Climate Change Vulnerability Assessment Beung Kiat Ngong Ramsar Site, Lao PDR

Colleen Cranmer, Amy Scott, Oudomxay Thongsavath, and Khamphat Xeuasing

Mekong WET: Building Resilience of Wetlands in the Lower Mekong Region

Food and Agriculture Organization of the United Nations

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

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ACRONYMS

CAM	Change Adaptation and Mitigation Methodology
CAWA	Climate Change in Wetland Areas
DAFO	District Agriculture and Forestry Office
DEQP	Department of Environmental Quality Promotion
DoNRE	District Office of Natural Resources and Environment
DWREO	District Water Resources and Environment Office
ENSO	El Niño Southern Oscillation
FAO	Food and Agriculture Organization
FCZ	Fish Conservation Zone
GIS	Geographic Information Systems
GMC	Global Climate Models
ICEM	International Centre for Environmental Management
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
Lao PDR	Lao People’s Democratic Republic
LECS5	Lao Expenditure and Consumption Survey (Round 5)
LEK	Local Ecological Knowledge
LMB	Lower Mekong Basin
MJG	Mak Jong Management Group
MoNRE	Ministry of Natural Resources and Environment
MRC	Mekong River Commission
MRWP	Mekong Regional Wetlands Project
NPA	National Protected Area
NTFP	Non-timber forest product
PAFO	Provincial Agriculture and Forestry Office
PDPI	Department of Planning and Investment
PoNRE	Provincial Office of Natural Resources and Environment
STRP	Scientific and Technical Review Panel
VA	Vulnerability Assessment
WCS	Wildlife Conservation Society
WREA	Water Resources and Environment Administration

INTRODUCTION

The effects of climate change are projected to result in a wide range of impacts across different systems. Assessing the vulnerability of natural resource areas to climate change is important for identifying high-risk areas for mitigation and adaptation. The complexity of wetland systems in their diversity of habitats and species as well as the provision of ecosystem services and resources for human populations, makes prioritising vulnerable areas a challenging but critical process for future management. In order to address this, a climate change vulnerability assessment was undertaken for the Beung Kiat Ngong Ramsar Site, in Southern Lao PDR under the CAWA project - Climate Adaptation in Wetland Areas.

There is a growing recognition of the importance of protecting wetlands in Lao People's Democratic Republic (PDR); efforts are underway to encourage environmental protection, thereby helping to secure the livelihoods of those that depend on their resources (Emerton, 2005). In September 2010, Beung Kiat Ngong (BKN) Wetland, in Champasak Province was formally recognized as a Ramsar site based on its unique habitats, vulnerable species and high socio-economic importance for the variety of ecosystem services it provides. It is one of only two Ramsar sites currently in Lao PDR. (Meynell et al., 2014)

Several studies on the Beung Kiat Ngong wetlands and the surrounding area have been carried out. A brief overview of the wetlands was included in Claridge's 1996 inventory of Lao PDR wetlands, even at that time it was noted that the area was heavily used by people, for resource collection and seasonal rice cultivation. In 2011, shortly after the wetlands were designated a Ramsar site, a baseline study of the area was conducted (IUCN, 2011). It provides a general overview of the landscape, ecology, biodiversity, economic, social and cultural values as well as management of the site and potential threats. In 2014, Duckworth and Timmins (IUCN, 2014), undertook a biodiversity survey of the wetlands, focused on assessing the bird community, its conservation significance, and threats to it as well as important wetland habitats that support it. An initial climate vulnerability study (Meynell et al., 2014), was also undertaken, with relevant data and information from this assessment cited in this document.

1 DESCRIPTION OF THE WETLAND

1.1 Location and site description

The Beung Kiat Ngong Wetlands is located in Champasak Province in southern Laos, approximately 25 kilometres southeast of the town of Champasak. The Ramsar designated site is 2,360 ha; but it is part of a much larger system of wetlands, the Pathoumphone wetlands complex, located in between the Bolaven Plateau to the north and the low lying hills of Xe Pian National Protected Area to the South (Meynell et al., 2014; International Union for Conservation of Nature [IUCN], 2014). The wetland area ranges from 125 to 200 metres above sea level, and is surrounded by forest and low, round hills with rocky outcrops (Claridge, 1996). The wetlands are an essential source of fresh water and food resources for surrounding villages (Claridge, 1996). They also provide many regulating ecosystem services such as reducing floodwaters in areas immediately downstream in the early wet season, and maintaining flows in the dry season.

Figure 1. *Location and site map of Beung Kiat Ngong Ramsar Site, Champasak Province*

1.2 Current and historic climate

The Beung Kiat Ngong wetlands are situated in a tropical region that is classified as a Tropical monsoon and trade-wind littoral climate (Am, under the Koppen Climate Classification) characterized by small annual temperature ranges, high temperatures and precipitation (Arnfield, 2017). The area experiences two distinct seasons, the dry season from November to early May and the wet season from May to October. Climate data for the site is based on closest meteorological records (Pakse Meteorological Station). Temperatures range from a minimum low of 14.5ºC in January (humidity 32-95%) to a maximum high of 38.3ºC in April (humidity 39-96%), with humidity approaching 99% throughout most of the wet season (IUCN, 2012). Over a 20 year period, between 1992 and 2012, mean maximum annual temperatures ranged from 30.8C and 33.1C and mean minimum annual temperatures between 22.6 C and 24.4 C (UN-Habitat, 2014). Average annual rainfall at the site is around 2,000 mm; based on historical records about 390 mm of that falls in August, whereas, January and February typically only see around 15 mm of rain (World Bank Group, 2018).

1.3 Hydrological characteristics

The two main water sources for the wetlands come from the Xe Khampho Basin in the Xe Pian Natural Protected Area (NPA) and the Tamo Stream Basin from the Dong Hua Sao NPA. The catchment in which the wetland lies extends over 133.64 km^2 (Lacombe et al, 2017). In the northern section, seasonal streams from the eastern slopes of the Xe Pian hills connect into the wetlands and a number of rivers and streams such as the, Xe Khampho, Tamo, Xe Pian and Xekong, the Takuan and Ta Euang connect throughout the wetlands; drainage generally runs from north to south (Meynell et al., 2014). Water permanence covers about 300-400 hectares of the main wetland area; the wetlands are fairly shallow throughout, however, there are some areas that can be as deep as 2-3 metres in the dry season (IUCN, 2012). Groundwater is an important component of the Beung Kiat Ngong hydrological system, and lateral groundwater inflows critical for maintaining the wetlands water balance. Groundwater levels peak at around 1 to 2 metres below the surface, in the latter stages of the wet season (typically September to November) and are at their lowest, around 4 to 5 metres below surface, at the end of the dry season (around May) (Lacombe et al., 2017).

1.4 Wetland habitats

The wetlands are a series of basins formed by lava flows from ancient volcanic activity associated with the Bolaven Plateau (Meynell et al., 2014). The basins have filled with alluvial sediments and peat; small areas of open water remain at the centre of these basins forming the main permanent water areas of Beung Kiat Ngong. The wetland complex is made up of a number of important habitat types, including peatlands, swamp/flooded forest, permanent ponds, freshwater marsh and seasonal flooded grasslands. Seasonal wetlands dominate the area but their ratio to permanent wetlands is hard to estimate as it varies year to year. Beung Kiat Ngnong is the largest basin in the Pathoumphone wetland complex and holds the complex's largest single expanse of permanent marsh (Meynell et al., 2014).

About 20-30% of the main marsh is covered by floating vegetation mats, predominantly graminoid-based (Meynell et al., 2014). There are patches of flood forest across the site, and seasonal and perennial flooded grasses are common in slightly elevated areas (IUCN, 2012). Peatland occurs in a number of locations in and around the Ramsar site and comprises a diverse vegetation assemblage. Peat depth in some areas is close to 4m (Quoi and Lo, 2015). The wetlands and its habitats provide a number of important ecosystem services that support communities living around the wetlands.

Figure 2. *View of the Beung Kiat Ngong wetlands from Phou Asa Mountain*

Ecosystem Services

The wetlands provide a number of both provisioning and regulating ecosystem services.

Provisioning services include the resources that are harvested such as a variety of aquatic plant and animal species for consumption, as well as water resources.

Regulating ecosystem services that the wetlands provide including:

- Flood mitigation
- Sediment trapping
- Storing and maintaining ground water
- Fish spawning ground
- Species habitat

1.5 Biodiversity

There have been several studies on the biodiversity in and around the Ramsar wetland over the past two decades. Birds have been the most well surveyed taxa group. Early assessments by Claridge (1996) considered the Beung Kiat Ngong Wetlands a significant area in Lao PDR due to the high concentration of waterbirds. A recent survey by Duckworth and Timmins (IUCN, 2014), included assessment of both mammal and bird populations in Beung Kiat Ngong but focussed on birds with respect to field surveys. While overall numbers of birds observed were low, diversity was relatively high, with over 120 bird species recorded across the Beung Kiat Ngong Ramsar Site and surrounding wetlands. It was identified that due to the size and complexity of the wetland complex, a number of species were present in nationally significant numbers: breeding Purple Heron, *Ardea purpurea*, Purple Swamphen, *Porphyrio* and Bronze-winged Jacana, *Metopidius indicus*, and perhaps Watercock, *Gallicrex cinerea* and Black Bittern, *Dupetor flavicollis*.

The survey also noted though that there are a number of bird species now extirpated or rarely seen, with high levels of hunting around the site identified as the major factor influencing conservation of most bird species. Other impacts are also present, and the survey determined that the bird most in need of direct protection is the critically endangered and long-distance migrant, the Yellow-breasted bunting (*Emberiza aureola*) (IUCN, 2014). The species conservation status was upgraded from endangered to critically endangered in 2018 with the species' global population decline greater than previously thought (BirdLife International, 2017). While direct hunting is not a known issue for this species at the site, its important grassland roost sites are vulnerable to trampling damage in the dry season when they become a favoured grazing area for domestic bovids (IUCN, 2014). Another important bird species identified in the survey is the large Asian openbill stork; it is listed as 'at risk' in Lao PDR but has been expanding its range through Southeast Asia (Meynell et al., 2014) Openbills eat the invasive snail, *Pomacea canaliculata* (Golden Apple snail), and as such act as a natural biological control benefiting both rice crops and wetland vegetation that are often destroyed by the snail, and should be considered an important species and a focus of protection for the site.

The wetlands also form an important habitat for fish during the low water dry season, as critical refuge, and in the wet season, as spawning grounds and migratory passage. Forty-three fish species have been recorded in the wetland during the wet season, while during the dry season about 20 black fish species remain in the area (IUCN, 2009). Black fish species found here are mostly carnivorous and detritus feeders such as *Channidae* (Snakeheads), *Clariidae, Bagridae* and *Anabantidae*. Migratory white fish use the main channels and streams to move into the wetlands at the beginning of the wet season when heavy rains signal their migration and raise water levels. Other important aquatic animals found throughout the wetlands are eels, shrimp, crabs, molluscs, and frogs.

The turtles found at Beung Kiat Ngong are of particular significance, regionally and nationally, however, species populations are highly depleted (Meynell et al., 2014). They are all listed as globally 'vulnerable' or 'endangered' on the IUCN's Red List (Asian Turtle Working Group, 2000). The following turtles (and tortoises) were either seen during village consultations, including recent VA surveys, or were cited by villagers as being present in or close to the Ramsar site:

- Malayan snail-eating turtle (*Malaemys subtrijuga*) - vulnerable
- Yellow headed temple turtle (*Heosemys annandalii*) – endangered
- Elongated Tortoise (*Indotestudo elongata*) – endangered
- Southeast Asian Box turtle (*Cuora amboinensis*) – vulnerable
- Giant Asian pond turtle (*Heosemys grandis*) – vulnerable
- Asian Leaf turtle (*Cyclemys oldhamii*) – vulnerable
- Asian soft shell turtle (*Amyda cartilaginea*) – vulnerable
- Big-headed turtle (Platysternon megacephalum) - endangered

Little is known about the population size, distribution and current status of most of these turtle species within the site and further research is needed.


Figure 3: *Turtle species present at the Beung Kiat Ngong Site (Clockwise: A. cartilaginea; H. annandalii (2x); M. subtrijuga; I. elongata, C. amboinensis)*

It is thought that most large mammals of conservation significance are now extirpated. There is a mosaic of forest types and habitat corridor areas, ideal for large ungulates and associated big predators. It is thought that many large mammals could once be found here, such as the Lesser one-horned rhinoceros (*Rhinoceros sondaicus*), Hog deer (*Axis porcinus*) Wild water buffalo (*Bubalus arnee*), Dhole (*Cuon alpines*), Leopard (*Panthera pardus*), Tiger (*P. tigris*), Asian elephant (*Elephas maximus*), Sambar (*Cervus unicolor*), Gaur (*Bos gaurus*), Eld's deer (*Cervus eldii*), and Banteng (*Bos javanicus*) (Duckworth, 2008).

The status of more wetland associated mammal species, including smooth coated otter and the fishing cat (*Prionailurus viverrinus*) are unclear. In recent VA surveys, there were indications that they may still occur, which would need to be investigated with further surveys. Mammal species more commonly reported include Muntjac, wild boar, lesser mouse deer, and several species of civet, ground- and flying squirrels and small rodents.

Flora diversity of wetland habitats is currently not well described. However, a medicinal plant survey was undertaken by Elkington et al. (2009) recording more than 240 plant species in the areas surrounding five of the core villages (Kiat Ngong, Topsok, Phapho, Kelae, and Phalai) (IUCN, 2012). One valuable tree species is Malva nut (*Scapium Macropodium,* Mak chong), which provides an important source of income for local people (IUCN, 2012). Mak Chong is only found in 3 districts of Southern Laos (Pathoumphone, Khong, and Sanamxay); also occurring in

Thailand, Cambodia and Malaysia (IUCN, 2008). Uncontrolled harvesting of Mak Chong trees is an issue with many being cut down immaturely due to their high market value (Sylavong, 2014).

2 COMMUNITIES, LAND USE AND LIVELIHOODS

2.1 Communities and population

Approximately 11,500 people from core villages and several outer villages live within the Beung Kiat Ngong wetlands area (IUCN, 2012). The eight core villages within or in close proximity to the Ramsar boundary were included in the current vulnerability assessment. The most up to date demographic information from these villages was collected during the September 2017 VA survey and is presented in Table 1. The current population of the eight villages is 9,025.

Table 1. *Village Demographics*

Village	Population	Male	Female	Households
Kiat Ngong	1220	651	569	223
Nongmakek	769	397	372	134
Phommalue	940	530	410	157
Kele	1127	545	582	209
Phapho	1852	900	952	325
Phalai	1538	749	791	329
Thopsok	661	340	321	112
Phak Kha	918	460	458	156

In 2014, a wealth ranking exercise was carried out in consultation with the eight core villages. When aggregated across all villages just under 7% of households were considered poor, 64% were considered middle class and 29% were considered rich. Estimates were based upon the villagers own perceptions of wealth and likely to vary somewhat between villages (Meynell et al., 2014). At the district level, the recent Lao PDR population census (LECS-5) identified a current poverty rate of 24% for the Patoumphone District (Coulombe et al., 2016).

2.2 Land use and livelihoods

Within the Ramsar site, wetland areas are on common or state land, owned by the government, however, local villagers have the right to use land and have 'owned' areas including house settlements, rice paddies, gardens, and fishing ponds (IUCN, 2012). The most common land use practice in Beung Kiat Ngong is agriculture, mainly rice cultivation, vegetable growing and large livestock production. Cattle, buffalo and elephants from 14 surrounding villages graze on the land (Meynell et al., 2014). Rice fields are present in approximately 30 – 40% of the Ramsar site, with the other 60-70% being natural wetland area (Meynell et al., 2014).

The villagers of the Beung Kiat Ngong wetland rely heavily on its resources, both in the form of direct wild plant and animal food resources, and its land and water resources for agriculture. Past estimates give an indication of the current importance of the wetlands for livelihoods, with annual economic benefits estimated back in 2009 to amount to US $849,682 from fish, non-timber forest products and agricultural products coming from the wetland (IUCN, 2012).

Tourism is another income generating activity that some villages of Beung Kiat Ngong are involved in. The BKN Wetlands and Phou Asa are among the most well-known tourism sites in

Champasak Province, after Khone Falls and Wat Phou Temple (IUCN, 2011). Elephant trekking is a popular tourism activity that makes up a large proportion of the site's tourism revenue (IUCN, 2012). In addition to elephant tours, other services include guided eco-tours of the wetlands and surrounding NPA, guesthouses, home-stays and sales of handicrafts and other local products (IUCN, 2011). In 2003 Kiat Ngong village was a focal community for the Emerald Triangle Initiative, which aimed to expand sustainable tourism activities in the area where Cambodia, Thailand and Laos meet (Autthapon and Suthida 2010).

There are some concerns for maintaining present tourism attractions of the site. One major concern is the sustainability of the elephant-based tourism and preservation of the elephant population in Beung Kiat Ngong. Low elephant numbers, lack of breeding opportunities and declining interest to carry on mahout traditions are highlighted issues. Other concerns include low bird populations within the wetlands (IUCN, 2014) which may reduce attractiveness of the site from a wildlife perspective compared to other wetlands in the region.

2.3 Gender and vulnerable groups

Gender

A gender survey was conducted by the CAWA team in January 2017 in several villages within the Xe Champhone wetland. While not undertaken in the Beung Kiat Ngong site, it is expected that some considerations will be similar in regards to gender roles that men and women play within their livelihood activities that stem from traditional gender norms and values (IUCN, 2017a).

Rice farming is the most prominent livelihood activity. Men and women take on separate roles and responsibilities to ensure the complex production process is carried out efficiently. An example of the typical division of labour for rice production in Xe Champhone villages is as follows:

Women's tasks: soaking and scattering rice seeds to create the seedling banks, transplanting seedlings to the rice paddy, helping with the harvesting and managing the money earned from rice farming.

Men's tasks: purchasing the seeds and fertilizer, preparing the rice paddies for planting, operating the tractor or other machinery (e.g. rice planting machine), maintaining the water levels, fertilizing the soil, transporting rice grain from the paddy to the storage barn, harvesting and selling the rice.

The collection and use of certain wetland resources is also divided between men and women. In regards to fishery resources, men fish for larger sized economically valuable fish found in the deeper parts of the wetland lakes using gill nets, cast nets, set pole and hook and traps. Women collect and fish using scoop nets, barrage nets, and lift nets, closer to shore in the shallower parts of the wetland (IUCN, 2017a). In processing, women ferment and dry the fish to make 'padek' for home consumption or selling. Women have principal responsibility for selling fish at local markets, and both men and women sell fish directly to middlemen or buyers that come to the village or wetland site (IUCN, 2017a).

Ethnic groups

The eight core villages surrounding the Ramsar Site are represented by only one ethnic group, Lao Loum.

Other vulnerable groups

Within villages of Beung Kiat Ngong, a small proportion of families were identified as vulnerable due to poverty (Meynell et al., 2014), and potentially less resilient to impacts of climate change. Additionally, the declining proportion of young people staying in communities, identified through

VA surveys may lead to loss of knowledge transfer as well as labour, making villages in general more vulnerable to future changes. The quality of elderly villagers' livelihoods may also decrease without the presence of the younger generation to care for and support them, and with increasing pressures of climatic events such as droughts, floods and extreme heat.

2.4 Governance (institutions, management bodies)

The key governmental departments involved in the on-ground management of the wetland are DoNRE and the District Agriculture and Forestry Office (DAFO). Regulations related to natural resource management have been enacted at the district level and these rules are generally implemented and enforced by villages and village development clusters (known in Lao as Khumbans) (ICEM, 2012a).

