field mission to the Sompoi reservoir, including the riparian buffer presented in Figure 2. It was noted that the channel and associated buffer does not fully extend down to the Khlong Sompoi reservoir, due to encroachment at the edge of the channel from cassava plantations, and a road built over the waterway. The waterway is seasonal. During the wet season, water flows rapidly to the Sompoi reservoir due to the steep slopes of the channel.

Figure 2: Example riparian buffer strip leading towards Sompoi Reservoir

Missing sediment traps upstream of reservoirs

During the wet season, water rapidly flows from the mountains upstream of the reservoirs downstream towards agricultural land, resulting in a high sediment discharge and surface water runoff via small streams into the Sompoi reservoir. Flash floods associated with steep slopes compound this problem, and result in highly turbid waters in the reservoir. The reservoirs are built without sediment traps to filter water on its way into the waterbodies. The topography and tenure arrangements mean that sediment traps would need to be strategically located in close consultation with farmers and local authorities.

Logging

Location 12 was home to United Nations (UN) refugee camps during the Khmer Rouge time in Cambodia. The increases in population in an otherwise relatively isolated area created high pressures on natural resources, including encroachment into the protected area, hunting and logging. The resulting degraded habits still exist to some degree and logging is not uncommon in this area. Past attempts at providing erosion control at the site have included vetiver plantations and restoration of forest landscapes within the national park. One example is located at the Tubtim Siam 03 Project site for reforestation, which was initiated in 1995 comprising an area of 900 rai (144 Ha).

1.2.2. Impacts

The most prominent adverse impacts related to flood and drought are deforestation of headwaters and sedimentation of waterways and reservoirs. Sediment reduces the capacity of rivers and streams and inhibits natural flow and greatly reduces productivity and water quality in reservoirs and irrigation systems. All reservoirs are located at the base of the hills. They are shallow and a small gain in water level generates a large increase of the water surface. This combination of natural and man-made features creates several problems:

Loss of water storage in the reservoirs and ponds

The sediment settles in the reservoirs and is difficult and expensive to remove. The structure of the outlets of the reservoirs in combination with the shallow bathymetry does not allow for sediment flushing. The consequence is a relatively rapid reduction of reservoir lifetime.

High turbidity in reservoirs and ponds

Turbidity in the reservoirs and ponds is often high due to sediment. This has been causing problems for domestic water supply and irrigation systems, particularly after heavy rainfall while the sediment has not yet settled.

High evaporation losses from the reservoir's water surfaces

The bathymetry of the reservoirs leads to high evaporation losses. A small increase in water depth causes a disproportional increase of the water surface giving rise to high evaporation rates.

Reduction of flow capacity in rivers due to sediment

Sediment in the rivers is a significant driver for a reduction of flow capacity. Since almost all streams are equipped with structures like weirs, regulated culverts, gates where the sediment settles, the benefit of storage volume is reduced, and the function of the structures is hampered.

1.3. Nature based and hybrid solutions project concept

1.3.1. Concept design of NbS

Measure 1: Natural drainage buffers

A number of waterways and drainage corridors have been identified as having the opportunities for riparian buffer establishment and rehabilitation. For example, the natural drainage channel identified in Figure 2 has the potential to be restored to prevent erosion/sediment build up and facilitate its reconnection to the Sompoi Reservoir. The waterway is situated on public land, separated from adjacent private land through its buffer zone. The dimension of this u-shaped waterway was measured as 4m deep, with a top width of 19m and a base width of 16m but showing clear signs of sediment accumulation.

Measure 4: Drainage in combination with nature-based retention

When NbS and hybrid drainage structures are developed at many places across the landscape as a key strategy in watershed rehabilitation, they contribute in mitigating sedimentation and help reduce flash flooding. Measures can be low-cost and no-regret with multiple benefits of improving water quality and enhancing biodiversity.

Figure 3: Zone for lateral drainage structures

Drainage diversion structures for roads, paths and areas suffering from sheet drainage can be combined with nature-based retention measures – i.e. areas of thick vegetation or bioswale channels designed to concentrate and convey stormwater runoff while removing debris and pollution. Generally, these kinds of drainage structures are effective in reducing the speed and volume of surface runoff.

The NbS and hybrid measures here are proposed for the transition zone from the hillside down to the plain where drainage improvement with nature-based retention would best demonstrate its potential. During the site visit to the Sompoi Reservoir, existing drainage channels were identified passing under the road and five drainage pipes along the road. Each pipe collects water from the streams to the north in the national park, transferring the flow to the agricultural land downstream and ultimately to the Sompoi Reservoir (Further details are provided in Annex 3, field report).

The more measures implemented the better, beginning at sites with high slopes and dispersive soil. While this demonstration is limited to the immediate areas upstream of the reservoirs, if rolled out more extensively stakeholders can benefit from the cumulative impacts of many natural interventions across the entire headwaters, including within the national park.