At the Province level, the Provincial office of Natural Resources and Environment (PoNRE) and at the central level, Ministry of Natural Resources and Environment (MoNRE) are responsible for management planning and administration. MoNRE is also responsible for Ramsar implementation and three Ramsar focal points (National; Community Education, Participation, and Awareness Focal Point [CEPA]; and Scientific and Technical Review Panel [STRP]) reside in the Division of DEQP at the national level. Cross-sectoral Ramsar committees have been established at the national and Champasak provincial levels. At the local site level, a multi-sectoral District Ramsar implementation team has been established, and is responsible for implementing designated management activities.

Local communities play important roles in developing and implementing village level regulations with respect to land use and conservation, including the establishment and enforcement of fish conservation zones and regulations associated with harvesting practises and seasonal restrictions. Land Use Plans (LUPs) have been developed for several villages under past projects that designate land use zoning.

3 CLIMATE PROJECTIONS FOR THE SITE

Climate projections for the Champasak Province and Beung Kiat Ngong indicate a number of changes in rainfall, temperature and extreme events. It is projected that by 2050 there will be an increased mean annual temperature of 2.2°C and an increased maximum temperature of > 3°C. This will manifest as the average daily maximum temperature rising steadily from around 32°C in January to 37°C in April. These changes will increase evapotranspiration rates in the dry season and lead to a decrease in the availability of water in the wetland.

With respect to rainfall, an overall increase of 10% in average annual rainfall from the baseline is projected. However, rainfall distribution will change during the year, showing a slight reduction in the dry season, but significant increase in May and throughout the wet season (between 5-15%). It is expected that the increase in rainfall will occur as more intense rainfall, rather than more rainy days. Increased frequency and intensity of storms from three to four events per year is projected, and increase in intensity of rainfall from 120 mm to 142 mm in a day (+8.5%) (MRC, 2012).

Similar projections with some variations are predicted across the Mekong Basin and the major risks and impacts that have been identified, include:

- Higher peak flood levels resulting in significantly increased flood damage during extreme events
- Changing extremes of drought years causing lower flows, water stress and increased salinity affected agriculture
- Food security may initially improve due to increased production and irrigation development but will suffer during severe drought years resulting in potential food shortages and/or economic loss

4 VULNERABILITY ASSESSMENT METHODOLOGY

The methodology used for the Vulnerability Assessment conducted at the Xe Champhone site has been taken from the guidance notes for rapid climate change vulnerability and disaster risk assessment for the CAWA and Mekong WET Projects (Draft V.0.5). It is based on the Mekong River Commission's 2012 methodology report for rapid climate change vulnerability assessments for wetland biodiversity in the Lower Mekong Basin (ICEM, 2012b). The vulnerability assessment process for the Xe Champhone Ramsar site aims to identify, and thereby mitigate, climate change vulnerabilities of communities and the wetland ecosystems they depend on.

4.1 Scope

The scope of the VA is focused on livelihoods related to wetland resources and climate threats within the Ramsar site boundary and the adjacent villages that rely on its resources. However, other factors outside of the scope were also considered when assessing holistic vulnerability, such as socio-economic issues, governmental policies, as well as the wetlands connectivity beyond the site boundaries.

4.2 Ecological Response Model

Researchers used an ecological response model to assess the vulnerability of the wetlands. This includes utilizing a combination of expert opinions supported by scientific evidence to identify the inputs into the model. Scalability is an important aspect to the model, especially in this assessment where data or information specific to the wetlands was not always available. The model uses the inputs of exposure, sensitivity and adaptive capacity to measure vulnerability. Exposure is the frequency and directness to which the wetland experiences one or more climate driven events, for example, temperature extremes, rainfall, hydrological changes (evaporation, runoff, water levels) and extreme events (droughts, typhoons). Sensitivity is the degree to which a wetland component, i.e. habitat, species, is likely to be affected by the threat. The potential impact is the combined effect of exposure and sensitivity when faced with a specific threat. For this assessment, researchers decided estimated impacts based on the direction and size of the observed trend. The adaptive capacity is the ability to change and continue to exist under the new conditions.

4.3 Local Ecological Knowledge (LEK)

An integral part to the vulnerability assessment is to include the communities who depend on the fragile ecosystems within the Ramsar wetlands. Researchers used this approach to provide a way to validate expert opinions and research. The CAWA team identified all relevant stakeholders in the area to ensure that all parties would be included and involved in the assessment process. The process considered gender as a factor to ensure that the survey considered the needs and perspectives of women. This included separate focus group discussions for women, and ensuring that there were women representatives on each VA team to administer the questions.

4.4 Vulnerability Assessment Process

The process for carrying out the VA can be found below. The final steps (10, 11) are currently underway and are being implemented over the next month.

1) Baseline research - conducting a comprehensive search of the existing information on the wetland and selected villages (GIS data, land tenure and land use rights, governance, stakeholder analysis, identification of vulnerable groups including women).
2) VA tool training for government counterparts & stakeholders
3) Identification of key habitats and preliminary habitat assessments
4) Formation of VA teams for village assessments
5) Introducing the project to the communities
6) Conducting the Village VA in a consultative process
7) Identification of key species and conduct species assessments
8) Collation of data and writing of the VA report
9) Validation of the VA results with team members and the communities
10) Developing adaptation options to be incorporated into the wetland management plan (or other relevant plans);
11) Implementing, monitoring and adjusting adaptation options.

Implemented VA Tools

The Vulnerability Assessment includes a suite of three tools that are simple and replicable, in the form of an Excel Spreadsheet. The tool and the associated information collected were done as a combination of field data collection and desk based research. All of the data and information from field and desk based research has been collated into excel spreadsheets and GIS maps. It has been analysed using Microsoft Excel tools, and evaluated spatially using QGIS to observe where wetland habitats and resources are being used relative to the Ramsar boundary.

Habitat VA Tool	Village VA Tool	Species VA Tool
• Habitat baseline • Habitat threat • Climate threat analysis of habitat	• Wetland information and baseline • Wetland socio-economic data • Climate history • Frequency of impacts • Current coping strategies • Future coping strategies • Wetland management	• Species baseline • Species threat • Climate threat analysis • Overall Assessment

4.5 Village Consultations

Eight villages were selected to be a part of the Beung Kiat Ngong assessment. The villages were chosen based on the criteria set out in the VA guidance notes. It ensures that the selection includes:

- A representation of different habitat types within the wetland

- Villages located along the Ramsar boundary as well as inside the boundary and core zones
- Different village clusters that have different socio-economic characteristics and ethnic groups
- Villages that depend on different types of resources in the wetland.

In September 2017, two local teams were formed to carry-out the village consultations. Half-day meetings were held in each village with about 30 village participants; there was an aim to have gender parity at each meeting and generally it was achieved though there were usually more men than women and women sometimes had to leave during meetings to attend to chores.

The teams used a printed out version of the rapid VA tools as a template for field notes that were later transferred to a digital format in Microsoft Excel. The VA survey teams included representatives from government (Department of Environmental Quality Promotion, DEQP/MoNRE; Provincial and District Offices of Natural Resources and Environment (PoNRE/DoNRE) and Provincial and District Agriculture and Fisheries Offices (PAFO/DAFO)) supported by team leaders from IUCN and FAO with experience in climate change adaptation.

As part of the Village VA tool several additional activities were carried out for the assessment. A participatory mapping exercise was performed using hand-drawn paper maps with each village to identify areas where they collect important wetland resources. The maps were then used to facilitate discussions on climate development threats to resources, as well as coping strategies. The maps were later digitized into Geographic Information Systems (GIS) for further spatial analysis. Seasonal calendars were also developed by asking the villagers to identify periods over a 12-month cycle when a particular wetland resource is being collected.

A VA validation workshop was held April 27th 2018 to review and present the findings of the assessment to all BKN villages. Village representatives generally agreed with the findings of the project and additional comments and recommendations have been collated and incorporated into this final report.

5 RESULTS OF VULNERABILITY ASSESSMENT

5.1 Habitat VA

A habitat vulnerability assessment (VA) was undertaken using the habitat VA tool for key wetland habitat types identified at the Beung Kiat Ngong Ramsar Site.

The habitat VA tool consists of a series of questions split into two major components a) habitat baseline vulnerability, that assesses existing threats or limitations for the habitat, and b) habitat climate change vulnerability, that assesses threats from projected climatic changes. The baseline component has questions relating to the habitat size, status and distribution at the site level and in the Lower Mekong Basin (LMB), habitat maintenance requirements and resilience, significance of the habitat in relation to keystone, flagship and resource/economic species, and current threats to the habitat. Climate vulnerability looks at questions related to a habitat's exposure, sensitivity and adaptive capacity to projected climatic changes and extreme events, i.e. drought, flood, temperature change. Each question is scored (1-low - 3-high risk/vulnerability) based on evidence sourced from the literature and/or local knowledge base. Final total scores translate to a category ranging from low vulnerability to very high vulnerability.

Six major wetland habitat types within the Beung Kiat Ngong Ramsar site were identified through field surveys, expert consultations and reviews of previous studies. Habitats are classified based on their physical terrain morphology, hydrological characteristics/water regime and/or vegetation type.

'Terrestrial' forest types, such as semi-evergreen and deciduous forests that border the wetlands, are not specifically *wetland* habitats, and as such, their vulnerability is not assessed here. However, forests other than flooded forest, were identified as important habitats/resource collection areas, and are discussed further in section 5.2.1.a.

Habitat descriptions:

- **Freshwater marshes**: Typically shallow seasonal highly vegetated habitat areas, dominated by reeds, sedges and grasses. The largest area of more permanent marsh is located in the northern section of the Ramsar site.
- **Peatland**: There is approximately 600 hectares of high quality peatland identified in the northern part of Beung Kiat Ngong, and several smaller surrounding areas High variability and diversity of plant species occur within peatland areas (Quoi and Lo, 2015; Meynell et al., 2014).
- **Streams**: Includes all flowing systems, from small to large streams that flow into and out of the wetland, incorporating the stream channels and their riparian area.
- **Permanent ponds:** Characterised by their depth and permanent water regime, often with open water areas but also vegetated, with various aquatic herbs, macrophytes, shrubs and floating vegetation mats (Meynell et al., 2014)
- **Flooded forest:** Areas of seasonally flooded forest dominated by tree species such as *Barringtonia acutangula* and *Xanthophyllum flavescens* (Khok seng).
- **Grassland:** The grasslands found in Beung Kiat Ngong are both terrestrial and seasonally flooded. A variety of grass species occur but with large areas dominated by one or two species.

Table 2. *Key values and ecosystem services of Beung Kiat Ngong habitats*

Habitat	**Key value/ecosystem service**
Freshwater Marsh	Food Resources/ ground water regulation/fish spawning grounds
Peatland	Carbon storage/ water storage/Refuge habitat
Stream	Food resources/Migratory fish habitat
Permanent Ponds	Food resources/Refuge habitat
Flooded Forest	Erosion-sediment control/ground water regulation/Turtle & fish nursery habitat
Grassland	Grazing resource/habitat for small mammals, birds

A vulnerability assessment was undertaken for each of the six wetland habitats. Table 3 displays final vulnerability ratings for baseline risk status and climate change vulnerability, identified for each of the habitats assessed, with a range of ratings from low to high identified across different habitat types.

Table 3. *Assessed baseline risk status, climate change vulnerability and overall vulnerability of Beung Kiat Ngong habitats*

Habitat	Baseline score	Baseline Risk Status	CC Vulnerability Score	Climate Change Vulnerability	Habitat Vulnerability (Baseline + climate change)
Peatland	2.4	High	2.3	High	High
Freshwater marsh	2.3	High	1.9	Mod	Mod
Permanent ponds	2.2	Mod	2.1	Mod	Mod
Streams	2.1	Mod	2	Mod	Mod
Flood forest	2.1	Mod	1.8	Mod	Mod
Grassland	2.1	Mod	1.6	Low	Low-Mod

Table 4. *Scoring scale for category intervals*

Category interval	Low	High
Very High Vulnerability	**2.7**	**3**
High Vulnerability	**2.3**	**2.6**
Moderate Vulnerability	**1.9**	**2.2**
Low Vulnerability	**1.5**	**1.8**
Very Low Vulnerability	**1**	**1.4**

A summary discussion highlighting the main justifications for vulnerability levels assigned is presented below for all habitats in order of vulnerability, firstly addressing baseline risk status and then climate change vulnerability. See Appendix II for sample assessments with details of questions and scoring.

5.1.1 Habitat baseline risk and threats

The natural habitats of Beung Kiat Ngong face pressure from a number of activities and threats occurring in and around the site, with surrounding communities highly dependent on the wetland's resources for their livelihoods. Baseline risk is also associated with the size, status and importance of habitats for resources and ecosystem services.

High baseline risk: *Peatland, and freshwater marsh*

- **Peatland**: The Beung Kiat Ngong Wetlands is unique as one of the few places in Lao PDR where peatland areas can be found (Quoi and Lo, 2015). Land clearing and water extraction by local villagers to create fish ponds has removed some peat areas, but major damage was done from 2006 to 2009 with commercial peat extraction undertaken by a Vietnamese company to sell as a fertilizer. Large quantities of peat were extracted over this period, with volumes of 650 cubic metres of peat per day for 3 months each year reported by the Ban Kiat Ngong council (IUCN, 2008). Peatland is difficult to restore, and maintenance of peat requires prolonged inundation that it receives from floods during the wet season. Fire is a current threat to the sites peatlands with areas known to be burnt in recent years (Quoi and Lo, 2015).
- **Freshwater marsh**: Significant areas of cultivation occur along the habitat's edge and in the central and southern sections of the wetland. Removal of shrubs and trees is undertaken to increase resource access. The greatest current impact to the habitat is the invasive Golden apple snail that is causing significant damage to marsh vegetation. Large livestock, cattle and buffalo use the shallow marsh habitat and where populations are too high they can trample and damage habitat vegetation. Water extraction is currently not extensive but has the potential to increase; proposed infrastructure projects may put further pressure on the habitat.

Moderate baseline risk: *Streams, Flood forest, Permanent ponds, Grassland*

- **Permanent ponds***:* This habitat type covers a small area compared to other habitats in the wetland but is critical in providing important refuge habitat for many resource species, including large economic fish species such as Pa do (*Channa micropeltes*). The habitat type suffers less from major disturbance or encroachment compared to marsh habitat due to the depth of the habitat, its importance for fisheries and being less suitable for conversion. In Beung Kiat Ngong permanent ponds tend to be found in the central area of the main marsh. A good groundwater connection is thought to maintain these habitats (Meynell, pers. com., 2017).
- **Streams***:* Some clearing has taken place along the riparian boundary of streams within the Ramsar site, but most surrounding streams are within a forested catchment and remain intact. Though currently limited, a few modifications and diversions occur, such as small dams with stop banks. A number of economically important fish species use the stream habitat, and it provides an important migratory route. Maintaining the sites streams is increasingly important on a broader scale due to unmodified flowing habitats declining throughout the Lower Mekong Basin as a result of increasing infrastructure and loss of riparian areas.
- **Flooded forest***:* Flooded forest now only covers a small area of the Ramsar site, and has experienced past clearing and conversion for cultivation as well as timber extraction (IUCN, 2015). Flood forest was highlighted during village consultations as an important habitat for several threatened turtle species in Beung Kiat Ngong. Regular seasonal flooding is an important process to regenerate and maintain its distribution.

- **Grassland***:* Conversion and modification of grassland for agricultural purposes (grazing, cultivation) is common in the site. Regular burning is undertaken to improve fodder quality; but certain levels of fire are tolerated and an important component of the habitat for its maintenance and regeneration (Meynell et al., 2015). The golden apple snail is also impacting the flooded grassland areas of Beung Kiat Ngong (CAWA VA, 2017).

5.1.2 Habitat Climate Change Vulnerability

Climate change threats vary on how they affect different habitats, with vulnerability ratings for the assessed habitats ranging from high to low vulnerability.

High climate change vulnerability: *Peatland*

Peatland: An important habitat for species refuge from climatic events such as drought and extreme heat, as well as playing a key role for livelihoods, storing water year round, and for fisheries and livestock grazing (Quoi and Lo, 2015). An increase in temperatures would result in more frequent drying of peatland, potentially leading to acid sulphate soil impacts, as well as increased fire risk leading to damage of peat (Meynell et al., 2014). Increased drought severity (length, frequency) would also risk the habitat's ability to regenerate. Hydrological changes in the catchment and increasing water resource pressure could lead to higher levels of water extraction from peatland areas.

Moderate climate change vulnerability: *Freshwater marsh, Permanent ponds, Streams and Flood forest*

Freshwater marsh: Shallow marsh habitats will be at risk from increased water temperature, a reduction of water quality and more rapid and frequent drying during low rainfall periods. Species that depend on longer periods of inundation (i.e. larger water birds) may experience a decrease in breeding success. Although this area of the wetland is extremely dynamic and will quickly re-establish itself in the wet season with increased rainfall, it has a moderate vulnerability to extreme drought events (such as El Niño events), which will dry up more permanent areas. Marsh water supply is dependent on local rainfall and will mostly benefit from the moderate increase of precipitation expected to occur during the wet season in the next few decades (MRC, 2014). The invasive golden apple snail is likely to increase under climate change due to higher flood levels (Joshi, Cowie, and Sebastion, 2017).

Permanent ponds: Deeper permanent areas will face threats from moderate decreases in rainfall during the dry season, and increased evaporation rates and severity of droughts, but be buffered by the greater depth of ponds compared with other habitats. Increased fishing pressure is expected during the dry season especially in shallower ponds, as less permanent areas dry out (Meynell et al., 2014). The expected ground water connection of deeper ponds reduces their reliance on rainfall/surface flows and more severe impacts (Meynell, pers. com., 2017). The habitat is likely to provide important refuge for many species in the future under climate change.

Streams: Due to the site having a small forested catchment, streams are relatively buffered from increased frequency and strength of catchment flows, and therefore are only expected to be moderately impacted from hydrological changes due to climate change. Some less protected stream channels in cultivation areas may see an increase in erosion and channel cutting from faster flows that occur during the wet season. Seasonal streams are expected to be vulnerable during the dry season but then experience flash flows in the wet season.

Flooded forest: The tree and shrub species found in the flooded forest, such as *Barringtonia sp*., are generally tolerant to prolonged flooding and moderate levels of drought. Temperature changes, however, may affect the timing and success of flowering, fruiting and seed set (Meynell et al., 2014). Flood forest trees are likely to survive periods of drought, but increased frequency could alter the habitat to an extent that they cannot further adapt, affecting habitat distribution. Sedimentation is not a major issue as the water flowing into the forest comes from small streams with low sediment loads. Increased temperature and evapotranspiration effects will likely be moderately buffered by the dense vegetation/canopy in this habitat.

Low climate change vulnerability risk: *Grassland*

Grassland: Grassland areas are expected to dry out faster during the dry season but are considered to be relatively tolerant to droughts and floods as the dominant grass species can quickly regenerate. There is a risk of increased fire frequency from higher temperatures and prolonged drought, and the potential for species composition to alter with change in drought/fire/flood regimes, but generally, grassland is considered to have a low vulnerability to climatic extremes then other habitats. More intense floods may cause the loss of terrestrial habitat that may impact some grassland bird species (Meynell et al., 2014).

Habitat VA Summary:

Baseline threats

Most baseline risks are associated with the past (or current) clearance and conversion of lands for agricultural, and resource use, including of peatlands, freshwater marsh, flood forest and grassland. The small distribution of some habitat types and their importance for resources and species as refuge areas (such as permanent ponds) puts them at increased base line risk in the assessment process.

Climate threats

Major climate threats include increased drying of habitats areas particularly during the late dry season, and increased flood levels/flows leading to increased erosion of small streams and sedimentation/damage to habitat areas, such as spawning grounds. Conditions are expected to favour periods of intense drought as average annual temperatures and evaporation rates rise, leading to increased water extraction, and exacerbating drying impacts. Increased rainfall during the rainy season may mitigate some of the issues from drought depending on the resiliency of the habitats.

5.2 Village VA

The Beung Kiat Ngong village vulnerability assessment collected data for a number of key attributes associated with resource use and climate change impacts. Parameters surveyed for each village, disaggregated by gender, were:

- Key wetland resources and priority ranking
- Use of resources and their availability across seasons and habitats
- Impacts of different climate change variables – in particular, drought, flood and extreme temperatures.
- Current coping strategies to manage impacts, and success level of strategies identified
- Identification of future coping strategies
- Community recommendations for wetland management

5.2.1 Wetland Resources

Twenty-one resource types were identified as priority resources between men and women across the eight villages. The average top 10 resources for men and women are presented in Figures 4 and 5, and resource rankings for all villages are presented in Appendix I. Differences between resources used are discussed below to highlight the differences in availability and priority.

5.2.1.a Priority resources

Both men and women in all eight villages ranked fish as their number one priority resource. Men identified seventeen priority resources while women identified eighteen. Overall, women and men identified similar priority resources in their top 10: *fish, snails, eels, frogs, shrimp, bamboo shoots, vegetables*, *crabs,* and *turtle.* The top five resources are identical, with only eels (3rd for men, 2nd for women) and snails (2nd for men and 3rd for women) switching rank between the genders. Not in the men's top 10 but found in the women's were birds (9th), whereas men ranked birds much lower (15th). This could be related to the roles in resource collection where women set and collect traps for birds. The top five resources are all aquatic animals, indicating the importance of the wetlands for priority resources. Turtles were the largest aquatic animal included in the top 10 resources, and with larger vertebrates generally facing high threats from overharvesting this is an important consideration (see text box).

The resources that men cited that women did not were red ant eggs, and women noted firewood and malva nuts that men did not. While women generally have a greater role in foraging activities such that they are usually considered the main collectors of plant based resources (IUCN, 2017a), women and men both cited the resources 'vegetable, bamboo shoot and mushroom', in overall similar priority positions. This may reflect the large areas of forest surrounding the Beung Kiat Ngong site, with these resources likely to be equally encountered by men and women. 'Wild animals' and 'Large mammals' were cited separately by men and women, with the category 'wild animals', including mammals as well as some large forest birds and reptiles, but they are considered generally similar categories of larger forest vertebrates.

Two types of algae (Grey algae 'thao' and green algae 'pham') have been identified as being exclusively important resources, by both men and women from several villages. The difference between green and grey algae rankings and whether it was ranked at all could be attributed to its availability within the community's resource area, with algae being principally found in stream habitats.

Several resources were only cited by one village each, including Red ant eggs (Thopsok), wild animals/large mammals (Phalai); Birds (Phommalue), small mammals (Phak kha). Individual village differences likely reflect proximity to certain habitat types, i.e. Phalai and Thopsok are close to larger terrestrial forest areas, where red ant eggs and wild animals/large mammals are more likely encountered.

Turtle Abundance – A Warning

Turtles were ranked overall 7th by men and 10th by women in Beung Kiat Ngong, whereas they were ranked much lower in the Xe Champhone wetlands, 18th by men and 20th by women. This is likely due to the rarity of turtles now in Xe Champhone, identified by communities, due to past overharvesting. This should be considered as a warning sign for Beung Kiat Ngong as it has not yet experienced the loss of turtle species to the extent that the Xe Champhone wetland has.

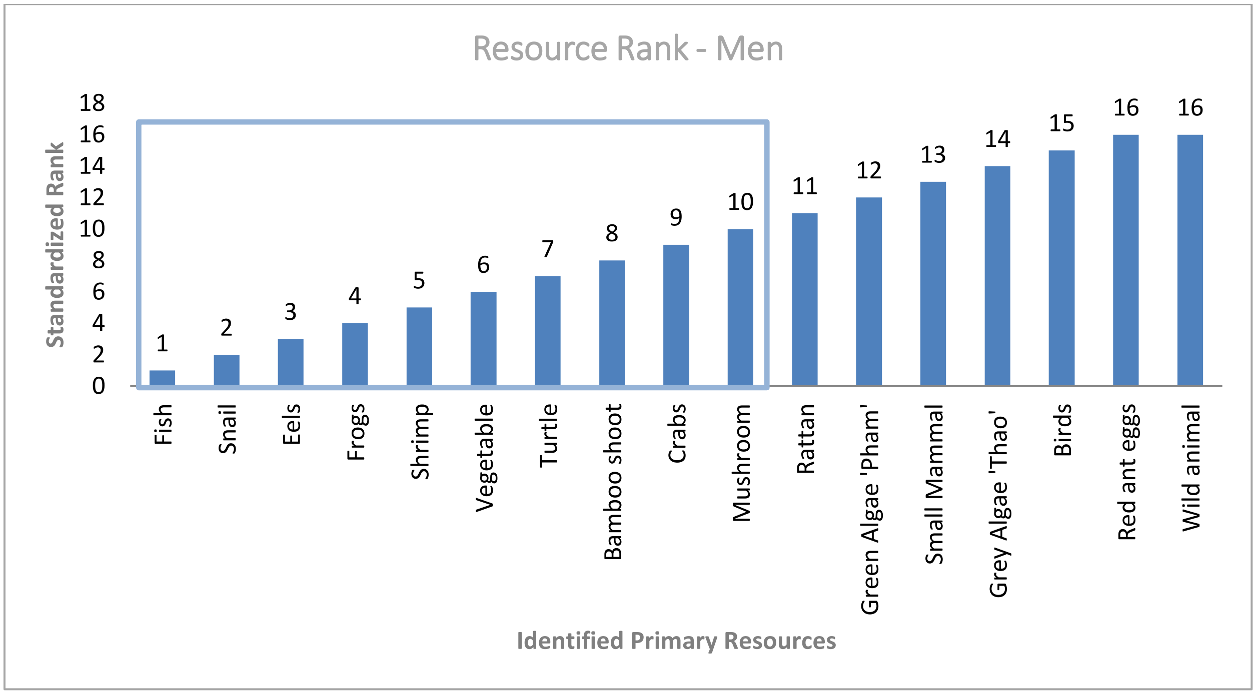


Figure 4. *Priority ranking of wetland resources (men)*

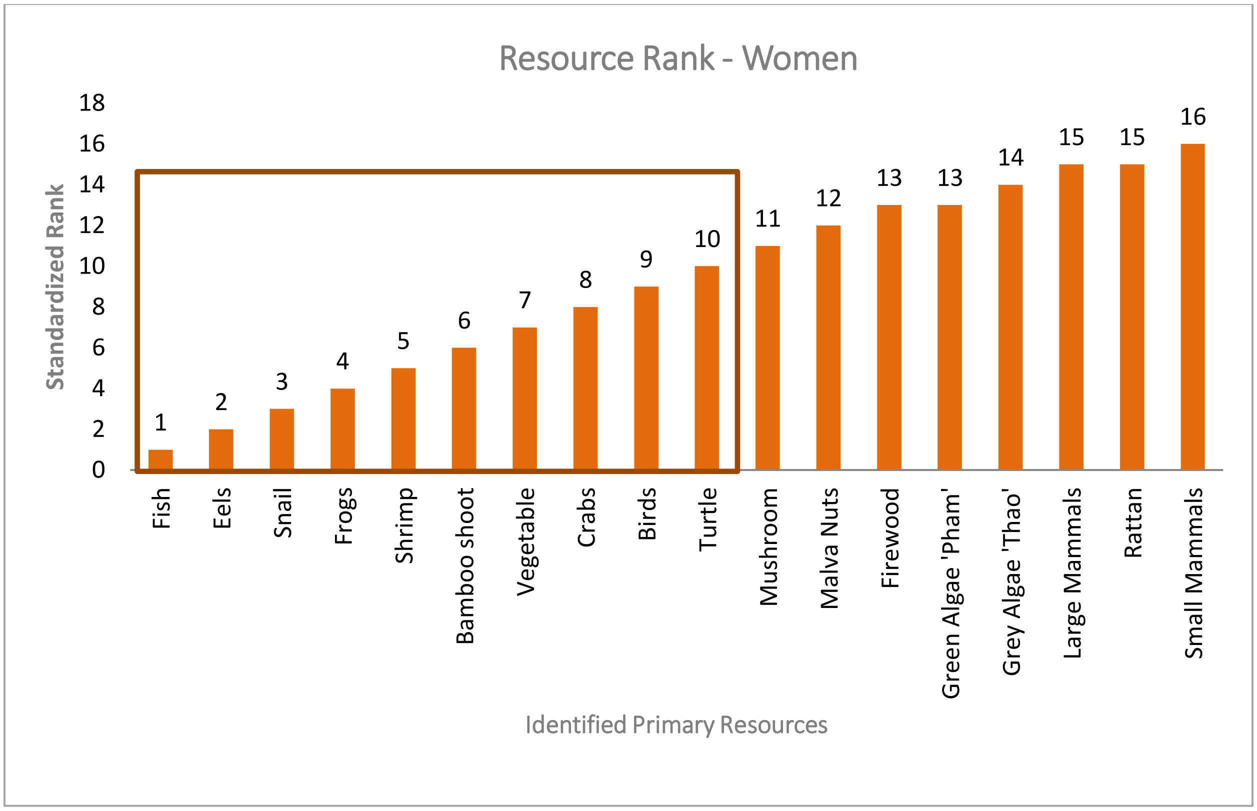


Figure 5. *Priority ranking of wetland resources (women)*

5.2.1.b Important species of priority resources

Villagers were asked to list key species for each resource, and a number of important species, including economic species were identified as priority resources:

Fish: Widely cited as a main source of income and used for personal food consumption, primary fish species caught include: Pa Khor (*Channa striata)*, Pa douk (*Clarias batrachus)*, Pa ka deut (*Trichogaster trichopterus)*, Pa Kheng (*Cirrhinus sp.)*, Pa serm (*Kryptopterus bchirrhis)*, Pa kod (*Hemibagrus filamentus*), Pa lod (*Macrognathus sp.),* Pa lad *(Mastacemblus sp.)*, and Pa Xew (*Opsarius koratensis)*

Eels: Compared to fish, eels have very low species diversity and resource use is restricted to a few species. Similar to the Xe Champhone wetlands, the most commonly reported eel species utilised is Pa ein, the Asian swamp eel (*Monopterus albus*). The species tends to burrow when there is a decline in water level at the beginning of the dry season, and emerges at the beginning of the wet season when the water levels start to rise (Meynell et al., 2014).

Snails/Molluscs: Most commonly collected are, Hoi Ka Tai, Hoi Joup and Hoi Pang *(Pila sp.).* Also consumed is the invasive golden apple snail *(Pomacea canaliculata)*, however it is less preferred than native species.

Invertebrates: Several species of crab are collected for subsistence and selling, the most common species found are Ka Pou Na and Ka Pou Deng, Ban Phapho also cited collection of Ka Pou hin. One type of shrimp, locally called Koung Foi, is collected.

Frogs: Often recorded as being caught in the rice paddy fields after rain. The species most widely caught are Kop Na (*Hoplobatatrachus rugulosus)*, and Kiat Na *(Fejervarya limnocharis)*. Important seasonal species include Eung Phao (*Glyphoglossus molossus)*, and species less widely favoured but still sourced are, Khiat Chik, and Khiat Leung *(Rana lateralis)*.

Birds: Although there are many bird species present in the wetland only 4 species were cited as a main resource: Nok Ka Ped, Nok Pet, Nok Kai Na, and Nok Pet Deng.

Turtles: A variety of species can still be found throughout the wetlands, the most commonly noted and favoured as a resource are: Tao sam san, (Malayan snail-eating turtle, *Malaemys subtrijuga*), Tao Goun (Yellow headed temple turtle, *Heosemys annandalii*), Tao phek, (Elongated Tortoise, *Indotestudo elongata*), Tao ngap, (Southeast Asian Box turtle, *Cuora amboinensis*), Tao kwai, (Giant Asian pond turtle, *Heosemys grandis*). *Note some turtle species have different Lao names between BKN and XCP Ramsar sites.

Mammals: 'Wild animal' defined by men are, lizards, civets, deer, wild pig, and wild chicken. 'Small mammals' have been defined as squirrels (Ka tae) and rats (Nou). Men in Kele noted the collection of several rat species (Nou vai, Nou thong khao, Nou phaeng, Nou phouk). 'Large mammals' were defined as wild boar and muntjac deer *(M. muntjak*).

Bamboo: Harvested predominantly for its shoots, bamboo makes up a large vegetable component of local diet. The main species utilised are, Nor Mai Lai, Nor Mai Ka Sa, (*Bambusa spp*.) and Nor Mai Heer. The Biodiversity Corridor Initiative carried out an analysis of the most important NTFPs in 11 villages in and around Beung Kiat Ngong, bamboo shoot was also ranked highly for this assessment, but with less market value than other NTFPs and used largely for domestic purposes (IUCN, 2011).

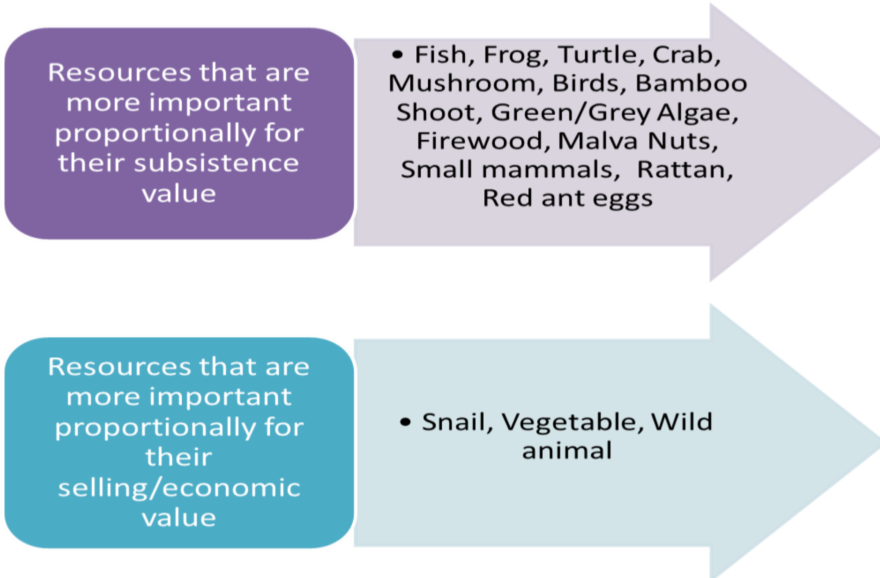
Vegetables: Wild plants collected for consumption include the leaves, flowers, stems, seeds, tubers and/or fruits of a wide range of terrestrial and aquatic plant species. Such species include, swamp morning glory, Pak bung (*Ipomoea aquatic*a) Phakadon (*Careya sphaeica*), Pak Kayeng (*Limophila aromatic*a), Phak nok (*Centella asiatica*), Pak Kha Mek, Pak Tew, and Pak Van.

Mushroom: A variety of species or types of mushrooms/fungi were identified from VA surveys. Only Lao names are available for most of these due to limited local inventories of mushrooms and/or scientific names. Major utilised varieties include Hed Khao, Hed bod, Hed Tin Pok, Hed Puak, Hed Phor, Hed Pok. Hed Phor is a particularly high value species with selling price per kilo reaching 50,000-100,000 LAK (CAWA VA, 2017).

Algae: This resource was specifically categorized as two different types of algae by several villages. Grey algae 'thao' and green algae 'pham' are both collected for consumption, but occasionally are sold at the market to other villagers.

5.2.1.c Use of resources

For priority resources identified above, the proportionate use of each resource was recorded. Uses were largely categorized as either 'subsistence/household' use or 'selling'. Averages for these two use categories, for each resource, were calculated across villages (see figure 6).



*Note: Proportion/percentage of use was not recorded for all villages and was not recorded for tall grass. Some resources were proportionally used the same (50/50) for both subsistence and selling (i.e. large mammals, eel).

All resources are used for consumption and/or sold at the markets with a few exceptions. Tall grass is used for making mats. In Kele village, crabs are used only 10% for consumption, the other 90% is used as bait for fishing.

For all records, the average of the responses has been used to represent the resource. Not all resources had a large data set to extract proportional values from. The data from the villages that did respond is applied to the resources as a whole to allow for an extrapolated analysis. Some resources only had one response for the percentage of selling versus subsistence, i.e. tall grass, firewood and wild animals.

The majority of records that cite birds as a resource come from women and record birds as being 100% used for subsistence. The lack of economic use for birds may reflect why men did not cite birds as a higher priority resource.

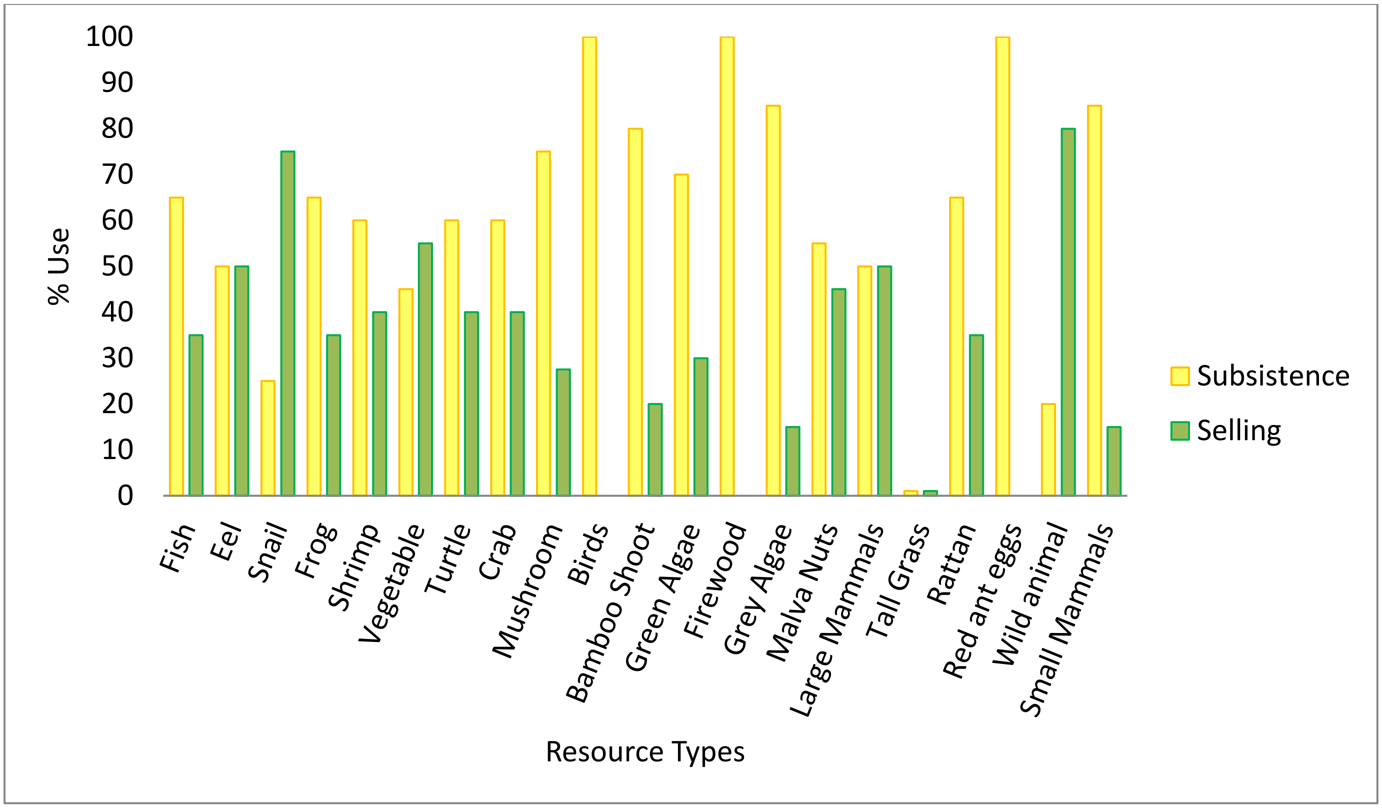


Figure 6. *Proportionate village use of different resource types*

5.2.1.d Key resource habitats / Village resource mapping

Villages were asked which habitat types they collect their priority resources from and the specific locations of the resource collection areas. Digitising of the habitat data was undertaken and maps produced. The overall habitat/resource collections areas used by each village can be seen in Figure 7; and the key resource collection areas by habitat type across all villages in Figure 8.