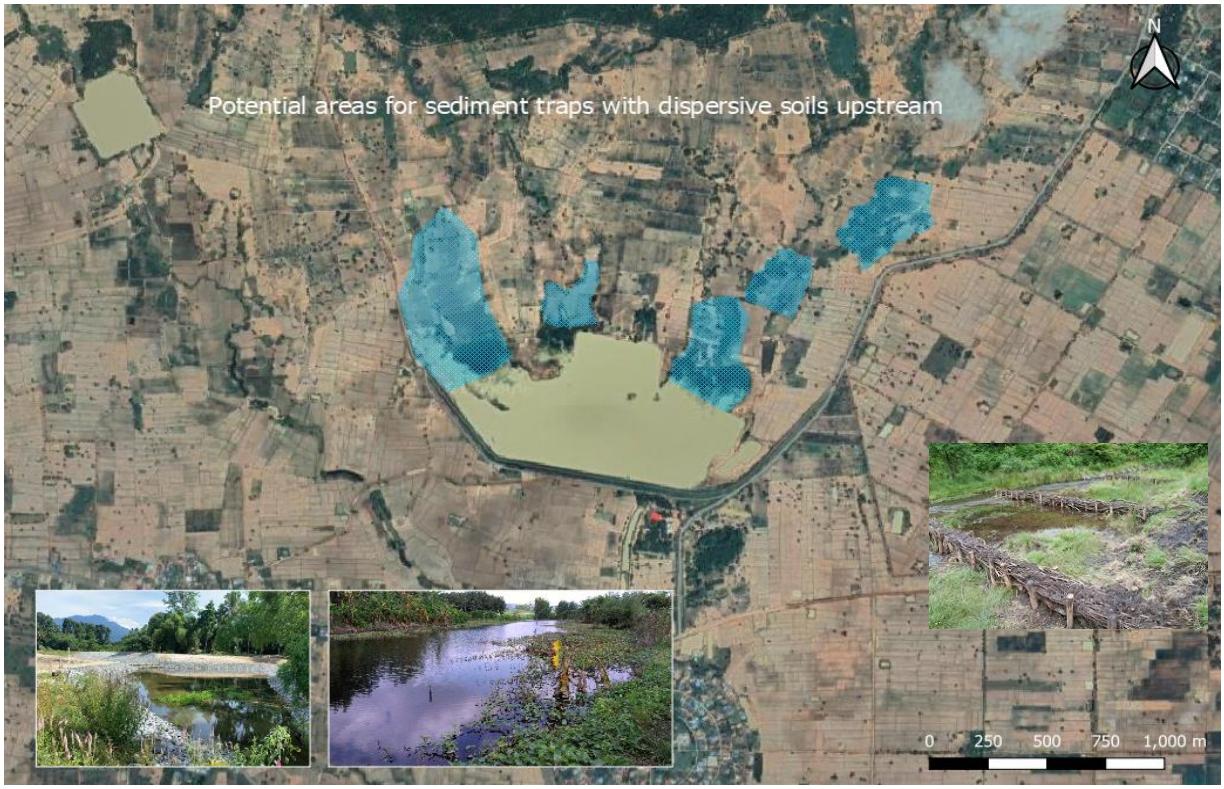
Measure 5: Sediment traps

The establishment of small multiple functioning sediment traps through NbS and hybrid structures offers significant potential within this landscape. Such interventions help to collect sediment before it enters the reservoir to reduce sedimentation, improve water quality and maintain water storage capacity.

During the field visit, opportunities were identified for establishing a sediment trap at the entrance of pipe drain on the National Park side of the road (Figure 3). It was noted that any proposed NbS measures at this location would require engagement and permission from the National Park. In addition, along drainage channels feeding into the reservoirs (see Figure 2 and Figure 4 as example), 2-3 sediment traps could be established.

At the location identified in Figure 2, local government representatives suggested the provision of 2-3 leaky check dams along a stream to reduce flow and sediment transport during the wet and facilitate the storage of water for use by farmers during the dry season. Although situated on public land, such NbS measures would require engagement and permission from the Thap Thai SAO, with further consultation with local farmers who are active in the area.

Figure 4. Potential areas for sediment traps with dispersive soil upstream.



Measure 6: Forest restoration

Forest restoration at five seriously degraded locations identified within the Tapraya national park and its buffer, will require a distinctive combination of actions for the park, the buffer and the riparian corridors, because each have differing challenges and opportunities (Figure 5). Yet measures in each location share the same objectives, as identified in Measure 6 (Annex 1). Restoration demonstrations would target degraded areas within the NP.

Figure 5: Identified degraded forest sites

Any exotic or invasive species identified at the sites should be replaced with native species, with fencing established to protect re-growth from ungulates and other pressures. From satellite and field observations, it is anticipated that each restoration site would be the equivalent of around 3 Ha. Plant nurseries should be established to support native species mix, with a planting regime of mixed native tree and understorey species following guidance from the national park authorities. There are a variety of tree species that have been identified by rangers at the restoration sites that offer potential for tree planting, including *azadirachta indica var. siamensis, peltophorum pterocarpum, Sindora siamensis, Dipterocarpus obtusifolius* and doussie.

Measure 13: Sustainable irrigation measures and Measure 15: Agricultural field buffers

Due to the sedimentation of the reservoir, drought risk and intensive agricultural practices within the catchment, water conservation irrigation measures are proposed for the three reservoirs in this landscape (see Annex 1, Measure 13). Field trenches and small-scale bioretention ponds provide opportunities for improved water resource management by farmers. Field trenches involve extensive ploughing to the right angle of a field's slope, filtering runoff water, reducing soil degradation and enhancing infiltration of surface run-off and soil moisture. These should be supported by the establishment of agricultural field buffers (see Annex 1, Measure 15). Figure 6 outlines potential demonstration locations for such interventions to the east of Sompoi.

Figure 6: Agricultural landscapes for sustainable irrigation measures

1.3.2. Project benefits

- Restoration of degraded reservoir and catchment, improving water supply functionality;
- Water conservation irrigation measures to support improved irrigation and more sustainable agricultural practices;
- Restoration of upstream forest and drainage system, decreasing sedimentation in the reservoir and increasing ecological connectivity and biodiversity.