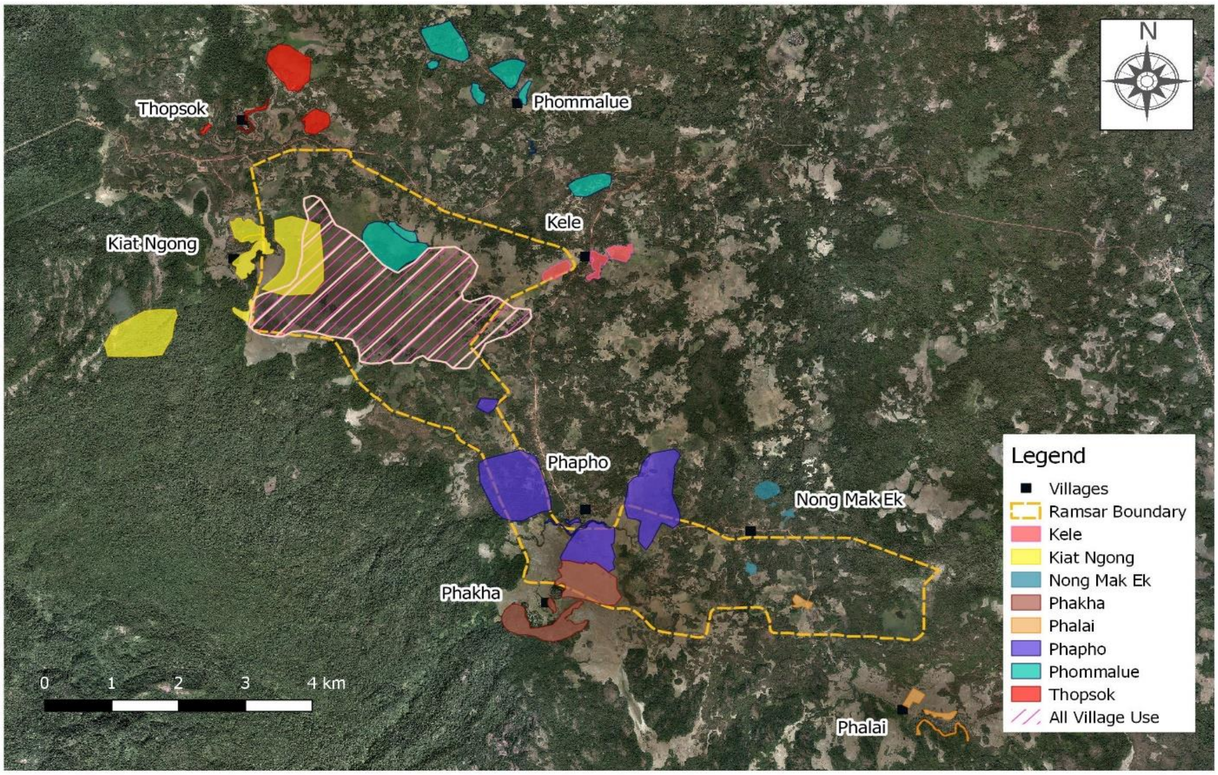


Figure 7: *Main area of wetland habitat utilised by each village for resource collection*

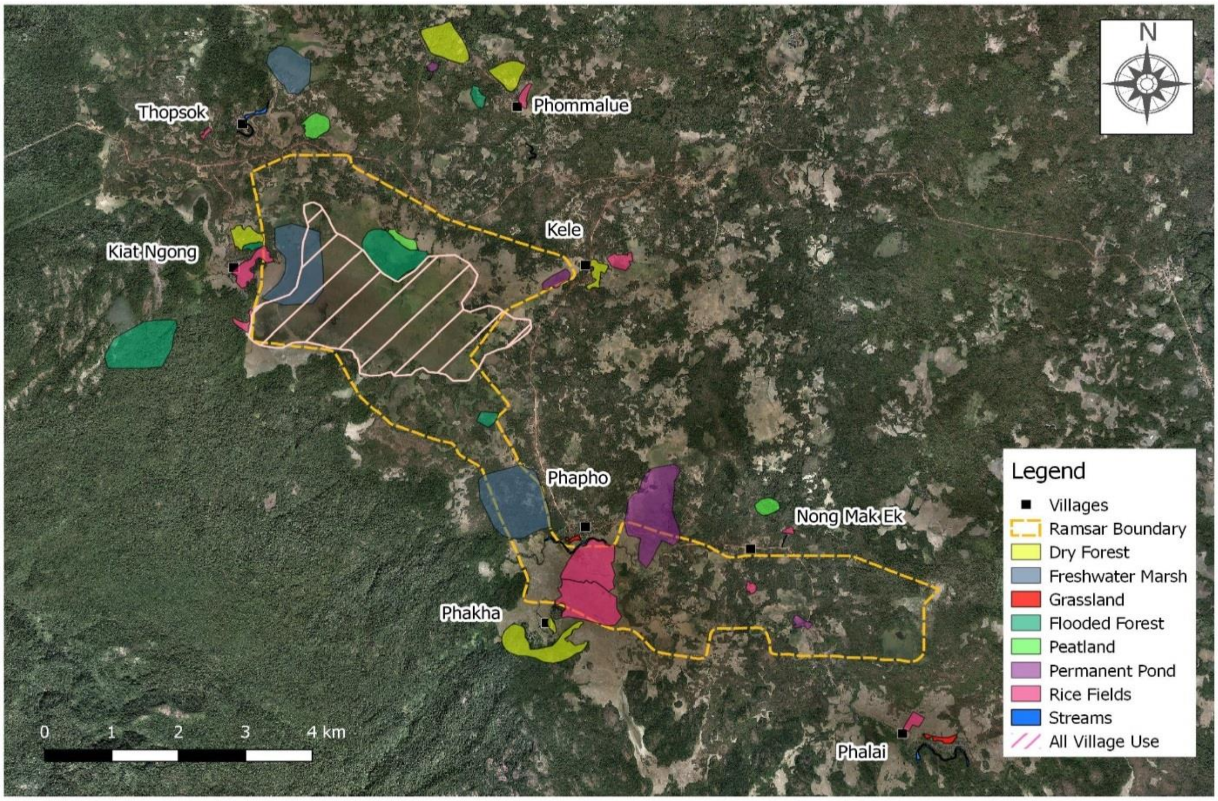


Figure 8: *Key areas of different wetland habitats utilised for resource collection*

Some resources are collected from only one or two habitat types, while some can be found across several or all of the habitats. Specific resources and the key habitats they are sourced from are discussed below. Figure 9 displays resources proportionally by the habitats they are sourced from and reflects the importance of the habitat for that resource by the number of times a habitat was identified by a village.

Specific resources and the key habitats they are sourced from:

- **Fish** are most commonly found in permanent ponds, followed by rice fields, and equally recorded as being found in streams, peatlands and freshwater marshes. It was noted that mostly small-medium sized migratory fish occur within the Beung Kiat Ngong wetlands due to the smaller streams present. Large migratory species such as Pa Khueng and Pa Khor are normally restricted to the Mekong mainstream and larger tributaries (such as the Xe Champhone).
- **Crabs** are mostly collected in rice fields, followed by: permanent ponds, freshwater marshes, streams and peatlands.
- **Shrimp** are most commonly found in permanent ponds, and less so in rice fields, streams, peatland and freshwater marsh.
- **Snails** are almost completely sourced from permanent ponds, some from rice fields and occasionally from freshwater marsh and peatland.
- **Birds and Eels** were similarly cited as occurring most frequently in permanent ponds and freshwater marsh; they were also noted to be found in peatland and rice fields.
- **Frogs** are most commonly collected from permanent ponds and freshwater marsh, as well as rice fields during the wet season. They are also found in peatland.
- **Turtles** were noted as being found in almost all habitats except for streams. They are the only resource/species recorded as being collected from flooded forest.
- Resources that were identified as being collected from only one main habitat type include lotus (permanent ponds), grey algae (streams), and large and small mammals, malva nuts, mushrooms, and rattan (forest).

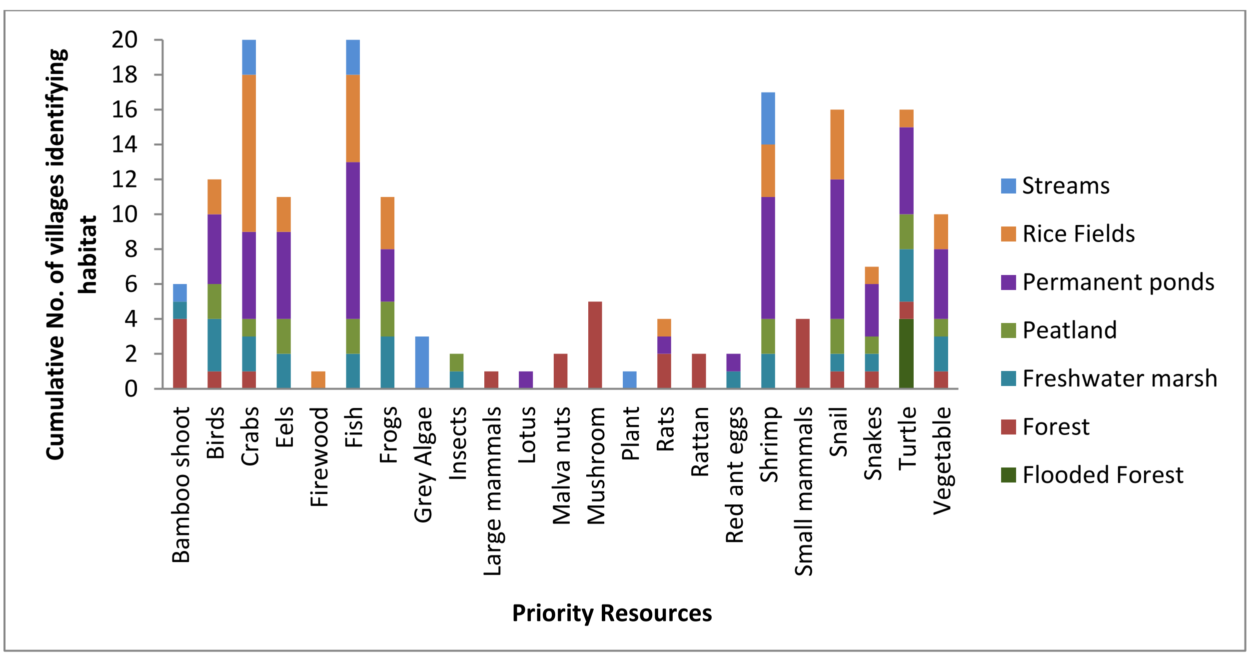


Figure 9. *Habitat location of resources*

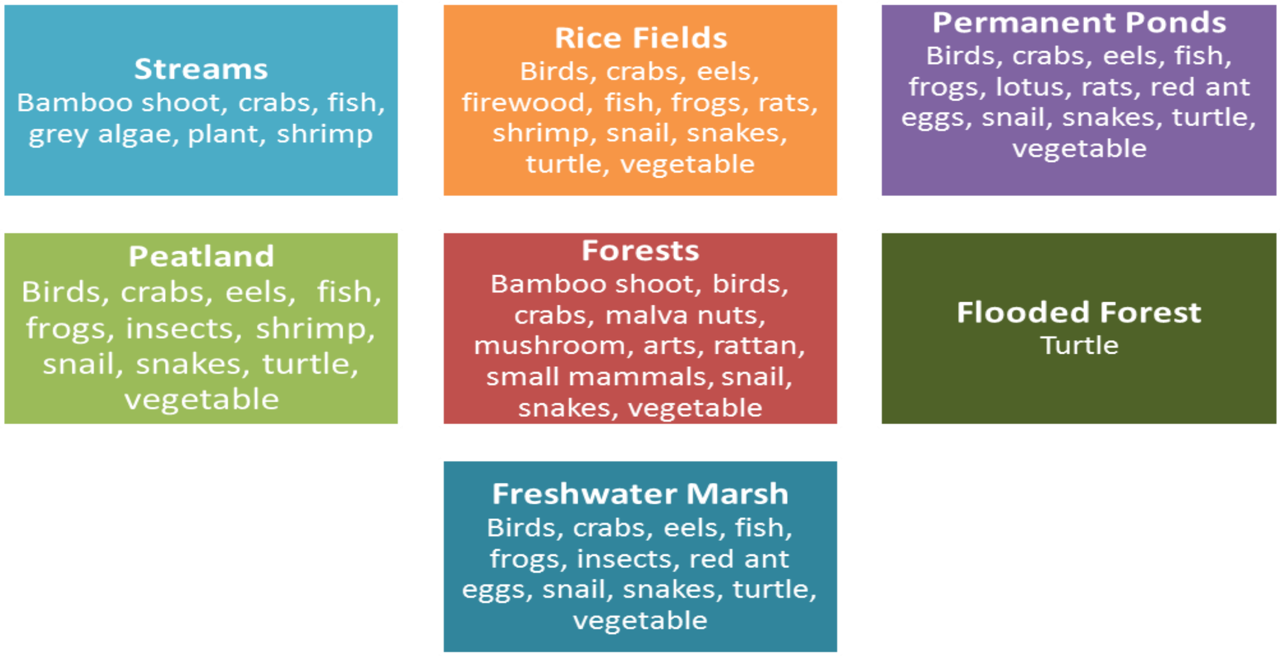


Figure 10. *Summary of key resources for different habitats*

Based on the total number of reports from village surveys for all habitats and the resources found there, permanent ponds were found to be the priority resource habitat, followed by, rice fields, forest, fresh water marsh, peatland, streams and flooded forest, seen in Figure 11 below.

Limitations

There are however some limitations with this data, such that the specific question of what are the most important resource habitats was not part of the survey, but data is instead based on the number of records of a resource being identified for a particular habitat area. Quantities or economic value of resources also were not recorded.

Grasslands have been identified as a key wetland habitat; however, villages did not cite it as a main place for resource collection. One village, Nong Mak Ek stated that tall grass is an important resource for them, which they use to weave mats, but they did not mention where it is collected from.

Some resources were noted as being found in the habitat collection areas but were not mentioned as being a priority resource and vice versa. Figure 11 shows which resources are found in which habitat. This data was collected separately when the villagers were asked to rank their priority resources. There are several apparent differences. Green algae (pham) did not have a collection habitat identified, but it is known to be found in streams. Snakes were not mentioned by any village as a priority resource, yet it was noted as being collected in four different types of habitat. This may be because it is not a highly sought after resource but will be collected when it is encountered while looking for other resources. Flooded forest was only recorded four times, all of which is attributed to the collection of turtle species. The lack of data for flooded forest may be in part to villagers or the interviewers considering forest and flooded forest to be similar and reported it as such.

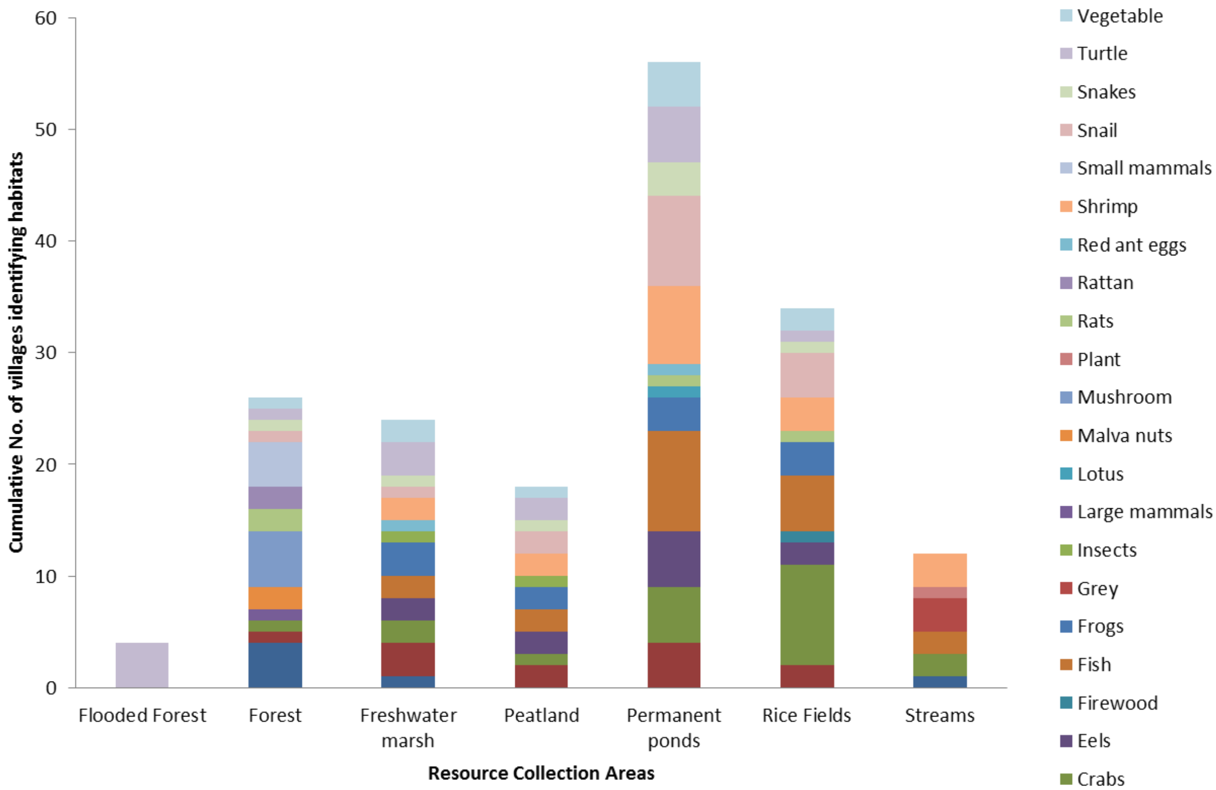


Figure 11. *Proportionate use of different habitat areas for village resource collection*

5.2.1.e Village seasonal calendars

Villagers were asked to illustrate a seasonal calendar of resources by identifying the time of year different priority resources could be found. Both men and women were asked to do this exercise for their priority top 10 resources. They were asked if a resource was collected in a given month, and if it was abundant. If a resource was abundant it was given a score of 2, if it was just present it scored 1 and if it was not available it received a 0. This methodology was not used consistently among villages; some only gave a 1 or 0 response. Results for men and women are displayed in Figure 12.

The resource data shows that the majority of resource collection occurs during the wet season in July and August. It should be noted that the data is dependent on what resources villagers recalled at the time, and therefore is only an approximation. The most commonly collected resources during the wet season are fish, eel, snail, frogs and bamboo shoots; with frogs, shrimp, and bamboo shoots showing a large increase in the wet season, and fish, snail and eel, a more consistent presence throughout the year, i.e. while fish increase in abundance during the wet season, they can be sourced all year from permanent areas.

A comparison of men's and women's views on resource availability provides insights to the differing perspectives they have on what resources are valuable as well as their respective roles for resource collection. Bamboo shoot collection spikes particularly for women between June and

September, during this same time men also cite an increase in their collection, but the change is not as significant. This shows that bamboo shoot availability does increase greatly during the wet season, but that it is women who are the primary collectors; it is likely men are more focused on fishing at this time. Data reveals that women collect a greater variety of resources in shallow water habitat areas, such as frogs, eels, shrimp and snails, and men work more in deeper water areas and/or from boats, with fish the predominant resource collected (IUCN, 2017a).

Key Observations:

- From the eight villages interviewed, women recorded a higher amount of total resources and responses for every month.
- Total cited abundance of resource collection remained relative between men and women across the months; no one month saw a large discrepancy of recorded resource abundance.
- Women were always the higher responders (possibly due to the data collection process, interviewer recorded more data).
- Year round resources cited by both genders include: fish, snails, vegetables, shrimp, and eels
- Turtles were cited as being collected year round by men; women cited them in all months except for December and January.
- Year round resources cited by women but not men: bamboo shoots, birds
- Crab was the only year round resource cited by men but not women.
- July and August were cited as the months of highest resource abundance by both men and women

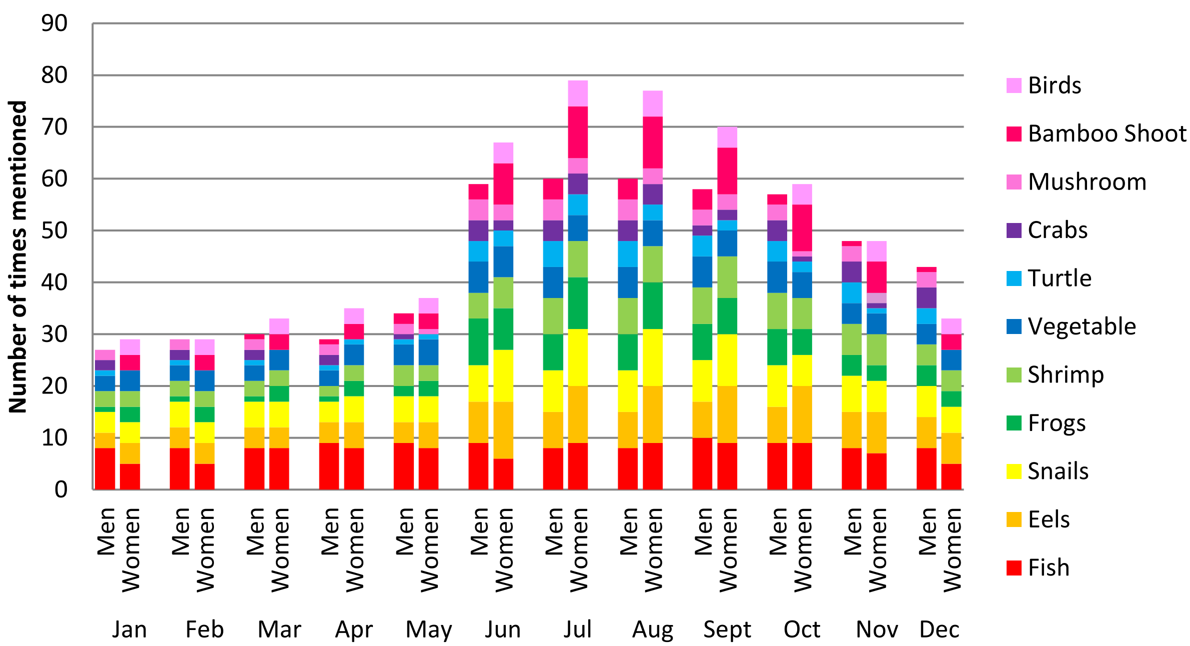
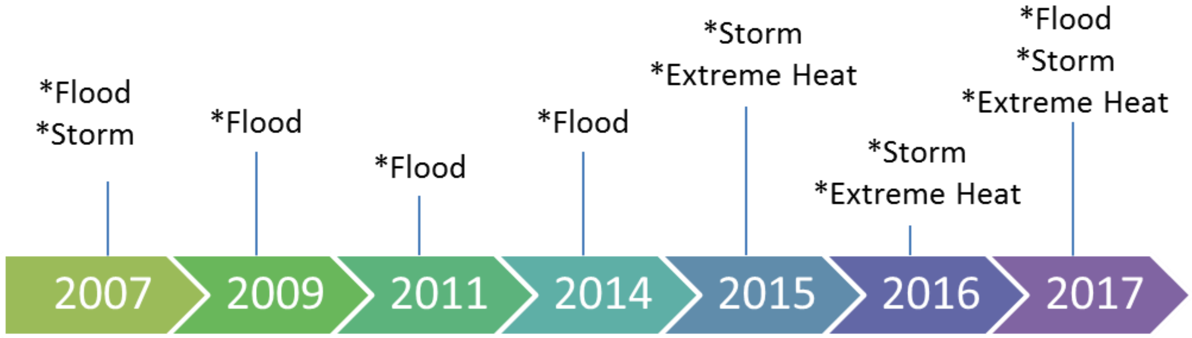


Figure 12. *Seasonality of Priority Resources by Gender*

5.2.2 Historical climate timeline and observed effects

Villagers were asked to give a timeline of memorable climatic events; flood was the main climatic extreme observed, but extreme heat and some storm events were also observed. The timeline below shows the years identified by villages for extreme events of major floods, storms or extreme heat. Years of drought were not specifically indicated but drought was mentioned in relation to impacts.



Flood events

Flood was the most commonly cited climatic event that occurs in the Beung Kiat Ngong wetland. All eight villages noted that flood has impacted their village in some way. Flooding has been recorded as occurring in 2007, 2009, 2011, 2014, and 2017, with most villages citing 2007 and 2017 as flood years. The year of 2017 was noted as a particularly bad year, perhaps due in part to how recent in memory it is. The women of Thopsok noted that some flooding happens almost every year, but 2017 was comparatively more severe. Three to four floods hit Thopsok during the wet season, in which one flood lasted 10 days. Women in Phak Kha also recalled the flood of 2017, with water levels reaching almost the height of the houses for several days.

Villagers observed a number of effects on wetland habitats and species during flood event years including erosion, damage to fish spawning grounds, expansion of golden apple snail and declines in water quality and associated fish death. They are further detailed in Figure 14. Strong flood waters that flow from the Xe Pian Range can cause erosion and damage fish spawning habitats. Additional issues associated with flooding reported by villagers, arise when large quantities of decomposing plant material & debris wash into low-lying areas leading to low oxygen levels in wetlands affecting native white fish species not tolerant of poor water quality such as Pa Khao, Pa Pak and Pa Sout. Several villages also noted that flooding leads to an expansion of the invasive golden apple snail. The snail tends to thrive in flooded areas, as it is able to enter water systems and spread out through the wider floodplain (Joshi, Cowie, and Sebastion, 2017).

The villagers of Nong Mak Ek have tried to plant the local shrub, *Xanthophyllum lanceatum* to increase habitat for birds and fish in the dry season but have found that very few of the plants survive due to early floods in June when the plants are still young.

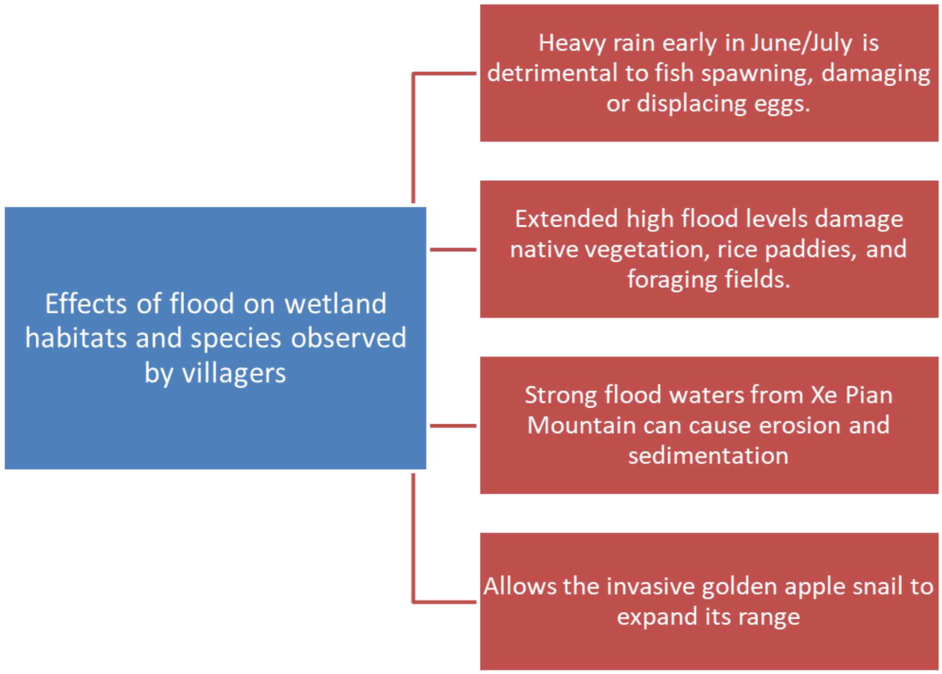


Figure 13. *Effects of flood on wetland habitats and species*

Drought events

Interestingly no specific year in which drought occurred was identified by villagers and it was not widely reported as a climate impact among the villages. However, women of Kele and Phak kha reported that their villages do experience drought approximately every 2 to 3 years.

Ecosystem effects reported include increased grass fires, as well as lack of water availability during the dry season putting pressure on habitats and species.

Storm events

Storms were reported for 2007, 2015, 2016, and 2017. Women of Thopsok and Kele noted that violent storms happen once every 2 years, usually during June and July. Minor ecosystem effects include loss or damage to trees.

Extreme heat events

Extreme heat events were only mentioned by two villages (Kele, Phak kha) as having occurred in more recent years, 2016 and early 2017. No specific heat effects on wetland habitats or species were reported but would likely be similar to drought effects of increased fire and lowering and warming water levels. Many countries across Southeast Asia experienced extreme heat during the period 2015-2017, due to a particularly intense El Niño cycle that saw high April temperatures throughout Lao PDR (Thirumalai et al., 2017).

5.2.3 Impacts of climatic events

Villages were surveyed with respect to the main impacts they experience from the climatic events identified above, which are predominantly impacts on livelihoods. The majority of impacts identified were related to flood followed by less cited impacts related to storm, drought and extreme heat events. The impacts identified could largely be classified into; resource impacts – agricultural and natural resources (separated by impacts on crops, livestock, fishing, water resources and invasive species); impacts associated with structures (trees, infrastructure, roads); and impacts associated with health (human health and livestock disease). Specific impacts by climate variable and details of livelihoods impacted are discussed further in the following sections.

5.2.3.a Impacts by different climate variables

The most frequently reported impact of flood is loss or damage of rice crop, identified by all eight villages surveyed and all men and women's groups. The secondary most reported impacts of flood were livestock disease and loss of forage/land for livestock reported each by six and five villages respectively, and decreased fish catch and increased invasive species impacts reported by four villages each. Other impacts reported by 1-3 villages include, crop damage (other than rice), and road damage.

Figure 14 shows each climate impact that was noted by villages as having occurred due to flooding, and differing responses by men and women. The number of times that rice crop damage was mentioned as an impact is a correlation to how important rice is economically. Rice production is a main livelihood activity, when the crop fails it has a large negative impact. Only flood impacts have been presented graphically due to the number of impacts identified for flood. Impacts of other climate events are discussed in text below.

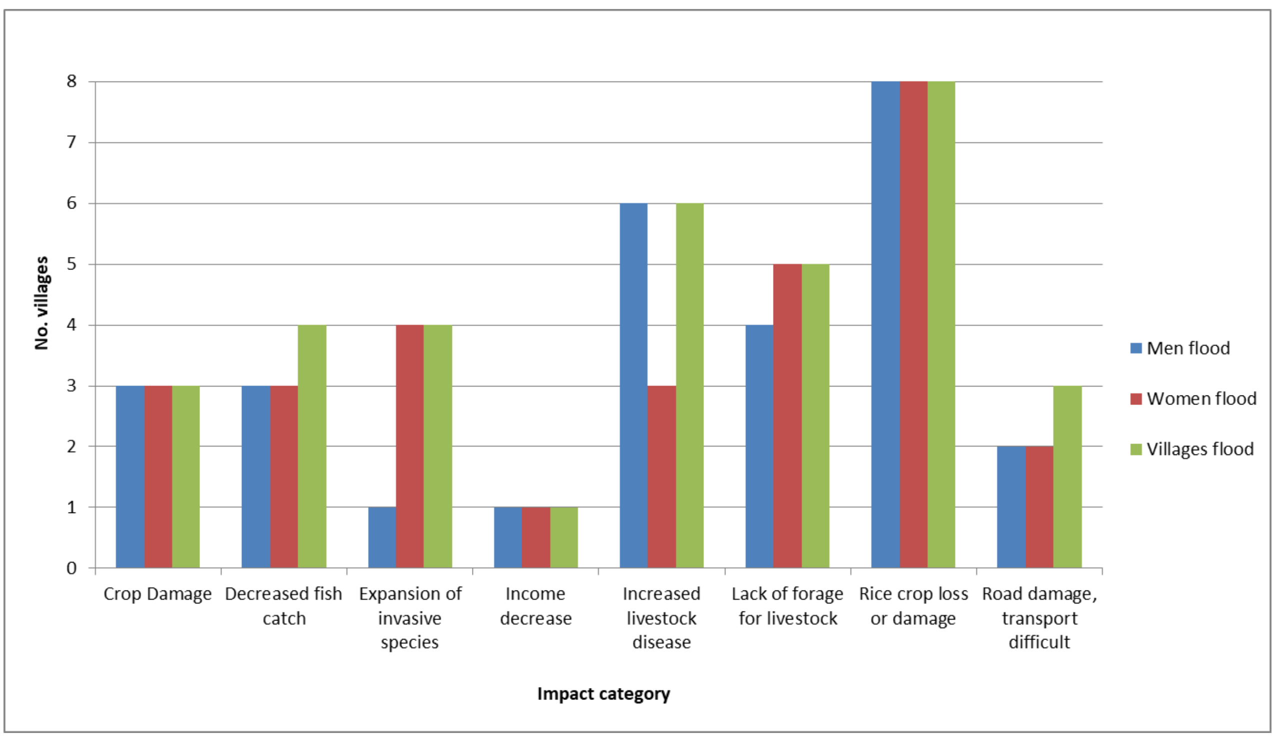


Figure 14. *Identified impacts of flood by village and gender*

Drought impacts were identified by two villages, the women's groups of Kele and Phak kha. The impacts cited were; 'Rice crop loss/damage' (2 villages), 'Lack of water' (2 villages), 'Lack of forage for livestock' (1 village), and 'Decreased fish catch' (1 village). Lack of water was further defined as drying up of village wells and insufficient water for livestock.

Extreme Heat impacts were identified by two villages, the women of Phak kha and the men of Kele, both citing, 'human health issues' as the main impact.

Storm impacts were identified by three villages, Kele, Phalai and Thopsok with two impacts cited, 'Damage to trees' and 'Damage to infrastructure'.

Impacts of all climatic variables/events will now be further addressed in more detail with respect to the different livelihoods and key areas that are affected. Some related impacts are combined for discussion.

5.2.3.b Impacts by livelihood/key area of concern

Agricultural and natural resources

Impact: Crop loss or damage (rice + other crops)

As the major impact of flood, damage or loss of rice crops occurs when floodwaters inundate crops and high water levels remain for 2-3 weeks killing or severely reducing the vigour of rice plants. For example, women in Phak Kha recalled that the floods of 2017 inundated rice paddies for a prolonged period and several flood events occurred, damaging or killing most rice plants. Other crops that are commonly impacted are in vegetable gardens, including corn, papaya, cucumber, cassava, sweet potato, sugar cane, bean, watermelon, chilies, pumpkin, and eggplant.

As previously indicated, drought was not identified as a significant issue in cropping but was noted by the women of Kele and the men of Phak kha as damaging to rice crops and decreasing yield.

Impact: Loss of land/shelter and/or forage for livestock

Loss of grazing areas/forage is due to several factors including flood, drought and invasive species damage (discussed further under 'invasive species impacts'). Excessive flooding leaves very little dry land for grazing and shelter for the animals. Depending on the duration of flooding, grass and natural forage may die and take time to regenerate, and animals will be forced to congregate in small areas. Several species of livestock are affected, for example, Phalai and Thopsok villages reported loss of land and shelter for buffalo, cows, chicken and ducks.

With respect to drought impacts, only the women of Kele cited drought as an impact on forage availability for livestock, with forage being limited during drought.

Impact: Decreased fish catch

The main impact associated with drought reported by villagers is declining fish availability during the dry season. Additionally, it is reported that fish and other aquatic species are being taken in higher quantities from the fishing holes known locally as 'lum pa'. Lum pa serve as areas of refuge for fish, and are used as way to increase natural fish collection during the rainy season for consumption during the dry season. They are small manmade wells built within the wetlands and rice fields using logs, branches and plants for habitat. Villagers try to not disturb the lum pa for as long as possible but decreasing fish populations have led to villagers depleting lum pa stocks earlier in the dry season in some areas (Mekong Watch, 2013).

Decreased fish catch as a result of flooding was reported as mainly due to early season flooding resulting in poor water quality, likely due to reduced dissolved oxygen levels, leading to 'fish kill' events (Dawson, 2002). This has been observed as an issue in Beung Kiat Ngong for certain white fish species, not tolerant of poor water quality. Most black fishes are able to survive such events as they have a wide water quality tolerance.

In 2015, villagers and DAFO/DoNRE released approximately 20,000 fish into the Beung Kiat Ngong waterways in an attempt to increase fish populations; species included Pa Pak (*Barbonymus gonionotus*), Pa Nai (*Ctenopharyngodon idella*, grass carp), Pa Kin Ngah (*Cyprinus carpio*, common carp) and Pa Nin, (*Oreochromis niloticus*, tilapia). It is reported however that the species not native to the wetland were thought unable to adapt and survive, though it is likely some have survived in permanent ponds.

Impact: Lack of water resources

During the dry season water can become scare; villagers noted that they have to queue at wells to collect water, which serves as a water supply for both village use and livestock. The drying up of water bodies in the dry season is an issue throughout the wetland.

Impact: Expansion & impact of invasive species

The main invasive species found in Beung Kiat Ngong is the golden apple snail (*Pomacea canalculata*). It has a serious impact on rice crops, livestock fodder as well as aquatic vegetation. It causes major loss of plant biomass, affecting water quality, and leading to significant ecosystem changes (Carlsson and Lacoursière, 2005). Four villages noted expansion of the invasive golden apple snail as an impact of flood, and women from Thopsok, Phak kha, Phalai and both men and women from Kele noted 'lack of forage/fodder' for livestock as the main impact. Villagers say the population is rapidly growing and they have noticed a decline in vegetation availability, which they attribute to the golden apple snail.

Structural damage impacts

Impact: Damage to infrastructure, roads and trees

Structural damage impacts include damage to trees, roads, and buildings. Flood damage to roads makes transportation for the villagers difficult. Inundated roads are unable to travel on and those that are not paved become extremely muddy. Storms have caused damage to trees and infrastructure (temples, houses, buildings) in Thopsok, Kele, and Phalai. The women of Kele recall intense damaging storms occurring once every 2 to 3 years. The men of Phalai say they experienced a storm in 2007 that destroyed a house, school and temple. In Phakha village a house was destroyed from a storm in 2015 or 2016 and in Phalai, houses, a school, and a temple were destroyed in 2007.

Health impacts

Impact: Increased livestock disease

An overall increase in livestock disease and death under climate change is predicted to occur globally, with warmer and wetter conditions increasing the incidence of heat-related and infectious diseases (Forman et al., 2008). All villages except Nong Mak Ek and Phak Kha reported an increase of disease in poultry, goat, buffalo and cows following flooding. Kiat Ngong and Phapho specifically referred to the disease of buffalo and cows, as foot and mouth disease (known locally as ‘Pak peuy long lep’). Poultry diseases in the area are likely to be either Newcastle Disease or Fowl Cholera (P. Vilay (FAO) pers. com.).

Impact: Human health

Extreme heat over a prolonged period can have a detrimental impact on human health, often causing dehydration and heat related illnesses. Men in Kele and women in Phak kha cited human health issues from extreme heat. The year 2016 was an especially intense year from April to May; many people felt ill due to the abnormally high and prolonged temperatures. In Kele, they experienced temperatures of about 40°C during the 2016 dry season; the main symptom noted was nausea.

Summary

- The most widely and consistently reported impact from a climate event is damage and loss of crops due to flood
- Effects on livestock (disease, lack of fodder/ grazing land) is predominantly due to flood, and occasionally drought
- Excessive flooding decreases fish catch, destroying fish habitats and reducing water quality.
- The golden apple snail is a significant issue; it destroys rice and other crops essential for livelihoods, as well as damaging areas of wetland vegetation/grassland, important grazing sites for livestock.

5.2.4 Current and future coping strategies

For each of the impacts cited, villagers identified current and future coping strategies. Discussion will largely focus on the major coping strategies for each impact, under the three major impact categories: **Resource impacts** – Agricultural & natural resources; **Structural impacts**; and **Health impacts**.

5.2.4.a Coping strategies for resource impacts (Agricultural)

Impact: Crop loss or damage (rice + other crops)

Coping strategy 1: Outside employment/ remittances	Future strategies
Men will often move to find work outside of their villages to supplement for lost income. Villagers reported some people have gone to Pakse to work in construction or to Paksong district to work at Dao houng coffee plantation for 4 to 6 months. Some will move to Thailand to work in factories or farms, sell items at markets, or work as cleaners. They will then send money back to their families in Beung Kiat Ngong. Two villages, the women of Phalai and Phak kha noted specifically the use of remittances as a coping strategy, with the money sent back used to buy rice and other food.	• **Diversify crop, re-plant crops, find/harvest more wild resources and practice dry rice irrigation**, no village said they would continue to look for outside employment (though Phalai said they will continue to use remittances to buy rice). • 10 families of Phak kha are *planning to undertake dry season irrigation* for newly planted crops using water from the Huayma stream to supplement for lost or damaged crops. In the future they would like to **build a dyke** (20mx2m) on the stream. • Phak kha says they would like to also **ask the government for support** to increase the value of the price of rice.

Coping strategy 2: Re-plant crop	Future strategies
Three villages noted that they attempt to re-plant a crop after it has been destroyed. Crops noted to be replanted are: corn, papaya, cucumber, cassava, sweet potato, sugar cane, bean, watermelon, chili, pumpkin, and eggplant. Depending on the time of the season when crops are destroyed, there may be sufficient time for them to re-grow and mature. Along with re-planting, villagers said they will re-plant in higher areas where future floods cannot reach.	• **Diversify crop/ grow secondary crops** (Nong Mak Ek, Phommalue and Phapho). They plan to look for new crop varieties that are tolerant to flood and that have high production value, several new crops identified by villagers in addition to what other villages are already planting include, pineapple, rubber, lemongrass, lime, ginger. • One village, Kiat Ngong, said they will continue to **re-plant their crops in the dry season and** use water from the local well to **irrigate**.

Coping strategy 3: Buy rice	Future strategy
The women of Thopsok say they will buy rice to supplement their lost crops. Similarly, the women of Kele will borrow or buy rice from other households in the village when they do not have enough.	• The two villages say they will continue to use the **same strategy** in the future.

Coping strategy 4: Harvest more wild resources	Future strategies
The most commonly cited coping strategy, and also the most diverse in how it is applied.	• Several villages said they will continue with the **same strategy** to collect and sell

Some villagers will collect greater numbers of golden apple snails. Many villagers will increase their fishing efforts to supplement the loss of rice and other crops. Men in Kele try different techniques of fishing. The most commonly caught fish in the dry season are Pa Douk and Pa Khor, they also collect and sell eels. Some of the surplus fish caught during the wet season are fermented into Padek to be used or sold during the dry season. Other resources that are increasingly collected include: grey algae, wild vegetable, and lotus which are then sold to buy rice or consumed.	more aquatic animals and golden apple snail • **Diversify crop** by trying new rice varieties that are flood tolerant

Coping strategy 5: Grow secondary crop	Future strategy
Only the women of Thopsok and Phalai said they will grow secondary crops after other crops have been damaged. In Thopsok they will plant cassava that can then be sold, using the income to buy rice for the household. Villagers in Phalai will plant chili, sweet potato, and corn for consumption; crops that grow during the wet season and can be planted after the rice crop is lost.	• Both villages said they would continue with the **same strategy**

Coping strategy 6: Practise irrigated dry season rice cultivation	Future strategies
Both men and women of Phalai noted that they practice irrigated rice during the dry season to supplement for lost rice crops, the only village to do so. They take water from Beungkaxay wetland to flood their fields.	• Women said they will continue with the **same strategy** • Men would like to **diversify** rice crop with flood tolerant varieties

Coping strategy 7: Sell personal belongings	Future strategy
Women in Nong Mak Ek were the only ones to suggest the strategy of selling their personal belongings, which includes predominantly livestock, i.e. selling cows and buffalo and using the profits to buy rice.	• **Diversify crop** with flood tolerant rice varieties. They would also like to increase their rice production to 4-6 ton/ha up from their current 3.5 ton/ha.

Coping strategy 8: Extend rice field to wetland	Future strategy
Kele village said they would extend their rice field closer to the wetland so that in times of drought there is more accessible water for irrigation.	• They plan to continue with the **same strategy**, they are unsure of what else can be done.

5.2.4.b Coping strategies for resource impacts (Livestock)

Impact: Lack of land/forage for livestock

Coping strategy 1: Move livestock	Future Strategies
Kele village allow their cattle to move freely to find their own forage. Phalai village move their cattle to higher ground away from the flooded areas.	• Kele plans to use the **same strategy** • Villagers of Phalai said they would **sell their livestock**

Coping Strategy 2: Find/harvest wild resources	Future Strategies
Villagers said they cut forage along ponds and paddy fields to feed the animals. Some villagers also harvest grass or corn from their gardens as feed.	• Thopsok will use the **same strategy** • As above, villagers of Phalai said they would **sell their livestock**

Coping Strategy 3: No strategy	Future Strategy
The villagers did nothing, they waited until the rainy season was over and hoped some livestock had survived, and or dealt with the loss	• **Same strategy** – no additional strategies identified

5.2.4.c Coping strategies for resource impacts (Natural resources)

Impact: Decreased fish catch

Coping strategy 1: Release new fish	Future strategies
Some villages have benefitted from government fish releases. The fish come from a fish-breeding centre. Some families have tried to release fish from their own ponds in an attempt to continue the cycle to farm more fish.	• Most villages said they will continue with the **same strategy**. • In the future Phommalue said they will restrict fishing to use of **traditional fishing** gear (hook pole, and bamboo trap, cast net, lift net, scoop net) as a conservation strategy. They also plan to release back any young fish during the spawning season

Coping strategy 2: Conservation	Future strategy
Phapho was the only village to cite conservation as a means of coping with their lower fish catch. They have created **fish conservation zones (FCZs)**; and agreed on regulations that prevent fishing in these areas so fish can spawn undisturbed in June and July. The village set up a conservation team to enforce the rules, violators are fined and funds go towards monitoring and equipment for the conservation team. (Other villages have FCZs but not cited as coping strategy).	• In addition to continuing their current conservation strategies, as above, villagers want to use more **traditional fishing gear** in their ponds.

Coping strategy 3: No strategy	Future strategy
Only reported by one village, the villagers of Phak kha say they currently cope by just continuing to harvest as they normally would.	• **Same strategy**, the villagers are unsure of what to do

Impact: Lack of water resources

Coping strategy 1: Find/harvest new water resource	Future Strategies
Only Phak kha responded that they have had to deal with drought leading to a lack of water resources for human and livestock consumption. They differentiated this from a lack of water for crop production. The villagers said they had to find other water sources or queue at the local well for their turn to collect water during a drought.	• **Additional and improved infrastructure** -proposed **construction of a dyke** to increase their water supply. • The villagers will use the **same strategy** until the dyke is built.

Impact: Expansion of Invasive species (impact on rice crops & wetland resources)

Coping strategy 1: Harvest and sell (golden apple snail)	Future Strategy
To reduce numbers and supplement income, villagers reported that they harvest the apple snail as a resource for selling and consumption. They sell the snails for 4,000-5,000 kip/kg. They boil and remove the snail heads in preparation for selling at the market. The villagers of Phalai pile the collected snails in the sun as a method of killing and drying. While the snails have a major impact, they are also a resource.	• All villages said they will continue use the **same strategy –** No additional strategies identified *Ban Phommalue noted they are using a barrier net to attempt to prevent the snail entering rice fields; however, it has not been successful.

5.2.4.d Coping strategies for infrastructure impacts

This section includes damage to infrastructure (houses, buildings, and temples), trees and roads. The damage has been caused by either excessive flooding or a storm.

Impact: Damaged Infrastructure/ Road Damage

Coping strategy 1: Repair/build infrastructure	Future Strategies
The villagers help one another and repair their houses and any other damaged infrastructure. The same coping strategy is often used for road damage, with villagers repairing the roads themselves. In Thopsok village recently	• All villages will use the **same strategy** in the future. • The villagers hope to get support from the government for repairs in the future.

the district authority made a small repair to the road to allow for temporary transportation.	

Impact: Damage to trees

Coping strategy 1: Use fallen trees for fire wood	Future Strategy
Two villages, Thopsok and Kele reported damage to trees from strong storms. They cut up and use the fallen trees as firewood.	• They will use the **same strategy**

5.2.4.e Coping strategies for health impacts

Health impacts are categorized into increased livestock disease and human health issues. Livestock disease was by far the mostly common cited health issue, exclusively related to flooding. Human health issues were connected with extreme heat.

Impact: Increased livestock disease

Coping strategy 1: Move livestock	Future Strategies
Moving livestock enclosures to higher ground during flooding helps to keep them dry and clean and maintain animals in a healthier condition. Phalai and Phommalue have moved their poultry sheds to higher areas.	• **Additional and improved infrastructure,** better enclosures to keep livestock • **Seek government support**, on information on how to deal with animal disease from the news (via the government).

Coping strategy 2: Use traditional medicine	Future Strategies
Traditional medicine is used to help the livestock recover. Tamarind leaves are boiled as a herbal medicine. For sick goats, they use vinegar or sour fruits. Cattle with stomach conditions are given a solution of water, padek, Pepsi and lao lao.	• **Continued use of traditional medicine** will be used in conjunction with **moving livestock** to higher ground. • Villagers of Thopsok would like to undergo **training** with an expert on livestock husbandry so that they know how to better manage the issue in the future

Coping Strategy 3: Vaccinate livestock	Future Strategies
Four villages reported they vaccinate their livestock to avoid foot and mouth disease. DAFO staff train Phommalue people on how to administer the vaccination and treat the health issues.	• **Same strategy** but to more regularly vaccinate and undertake before the wet season • **Ask for increased technical support** for training, education, from DAFO

Impact: Human health

Coping strategy 1: Take medicine/hospital	Future Strategies
Human health issues reported by Kele and Phak kha relate to extreme heat. They currently use local medicine and/or go to the hospital for treatment.	• Kele did not mention additional future strategies • Phak kha said they will continue to use the **same strategies**

In Figure 15 below, the responses have been collated to show the major coping strategies across all impacts; displaying a count of each response citing a certain coping strategy. The most commonly cited coping strategy by both men and women was to 'Harvest more wild resources'. Some coping strategies are noted twice by the same village, but refer to a different climate variable. For example, Kele said they harvest more wild resources as a coping strategy for both drought and flood. One coping strategy, 'move livestock' was reported for two impact categories, health impacts and resource impacts as the strategy acts to reduce disease risk and mitigate loss of fodder resources.

Figure 15. *Current coping strategies by gender and main impact category*

5.2.4.f Current Coping Strategies: Success rating

Flood coping strategies: Only men identified some flood coping strategies as mostly successful (12%); 33% of women and 10% of men reported coping strategies as not very successful; the majority of responses indicated that strategies were of average success (73% women, 78% men). Coping strategies where some individual villages gave lower success scores were related to livestock and invasive species impacts and in which more technical knowledge from experts is needed to properly mitigate the issues. Contrary to that, the men of Thopsok believe the use of traditional medicine for livestock disease has been successful, and men of Phalai gave dry season rice irrigation a high success score as a means to coping with destroyed crops from excessive flooding.

Drought coping strategies: Drought was infrequently recorded; the dataset for the coping strategies is small, and there are only three responses from men, all of which said the strategies are of average success. Women said that 60% of their coping strategies for drought are not very successful. Low success scores were related to coping strategies where the villagers were unsure of what to do in the situation, for example when fish catch decreased, the villagers of Phak kha said they did nothing.

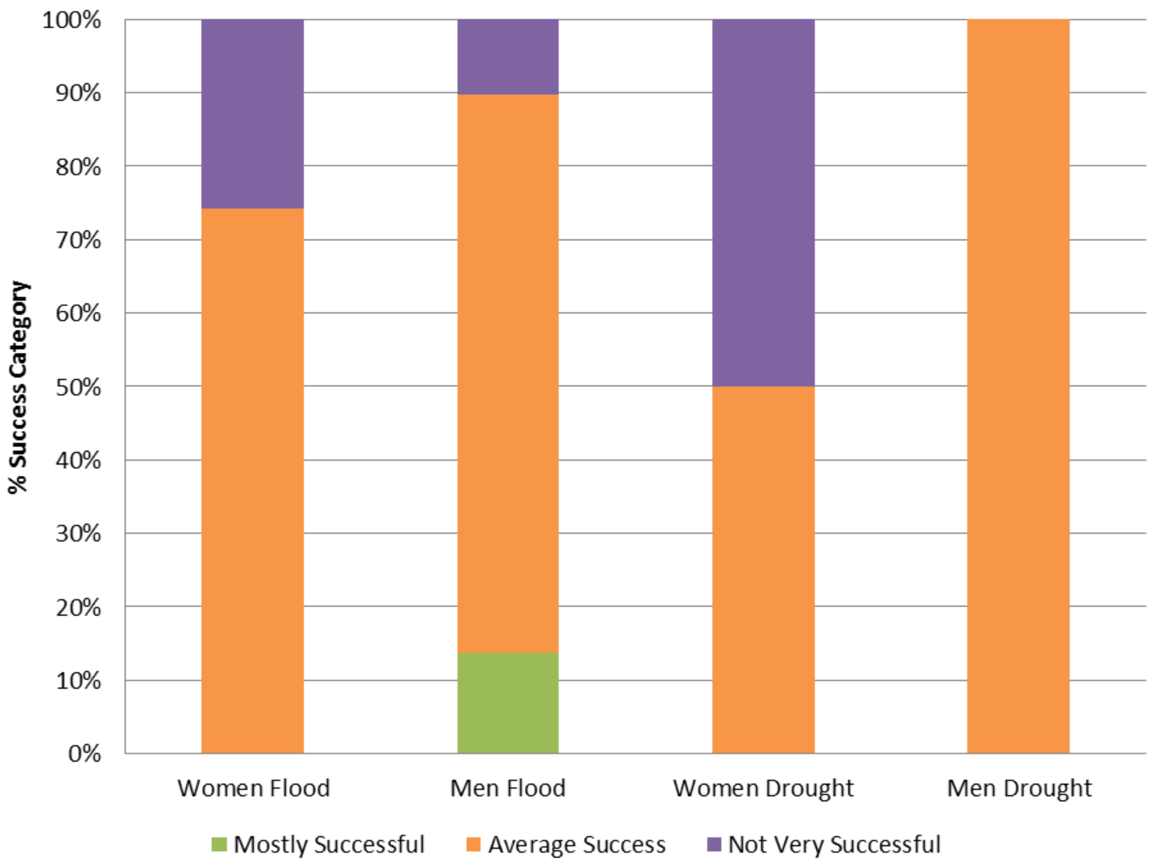


Figure 16. *Success of flood and drought coping strategies (men & women)*

Overall between drought and flood coping strategies women gave an average success score 70% of the time, and 30% for not very successful. Men gave an average success score of 83% of the time, not very successful 10% of the time and 7% for mostly successful. See Table 8 (in summary) for mean success categories for each coping strategy, and where few coping strategies were indicated.

5.2.4.g Future Coping strategies: Frequency of responses

The dominant response for future coping strategies was to continue with the same strategy, mentioned 38 times (51%). The second most common future coping strategy was to diversity crops, mentioned 14 times (19%). All other strategies were only noted one to three times. Figure 17 depicts the number of times a future coping strategy was noted by villagers.

Extreme heat and storms have not been discussed in as much detail as flood and drought due to the minimal data available for these climatic events, but are aggregated with flood and drought data in Figure 16. Future coping strategies for storms were all cited as using the same strategy, one village said they do not have any other choice but to rebuild if a storm destroys infrastructure, they have no other ideas or means for preventative action. The other climate impact, extreme heat, was only mentioned twice but could become a bigger problem as climatic changes are predicted to lead to higher annual temperatures. Villagers reported they will continue to take medicine when they are ill and seek medical attention as needed.

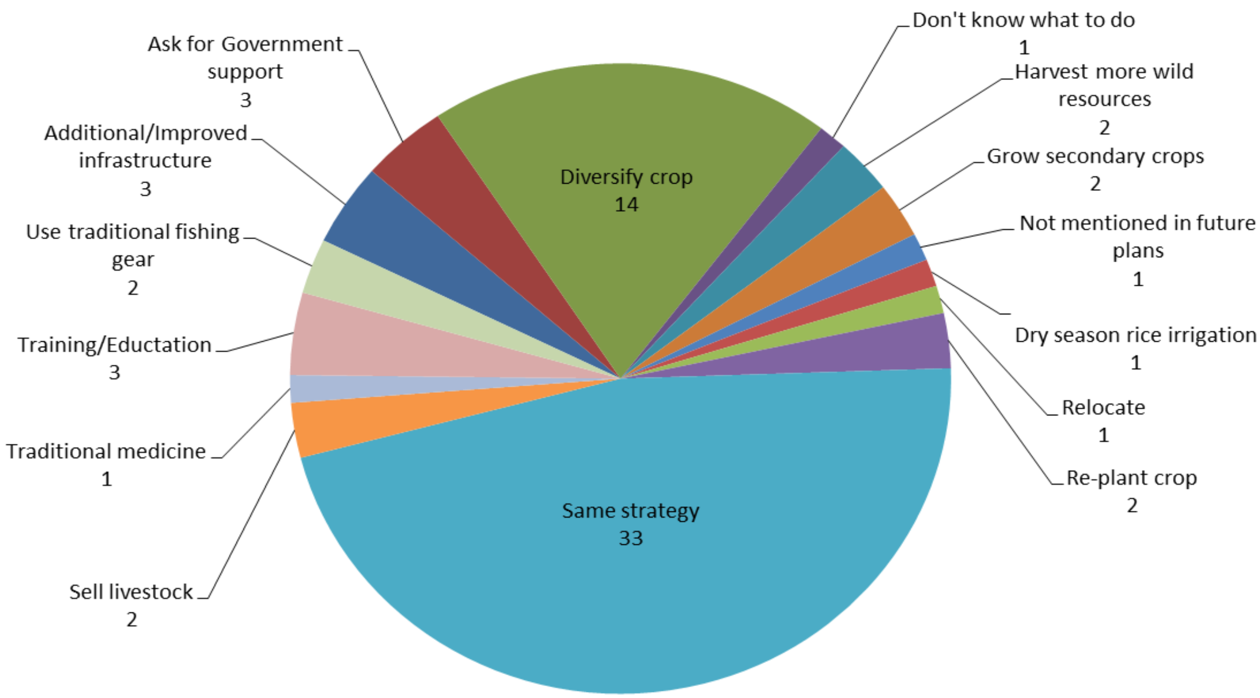


Figure 17 *No. of responses per future coping strategy*

While the same strategy was often indicated for future use, it was sometimes expressed as improvements or expansion of the current strategy, i.e. expanding infrastructure to continue irrigated rice cultivation, or continue vaccination but ensure early vaccination. An overview of future strategies indicated and/or improvements on current strategies of the three impact areas is further summarised below (combining all climate variables).

Future resource impact coping strategies:	Future health impact coping strategies:
• Commence/continue irrigated rice cultivation in dry season (currently only Phalai, but Phak Kha say they hope to commence irrigated cultivation). • Experiment with flood tolerant seed types. • Grow a more diverse range of crops, or have a secondary crop to depend on. • Ask government for support in increasing the value of rice • Use traditional fishing gear to support conservation	• Use traditional medicine for livestock • Ensure vaccination is undertaken earlier in the season, and that vaccination program is regular/on-going. • Seek advice and support from DAFO Livestock unit. DAFO is the main source of news/advice on disease status to villages, and increased interaction by communities and DAFO was highlighted as a future strategy. • Seek training to improve knowledge on livestock care
Future infrastructure/structural coping strategies: • Ask government for support when there is damage • Continue to repair infrastructure as needed	

5.2.4.h Influence of gender on reporting impacts and coping strategies

Overall the major impacts that significantly affect livelihoods and economic situations, such as loss of rice crops to flood were relatively evenly reported by men and women, but some of the less reported impacts reflect that men and women are more likely to notice the impacts on livelihood tasks they are most responsible for, and some gender differences were apparent. Reporting of increased livestock disease was more often cited by men, however, lack of forage for livestock was reported almost equally between genders. Although both genders work with the livestock and are aware of their resource needs, the reporting suggests that when livestock are sick it is more the men's role to take care of them.

Expansion of invasive species was mostly cited by women as an impact with the exception of the men of Kele. The current coping strategy for the golden apple snail at every village is to harvest for selling and consumption. Collecting the species is likely the primary role of women as the main collectors of NTFPs and smaller aquatic resource species (IUCN, 2017a). A lack of water for human and livestock consumption was only noted by men, which is similar pattern to the Xe Champhone site, where only men ranked water as a priority resource. Water may have been generally overlooked as an important or limiting resource as discussions mostly focussed on food resources. Only women reported the impact of damage to trees during storms, and the associated coping strategy was to use the fallen trees as firewood. This may be associated with women's greater awareness of different fuel sources as they have the principal responsibility for household chores including cooking (IUCN, 2017a).

There is overall a greater number of current coping strategies reported by women than men. Strategies that women suggested that men did not include: buy rice, conservation, extend rice field, grow secondary crops, use remittances, sell personal belongings, and use trees for firewood. Strategies that men noted and women did not include: look for outside employment and vaccinate livestock. Outside employment and remittances are linked, with men or younger family members often leaving to work, and women receiving the remittances in the village.

5.2.5 Current management and community recommendations for future management

Communities are involved in various conservation and management activities across the wetland complex. The predominant management area is associated with fishing regulation, and several villages are involved in Xe Pian NPA conservation programmes, such as patrolling. A summary of current community management and future recommendations is presented below and details for each village is outlined in Appendix III (includes only management specifically highlighted during surveys).

Summary of key conservation actions in place and wetland management involvement:

- The main wetland associated management undertaken by most villages is the establishment of fish conservation zones, only one village (Kele), has not yet established one. Phak kha does not have an official FCZ but has established a local protected conservation area, where fishing is only permitted every 2-3 years. No fishing is allowed in FCZs.
- All villages have regulations prohibiting the use of toxins or electro-fishing methods and/or permit only the use of traditional fishing equipment
- Phapho and Nong Mak Ek specified that they do not allow fishing during drought periods
- Several villages specified they have regulations restricting fishing during spawning season (June-July) in certain areas, but enforcement is limited.
- Some villages said they do not allow the burning of land or forests
- Four villages have been involved with the BCC project and patrolling/monitoring programmes within the Xe Pian NPA (Ban Kiat Ngong, Thopsok, Phalai, Kele).

Future *community* recommendations for management include:

- Continue with current management and regulations but stricter enforcement of laws, as warnings are often only given rather than fines
- Increase and/or improve fish conservation zoning: Recommendations for new FCZs in Nong papeo yai (Ban Kele) and Vang Kainoun (Ban Phommalue); and to improve the old Vangmon FCZ (Ban Phalai) and FCZ in Ban Thopsok
- Improve consistency of regulations between villages (i.e. not all specified fishing regulations with respect to spawning and drought periods)
- Increase technical training and equipment for improved monitoring/patrolling
- Install additional signage for FCZs to promote awareness
- Release of native fish species such as Padouk, Pakheng into the main Beung Kiat Ngong wetland

5.3 Species VA

The species VA tool is similar in format to the habitat VA, with two components: a) baseline vulnerability, addressing existing threats or limitations for the species, and b) climate change vulnerability, addressing threats from projected climatic changes.

The baseline component has a number of questions relating to: Species population status and distribution within the LMB; Habitat requirements and degree of specialization, i.e. generalist or specialist; Current threats – human and natural; Reproductive requirements and characteristics, i.e. opportunistic or strongly seasonal/linked to climatic cues. Climate vulnerability looks at questions related to species exposure, sensitivity and adaptive capacity to climatic changes expected/ extreme events, i.e. drought, flood, temperature change. Each question is scored based on evidence sourced from the literature or local knowledge base. The final totaled score relates to a category ranging from low vulnerability to very high vulnerability - See Table 4 (page 14) that shows scoring scale and category intervals for both habitat and species vulnerability.

5.3.1 Species selection

Five species were selected to be assessed for vulnerability. Species were selected based on several criteria including their flagship or keystone status; conservation/ population status; and/or resource or economic importance. Local population status and resource importance was assessed from Village VA surveys. Whether species had previously been assessed by another study was also taken into consideration in order to maximize the total number of Lao wetland species assessed for climate change vulnerability across projects. Species for selection also focused on fauna and in particular vertebrate species because the majority of priority resources were of animal origin and targets of over-exploitation were often vertebrates.

The five species selected for the Xe Champhone VA assessment, include 2 species of reptiles, 2 species of fish, and one species of bird. The species and justification for their selection are outlined below:

- *Chitala ornata* (Clown featherback/Pa Tong dao), and *Channa micropeltes* (Giant snakehead/Pa Do) were identified by Beung Kiat Ngong communities as priority economic resource fish species, and to have observed local population declines.

- *Heosemys grandis* (Giant Asian Pond Turtle/Tao Ka), and *Cuora amboinensis* (Asian box turtle/ Tap ngap) were selected for the assessment due to their threatened conservation status, listed as globally vulnerable on the IUCN Redlist, locally declining, and their high resource importance.

- *Anastomus oscitans* (Asian open bill/Nok kethoi) can be found across the South Asian continent, but is not as common in Beung Kiat Ngong as it once was. It is a natural predator of the invasive golden apple snail species and is therefore an asset to the ecosystem. It is also a flagship species, due to its large size and iconic regional status.

A number of species at the Beung Kiat Ngong site have been assessed by past projects and are also relevant to this study. They will form part of the discussion following the analysis of species assessed for this project.

5.3.2 Species VA results

The summary of results for the five species assessed in this study, showing the categories of baseline risk status, climate change vulnerability and overall vulnerability are presented in Table 5.

In assessing overall vulnerability, and for both baseline and climate change threats, the two turtle species, *Heosemys grandis* and *Cuora amboinensis,* were assessed to have ‘high’ vulnerability; and both fish species, *Channa micropeltes* and *Chitala ornata*, together with water bird species, Asian open-bill (*Anastomus oscitans)* have ‘medium’ vulnerability.

Table 5. *Assessed baseline risk status, climate change vulnerability and overall vulnerability of Xe Champhone species*

Species	Baseline Score	Baseline Risk Status	CC Vulnerability Score	Climate Change Vulnerability	Overall Vulnerability (Baseline +CC Vulnerability)
Heosemys grandis (Tao ka, Giant Asian Pond Turtle)	2.6	High	2.6	High	High
Cuora amboinesis (Tao ngap, Southeast Asian Box Turtle)	2.6	High	2.4	High	High
Anastomus oscitans (Nok kethoi Asian Open bill)	1.9	Med	2.1	Med	Med
Channa micropeltes (Pa do, Giant Snakehead)	1.9	Med	2.1	Med	Med
Chitala ornata (Pa tong dao, Clown Featherback)	2.0	Med	2.0	Med	Med

A summary discussion highlighting the main justifications for vulnerability is presented below for the five species, first addressing 'baseline risk status' and then 'climate change vulnerability' for each species. See Appendix II for sample assessments with details of questions and scoring.

5.3.3 Baseline risk and threats

'High' baseline risk species:

Heosemys grandi, Giant Asian Pond Turtle

During VA surveys *H. grandis* was identified as one of the rarest turtle species in Beung Kiat Ngong. It is listed as 'At Risk' nationally and globally 'vulnerable' (Asian Turtle Trade Working Group, 2000a). Very little is known or documented about this species and its habitat needs. It lives in freshwater wetlands, reportedly sometimes on land, partially hidden under vegetation, and has been observed in grassland and forested areas (Stuart and Platt, 2004). The biggest threat to the species is hunting with the population seeing a decline over the last 50 years due to exploitation, as well as loss of habitat (Asian Turtle Trade Working Group, 2000a). The species has a high trade value and demand is likely to increase as it becomes scarcer and demand rises. The species produces few offspring per year (2-6 eggs/clutch), and has a long incubation period of up to 6 months (Heosemys, 2017). As with most turtle species, eggs and hatchlings are thought to suffer from high predation.

Cuora amboinesis, Southeast Asian Box Turtle

Previously thought to be common by local villagers C. *amboinesis*, is now becoming rare at the Beung Kiat Ngong site. It is listed as 'At Risk' in Lao PDR and globally 'vulnerable' on the IUCN Redlist (Asian Turtle Trade Working Group. 2000b). The species is still relatively common in some areas of its range where it is protected due to its ability to adapt to a variety of habitats including modified areas, such as rice fields and within the vicinity of human settlements (Schoppe and Das, 2011). The species has a high market value and suffers from high rates of hunting for consumption and trade. It has a medium incubation period of ~2 to 4 months, but produces very low egg numbers (Schoppe, 2008; Schoppe and Das, 2011), which makes maintaining populations difficult.

'Medium' Baseline Risk Species:

Anastomus oscitans, Asian Open bill

The Asian openbill population is considered stable across its range, however it is listed as 'at risk' in Lao PDR, being relatively scarce until recent years when populations have started to increase. It is not as abundant as it is in neighbouring countries, such as Thailand that have large breeding colonies (Timmins, 2014). Individuals are able to migrate to avoid unfavourable habitat conditions and find sources of food (Low et al., 2013), but require a large habitat area for their feeding, breeding and migratory behaviours. The species is an asset to the environment, and a welcome visitor in farmers' fields, particularly in rice paddies where they feed on golden apple snails (Sin, 2003). Threats to the species include hunting, with the meat and eggs of the species regarded as delicacies and as such, they are poached to earn substantial market prices (Quasmieh, 2013). Long incubation periods also leave the eggs vulnerable to egg collection and predators.

Channa micropeltes, Giant Snakehead

C. micropeltes is considered to have a stable population throughout the Mekong basin (Allen, 2012), but villagers of Beung Kiat Ngong have noticed a decline in local populations in recent years. Overfishing across its range is a moderate issue, but locally it may be a higher threat and the main reason for its decline. It is a generalist species and can inhabit a wide variety of freshwater habitats, but prefers slow flowing deeper pool areas (Kottelat, and Widjanarti, 2005). It is capable of producing large amounts of eggs (Piazzini et al., 2014), though generally only breeds once a year, which could restrict population growth under unfavourable conditions.

Chitala ornata, Clown Featherback

This species is cited as decreasing in the Beung Kiat Ngong wetlands, and also reported at risk from overfishing in other areas of it range. It is fished at large and small scales, being a favourable species for consumption, as well as the aquarium trade (Vidthayanon, 2012). The species' preferred stream and pond habitats, including rapids and pools with rocks and submerged vegetation, have suffered from degradation due to modification, infrastructure and anthropogenic pressures. It migrates from the Mekong mainstream and tributaries to slower moving waters to spawn (Poulsen et al. 2004).

Species Baseline Risk Summary:

- Turtles and fish species have high market value and are extremely vulnerable to overexploitation for consumption and selling
- Habitat loss/degradation is an issue for all species assessed
- Low reproductive levels of turtles and the Asian openbill exacerbate the impacts of hunting pressure on maintaining populations.

5.3.4 Climate change vulnerability

Levels of climate change vulnerability and reasons for vulnerability varied across fauna species assessed, key criteria are discussed.

'High' climate change vulnerability

Heosemys grandis, Giant Asian Pond Turtle

The greatest climate impacts on this species, are projected for eggs, juveniles and overall reproductive success. Temperature increases are considered a major vulnerability for turtle eggs, with known influence of temperature on hatchling gender ratios, due to environmental sex determination (Lang and Whitaker, 1989). Changes in timing of rainfall and flooding, such as increased early wet season rain, may destroy nests and affect reproductive success; the species nests in November and eggs hatch at the start of the wet season (May-June). Drought will likely impact the species' preferred habitat areas, impacting all stages of development, but semi-aquatic adults can seek alternative terrestrial refugia for short periods, and reportedly aestivate in shallow areas of mud (Platt et al., 2008). Long incubation periods and increasing risks of extreme climate events will make it difficult for many hatchlings to reach maturity. Little is known on this species in the wild and whether it has behavioural traits that allows for adaptation to the new climate.

Cuora amboinensis, Southeast Asian Box Turtle

Similar to *H. grandis*, temperature increases and changes in timing of rainfall are considered potentially serious issues for the eggs and reproductive success of *C. amboinensis*. Refuge availability from drought and heat varies depending on life stage. Adults are semi-aquatic with several refuge options, but juveniles are fully aquatic and potentially more impacted from drought if habitats dry up, while eggs have little refuge from extreme heat and drought conditions. The species is adaptive to a variety of habitats as a generalist species (Shoppe and Das, 2011), but the very low fecundity and survival rates of offspring may limit the capacity of the population to bounce back from extreme climate change, compounded by baseline threats.

'Moderate' climate change vulnerability

Anastomus oscitans, Asian Open bill

The species tolerance to high temperatures is unknown, however, its migratory nature allows it to escape unfavourable climatic conditions to a certain extent. The bird migrates away from drought conditions when possible, but must stay stationary while incubating and rearing their young for two months. The species is likely to benefit from increased precipitation, it requires ample amounts of rainfall to support foraging areas, however, extreme flood levels could affect conditions of breeding grounds (Ishtiaq et al. 2010). With variable climatic conditions leading to changes in resource availability, this species may be well equipped to forage in altered conditions. However, despite being one of the most successful large water birds in Southeast Asia, it is unclear if its reproductive traits would allow it to recover in a new climate. The need to remain at nesting sites for extended periods during breeding may be a limiting factor.

Channa micropeltes, Giant Snakehead

There is expected to be a medium impact of habitat loss from excessive periods of drought. The species spawns during the dry season (Piazzini et al., 2014) so is tolerant of conditions during this time; but increased drought may dry up the small, densely vegetated streams where they spawn (Kottelat, and Widjanarti, 2005). Hydrological and temperature changes may have moderate impacts on the preferred cooler deep pool habitats and cause further sedimentation of pools and shallow spawning grounds. The species may experience changes to habitat connectivity, impeding their ability to migrate between habitats, though it is able to migrate overland for short periods if needed (Allen, 2012). Annual precipitation is predicted to increase in the basin (MRC, 2005), possibly creating more refugia for the species.

Chitala ornata, Clown Featherback

Hydrological changes are likely to have a moderate impact on the species' migratory cues. Where there are available refugia to buffer the impacts of drought, the species seeks out deep pools along the Mekong mainstream during the dry season (Poulsen et al., 2004). Considered adaptive to changes, the species utilizes a variety of habitats; it can survive in warm stagnant water with little oxygen (Animal-World, 2015), but extended periods of drought will risk the degradation and drying up of riverine and deep pool habitats. It is unclear if their migratory response would be impacted by extended periods of drought, as they are known to have an early migration before the rainy season begins. The species are nocturnal and prefer to swim during twilight hours; this behaviour may help to shield it from extreme daily temperatures (Poulsen et al. 2004). They are known to have very good eyesight (MFK, 2010) giving them an advantage for finding what could be scarce food resources under a new climate.

Species Climate Change Vulnerability Summary

Further development of the Lower Mekong Basin is likely to impact hydrological conditions, and with projected changes in precipitation, species will experience higher variability in seasonal flows. Eggs and juveniles of turtle and bird species are expected to be more affected under climate change than adults, as they have less mobility. Eggs of turtles may also suffer developmental issues with increased temperatures and changes in flood seasonality. For fish species, adults may be more affected than eggs and juveniles, due to effects on their migratory and dry season refuge habitats. Extreme flood events are detrimental to spawning and nesting grounds.

Baseline stress is likely to increase as ongoing environmental/hydrological modification encroaches on intact habitats. Poaching of turtle species for their eggs and meat is likely to continue without heightened conservation protection. Overfishing due to resource scarcity and a growing Mekong population will increase pressure on the fish species.

5.3.5 Previously assessed species/taxa of interest for Beung Kiat Ngong

Fauna

With respect to turtles, this vulnerability assessment was focused on *H. grandi*s and *C. amboinensis* species because although the other turtles found in Beung Kiat Ngong are equally threatened, these two have not been assessed previously. The four previously assessed turtle species identified from the site are: Elongated Tortoise/Tao Phek (*Indotestudo elongata*), Asiatic softshell turtle/Pa fa ong (*Amyda cartilaginea*), Yellow-headed temple turtle/ Tao Goun (*Heosemys annadalii.) and* Mekong snail eating turtle/Tao sam san (*Malayemys subtrijuga*) (ICEM, 2012; Meynell et al., 2014). These species were also identified to have high vulnerability, due to similar impacts associated with hunting and trade, low reproductive rates, and climatic changes of increased temperature and altered rainfall patterns.

Other fauna species and taxa groups will be discussed briefly with data from previous assessments (Meynell et al., 2014, IUCN, 2018; ICEM, 2012a):

- While large **black fish** species *C. micropeltes*, Pa do, was found to be moderately vulnerable in this assessment, overall Black fish populations of Beung Kiat Ngong show low vulnerability to climate change. They are adaptable, hardy species that have evolved to be able to cope with the long dry seasons when conditions are at their most stressful, having tolerance to poor water quality and very low water levels (Meynell et al., 2014).
- **White fish** populations only enter the wetlands during the wet season when higher rainfall, increased inundation and lower temperatures make the conditions acceptable, and even beneficial, for white fish populations. However, the effect on populations may depend upon how climate change and other threats affect them outside of Beung Kiat Ngong during the dry season and changes to flood timing (Meynell et al., 2014), and are generally considered overall moderately vulnerable as assessed for *C. ornata* and other white fish species (IUCN, 2018).
- **Eels** are versatile, found throughout many habitats, tolerant to poor water quality, and low water levels, and considered resilient to climatic changes; assessed as having low climate vulnerability (Meynell et al., 2014)
- **Snails** of the wetland have a high water temperature tolerance and are considered relatively adaptive to climate change (Meynell et al., 2014). It is expected that the invasive golden apple snail will thrive and continue to spread under projected climate conditions, and is already noted to be impacting native snail populations. The impacts of invasive species, coupled with the high priority resource use of native snails, puts them at increased vulnerability (Halwart, 1994a; ICEM, 2012a).
- **Frogs** have been assessed to have medium vulnerability to climate change, rising to high vulnerability when other threats were considered, such as resource pressure (ICEM, 2012a). Species previously assessed include *Hylarana lateralis* (Kiat leuang), *Hoplobatracus rugulosus* (Kop) and *Glyphoglossus molossus*/Eung Phao) (IUCN, 2018; ICEM, 2012a).

Flora

Several flora species that occur within Beung Kiat Ngong Marsh have been assessed by past projects and overall were identified to have low to moderate vulnerability to climate change and baseline threats. The shrub, *Sesbania sesbania* was assessed to have a low vulnerability due to its wide tolerance to heat, inundation and drought (Meynell et al., 2014). Flood forest tree, *Barringtonia acutangula* was assessed to have moderate vulnerability. While it is tolerant to flooding and identified to have adaptive capabilities to drought where it will shed its leaves to reduce evapotranspiration, temperature changes can affect reproduction and change in extremes of flood and drought may alter species distribution (ICEM, 2012; Meynell et al., 2014). Invasive species *Mimosa pigra,* currently in low abundance in BKN is drought and flood tolerant, which promote its increase under climate change. Drought can aid spread of the species by allowing it to colonise shallow water areas during dry times, and once established, it is able to survive in deeper water areas, with floods facilitating the dispersal of seeds.

6 SUMMARY OF VULNERABILITIES

6.1 Summary: Habitat vulnerability

Key finding: Peatland, was assessed as the habitat with the highest baseline risk and climate change vulnerability, followed by medium vulnerability habitats such as freshwater marsh, permanent ponds, streams and flood forest.

Peatland: High Vulnerability

- Beung Kiat Ngong is unique as one of the few places in Lao PDR where peatland exists. Past peat extraction has caused degradation of the habitat. An important water storage ecosystem, it is vulnerable to drying and fire from increased temperatures and drought. Maintenance of peatlands is globally important for carbon storage and climate change mitigation.

Key threats to other habitats:
Other habitats, while assessed to have lower overall vulnerability, face a number of key threats that on their own present a high risk to the habitats, their species and important resources.

- **Freshwater marsh** was assessed to have high baseline risk due to combined impacts of cropping, livestock grazing and golden apple snail; and medium risk to climate change from increased drying of shallow areas.
- **Permanent ponds** were assessed to have a moderate vulnerability due to their small area, importance as a refuge habitat, and risks from higher temperatures and reduced water levels, but buffered by their depth and reported good connection to groundwater.
- **Streams** were assessed as moderately vulnerable due to riparian and flow modification, and under climate change to face increased flows and erosion during floods and greater drying and water extraction in drought.
- **Flood forest** covers only a small area of the site and has faced high levels of clearing and conversion in the past. The habitat is considered moderately tolerant to flood and drought but reproduction may be affected by temperature and distribution of habitats altered by changing hydrology.
- **Grasslands** were assessed as overall low vulnerability, but are at risk from high rates of conversion for agricultural purposes. Relatively resilient to climate impacts, there is a risk of the habitat altering in species composition with changes to drought, flood and fire regimes.

In addition to key wetland habitat areas assessed, **terrestrial forest** habitat is considered a significant area of resource collection for local villages. The forest provides important ecosystem services to reduce run-off and erosion/sedimentation and support water regulation, and is currently threatened by clearing and resource extraction.

6.2 Summary: Community/livelihood vulnerability

Priority resources & resource collection areas

Eleven key wetland resources (See Table 7) were identified as the top 10 men and women's resources.
While no resource is identified as entirely vulnerable due to each resource type comprising many species and all have different vulnerability, a few priority resources are considered more vulnerable overall due to their high priority status, and therefore harvesting pressure, and other threats identified.

- **Fish**, **frogs, and snails,** as top priority food resources are under additional pressure as highly targeted taxa groups
- **Turtles** occurred in the top 10 resources and were also identified as highly vulnerable to climate change and baseline threats

Permanent ponds were identified as the **priority resource habitat** where the highest proportion of resources are collected**,** followed by rice fields, as an important semi-modified habitat, and freshwater marsh and forest habitats. The dominant resources found in each of these habitats are shown in Table 6.

Table 6. *Key resource collection areas for priority resources*

Men/Women top 10 resources	Permanent ponds	Rice Fields	Freshwater marsh	Forest
Fish				
Snails				
Eels				
Frogs				
Shrimp				
Wild Vegetables				
Turtle				
Bamboo shoot				
Crabs				
Birds				
Mushrooms				

Climate impacts and coping strategies

The major identified climate impacts, most common current coping strategies (and success ratings), followed by key future coping strategies reported are summarized in Table 7.

Major impacts were associated with crop loss, livestock disease, lack of livestock forage/fodder, reduced fish catch/availability, water shortages and invasive species.

Current coping strategies (mean values) are highlighted as average to 'high success' (green), 'average success' (orange), and 'average to low' success (red). Future strategies are identified or 'same strategy' indicated meaning no new strategies for dealing with the impacts were identified.

Most current strategies scored overall ‘average’ success. Below average success was associated with some coping strategies for impacts of livestock disease, and/or where only one coping strategy was indicated for an impact, i.e. for golden apple snail expansion, where the only strategy was to harvest snails. Few strategies were considered of higher success. Table 7 only shows the three most reported coping strategies for each impact; one additional strategy considered successful for crop loss was irrigated dry season rice cultivation, but it was only indicated by one village as it is not currently widely practised at the site. Considerations of strategies, with respect to their effect on wetlands and sustainability, adaptation and future management will be addressed in Section 7.

Table 7. *Summary of current coping strategies, success ratings & future coping strategies identified by villages*

Livelihood	Impact	Coping strategy 1	Av. Success	Coping strategy 2	Av. Success	Coping strategy 3	Av. Success	**Future strategies**
Resource Impacts	Crop damage/loss (rice + other crops) (F,D)	Harvest more wild resources		Look for outside employment		Grow alternative/ secondary crops		• Diversify crop • Practice irrigated dry season rice cultivation • Re-locate/find new land
	Lack of forage/fodder (F,D)	Move livestock to higher ground (F)		Find/harvest new resources (F,D)		Do nothing		• Same strategies; plus • Sell livestock
	Reduced fish catch/ availability (F,D)	Bring in new fish to restock ponds		Fish conservation zones		Nothing - No effective strategy for loss due to drought		• Same strategies; plus • Use traditional fishing gear
	Expansion of Golden apple snail (F)	Collect snails for consumption and sale		No additional strategy		No additional strategy		• Same strategies
Structural damage impacts	Damage to roads, impeded transport, damage to infrastructures (F,S)	Community repair of roads/ infrastructure		No additional strategy		No additional strategy		• Same strategy; plus • Seek government support
	Damaged trees (S)	Cut into firewood		No additional strategy		No additional strategy		• Same strategies
Health Impacts	Lack of water/drying of water source (D)	Find alternative water point		Queue at local well to collect water		No additional strategy		• Same strategies; plus • Build a dyke on stream
	Increased disease (F)	Vaccinate livestock		Practice traditional medicine		Move livestock		• Same strategies; plus • Training/technical support in livestock care • Improve infrastructure for livestock
	Negative impacts on human health (E.H.)	Take medicine/go to hospital		No additional strategy		No additional strategy		• Same strategies

Key findings: Overall livelihood and community vulnerabilities

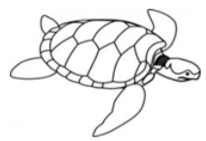
Flood was the most common and detrimental climatic impact to livelihoods. Combined with the effects on resources observed by communities and success and sustainability of strategies, the main livelihood vulnerabilities identified for Beung Kiat Ngong include:

- Loss of rain-fed rice production was the main livelihood impact cited by every village as a major issue.
- Lack of forage for livestock was the second largest impact relating to livelihood production.
- Decreased fish catch and increased livestock disease are significant issues for the majority of villagers.
- Expansion of golden apple snail was identified as an issue across the wetland

6.3 Summary: Species vulnerability

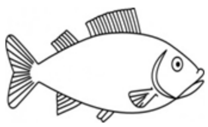
Several species and taxa groups have been identified as most vulnerable from the combined results of both the CAWA Vulnerability assessment and previous vulnerability assessments. Status as a high priority resource (i.e. fish, frogs, snails), additional high hunting pressure and/or breeding restrictions (i.e. birds, turtles); or specific habitat threats (i.e. yellow-breasted bunting), were also considered.

Turtles, fish, birds, frogs and snails have been identified as the key wetland species and/or taxa groups considered most vulnerable and in need of conservation and management under adaptation planning.



Turtles (*H. grandis, C. amboinensis. I. elongata, H. annandalii, M. subtrijuga, A. cartilaginea)*

The species found in Bueng Kiat Ngong are at high risk of climate change and baseline threats; and all listed as globally 'vulnerable' or 'endangered'. They are vulnerable to temperature and flood timing effects on reproduction, loss of refuge habitat, & high harvesting pressure.

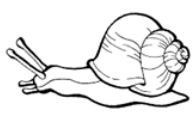


Fish (economic species, *C. ornata, C. micropeltes)*

Fish are identified as No 1. priority resource. Species assessed are significantly important economically, they have been observed as locally declining. Overfishing and a risk of habitat loss put these species at further risk from future climatic changes.

Birds *(such as Asian openbill)*

Birds are in the top 10 resources sourced by BKN villagers. With most species having limited seasonal breeding opportunities & low numbers of offspring, maintaining populations under resource pressure is difficult. The Asian openbill is a natural predator of the invasive apple snail, and its presence important to the ecosystem. Habitat degradation is affecting species such as the Critically Endangered, yellow-breasted bunting.



Snails

A high priority resource, with several species, including Hoi Ka Tai, Hoi Joup, Hoi peng (*Pila sp.*), being harvested in large numbers. Some local species are noted to already be suffering impacts due to golden apple snail expansion, and further population declines may be seen in the future.

Frogs

Particularly large and/or seasonal breeding species such as Kop na (*H. rugulosus) and* Eung Phao (*G. molossus*) assessed as moderately to highly vulnerable. They are at risk of increased drying of habitats, and overharvesting pressure as a high priority resource. Little is known about frog populations of the BKN wetlands.

7 ADAPTATION PLANNING AND DEVELOPMENT OF AN ADAPTATION PLAN

The vulnerability assessment has identified a number of habitats, species and livelihoods vulnerable to the effects of climate change and present baseline threats. While improving resilience and adapting to climate change is the goal of the CAWA project, addressing baseline threats is critical. If a habitat, species or population already has low resilience from other threats it is less likely to adapt well to climate change. For example, a species with a low population or modified habitat area may have limited capacity to adapt if their ability to reproduce or find adequate food sources is restricted.

7.1 Key considerations to address habitat vulnerability and adaptation

Maintaining habitat quality and function is important for preserving species, resources and livelihoods, under climate change. While some habitats scored high on climate change and/or baseline threats, others scored high for individual threats which are as critical to address in an overall adaption plan because these habitats are playing key roles in supporting wider ecosystem health and function. Below is a summary of the main priorities and threats that should be addressed in adaptation planning and management.

Key habitat issues to be further assessed and addressed:

- **Peatland** is a priority habitat for conservation and adaptation management under climate change.
- **Permanent ponds** have been identified as a priority resource area and important refuge habitats for many species
- Several current threats and/or future concerns pertaining to a number of habitat types have been identified, and should be addressed to ensure the small Ramsar site maintains its *current habitat value and ecosystem integrity*, and include:
    - Invasive species expansion and increasing impacts on freshwater marsh/grassland vegetation.
    - Water extraction/diversions and modification of streams, ponds and marsh.
    - Habitat conversion/encroachment/forest removal around the Ramsar site *and within the wider watershed.*

- Policies should be implemented to ensure any future peat extraction or modification of peatland habitat is prevented, and regeneration is promoted. Results from the past peatland survey (Quoi and Lao, 2015) shows that the ecosystem plays a significant role for local communities for food sources and income generating resources, but a lack of awareness of conservation needs among local staff and communities persists.

- Permanent ponds require priority protection as important resource and refuge habitats. Their inclusion in current conservation zoning should be assessed and steps made to ensure future protection

- Agricultural encroachment within the Ramsar site has been identified by site managers as currently at a low level, but there is small-scale habitat modification occurring. A few villages indicate expanding rice fields into the wetland as a current and/or future coping strategy during drought periods and there is some forest clearing on boundary edges. Increased awareness of Ramsar boundaries and regulations should be a priority.

- Increased awareness of ecosystems services and sustainability measures should be highlighted in future community programs. *Improved agricultural practices (no-till, crop diversification, integrated systems, efficient irrigation) should not only be implemented, but emphasis placed on the long-term benefits of more sustainable practices.*

- While current levels of water extraction are relatively low, several proposals for hydrological modification were indicated during the VA. Increased water extraction (both surface and ground water) and/or diversions could pose threats to refuge habitats during drought times. Growing village populations and limited controls on water extraction could cause future issues. *Steps to ensure current low levels of water off-take and reduce future water extraction from natural wetland areas needs to be addressed. This could include policy implementation by the Lao Government to ensure Environmental Impact*

Assessments for any infrastructure project that would use water resources from the catchment. To address population increases and thereby household water use, a survey could be conducted to identify which areas are projected to have increased water demands. A feasibility study should be done in conjunction to see if there are aquifer locations that could be sustainably accessed and allow for several new wells to be built easing the demand, as well as other water catchment/storage options.

- Control is needed for the invasive golden apple snail; it is likely to have a great impact long-term on the wetlands and is extremely difficult to control. The golden apple snail is already established and eradication is no longer possible*. Innovative solutions and incentives for control are needed to gain widespread support from communities and increase control outside immediate areas of agriculture. Intensive programs to reduce abundance will limit impact and speed of expansion. Support for research and testing of bio-controls and alternative techniques for the invasive species currently in the area has potential to reduce impacts in the future. Emphasis on the importance of natural snail predators, including large water birds such as the Asian Openbill, as well as other animals including turtles, and their role in reducing golden apple snail populations should be made, as has been undertaken in other areas (see Text box).*

Ideas from another district

In Viangthong district, Houaphanh province, fish-farmers had been killing Asian openbills because they eat fish from aquaculture ponds. In 2012 the District Agriculture and Forestry Office set a fine in an attempt to stop this. An announcement was made via louder speaker, explaining the benefits the Openbills have for rice farming; this approach could be used in Pathoumphone district to ensure the growth of the population (Timmins & Duckworth, in IUCN, 2014)

7.2 Key considerations to address species vulnerability and adaptation

Because habitats and species are intrinsically interlinked, a number of the considerations to be addressed for habitats are also a major consideration for species. Species-specific threats include those linked to resource use and invasive species. Listed below are the major threats – baseline and climate change- for the vulnerable species identified. Improved habitat protection and restoration, as well as regulation and law enforcement, will lead to a more sustainable environment for many of the species living in the Beung Kiat Ngong wetlands.

Major threats on vulnerable species to be addressed

Overharvesting of resource species for local consumption as well as provincial and international trade	• High levels of resource harvesting including key and common resource species is a major threat to wetland biodiversity as well as future livelihoods. Turtle species are at a high risk of due to their high market price and use for consumption. Fish species are also at risk of overexploitation from the growing human population in the area.
Competition/displacement of native flora and fauna by invasive species	• Wetland flora is being severely damaged by the invasive golden apple snail. It also poses a risk of outcompeting native snail species. Loss of crops and fodder to invasive snails increases wild resource collection and pressure by local communities.
Increased water extraction/diversion or altered hydrology potentially affecting refuge & breeding areas	• Turtle and fish species, as well as other aquatic taxa, could be affected by hydrological modification that alters refuge, breeding or migratory habitat specially during extended dry periods and where timing of water levels are critical.
Species habitat loss due to any increased conversion, clearing, modification	• Potential to threaten already vulnerable and reduced species populations, of turtles and birds, and limiting opportunities for species to successfully breed, maintain populations and adapt to climatic changes
Climate and hydrological influences on species movements and breeding success	• Climate impacts of increased temperature and altered rainfall/hydrological regimes are expected to impact breeding success of a number of species but in particular turtles. Interventions and measures to support breeding and protection of breeding habitats should be addressed.

7.3 Key considerations to address community/livelihood vulnerability and adaptation

With respect to the current strategies identified as successful and unsuccessful, and additional possibilities identified in future strategies and/or community management recommendations, strategies will now be assessed in regards to their potential positive or negative effects on the wetlands, and/or maladaptation considerations. On-ground adaptation measures recommended need to be beneficial to communities but also sustainable to maintain wetland biodiversity and healthy habitats and species populations, and therefore resources and ecosystem services.

Coping strategies identified that improve livelihood but potentially ***increase pressure*** on wetland

- *'Harvesting more wild resources'* for consumption, selling and fodder, as a coping strategy is likely to put increased pressure on species and habitats. Increased fishing and aquatic animal collection would put further pressure on already depleted species populations, and increased harvesting of vegetation for fodder and timber/NTFPs from within and surrounding the wetland area may increase the risk of erosion and habitat damage.
- *Irrigated dry season rice cultivation* was not cited as a currently widely occurring practice, but it was identified as a future coping strategy by some villagers and is likely to increase as climatic changes are projected to alter temperatures and hydrological regimes. Increased water extraction for agriculture may put pressure on other wetland resources and result in maladaptation, if this puts alternative pressure on village livelihoods.
- *Releasing fish* into the wetland was undertaken in 2015, by villagers and the district government. Introducing fish may initially help fisheries resources and benefit livelihoods, but is a quick fix solution that does not necessarily support improved sustainability of natural resources. Additionally, a number of species released were non-native, which may be detrimental to the wetland ecosystem, potentially causing impacts on resident native fish and other aquatic species. Fish stocking can be a useful fisheries enhancement tool if well-planned and selected species are used. Non-native species are suitable in man-made community ponds that are hydrologically disconnected from the wetland but serious consideration should be given to releasing exotic species into natural wetland areas. Discussed in more detail below, a fish stock recovery plan could be developed to improve livelihoods and reduce pressure/impact on wetlands.
- *Hydrological modification:* Villagers identified a number of current and future coping strategies and proposals to increase water availability or reduce flooding. These involved altering water movement through diversions and/or establishment of small dams/water gates. Interventions mentioned during the assessment and validation process include; a dyke on Huayma stream to increase water availability (Phak kha); small water gate on Khongmeuang and Kaenkham streams for water availability and reduced flooding (Ban Phapho; Phak kha); and a new canal in Nong mak ek to support rice cultivation. Each of these should be assessed for both their benefit to livelihoods and potential impacts on wetland ecosystems and the Ramsar site, via thorough hydrological and environmental impact assessments

Strategies that improve livelihood and potentially ***reduce impact*** on wetlands

- Enhanced *conservation* activities and awareness among all villages would help to reduce pressure on wetland resources and support livelihoods. Fish conservation zones have helped to increase fish populations and are recognised as important by communities; continued observation of fishing regulations will help to see future sustainable fish resources, plus increased enforcement/update of regulations that protect other aquatic animals such as turtles, birds, frogs and mammals.

- *Find alternative water points/water storage options* – pressures on the wetland will increase due to the growing population in the area. However, if alternate water sources are established, using multiple water sources/catchment methods spread out over a larger land area is a better solution than continued use of a single point that risks depleting an aquifer or important water body.
- *Growing alternative or secondary crops*, including drought and/or flood tolerant rice varieties, and drought tolerant and wet season suitable vegetable crops is a sustainable strategy that will help villagers adapt to changing conditions, and reduce pressure on wild resources.
- *Increased sustainable aquaculture/community fish ponds* that are separated/enclosed from the wetland area or using native species would benefit reduced pressure on fish resources. During the validation process Ban Kiat Ngong identified they would like to build a new community pond, which should be assessed for feasibility and sustainability.

In addition to targeted on-ground activities it's important to have strategies that support ***improved capacity, knowledge sharing and long-term sustainability*** of adaptation measures:

- *Research partnerships and collaboration* with universities, NGOs, government agencies, and inter-governmental organizations, should be developed with potential to support and enhance activities implemented by the CAWA project, such as through university research programs. Increased development of student projects through Champasak University should be encouraged for a number of key areas that are lacking baseline knowledge to implement effective management.
- Eco-tourism promotion – tourism as a large source of income for the Beung Kiat Ngong wetlands and surrounding area is an environmentally friendly strategy that improves livelihoods while promoting protection and conservation of the area to both outsiders and locals. One activity, the 2003 Emerald Triangle initiative, which aimed to expand sustainable tourism activities in the area where Cambodia, Thailand and Lao PDR meet, has not been implemented due to a lack of local support (Hatsukano, 2012). If re-initiated, plans could help to establish regional tourism information centres, infrastructure for the area (roads, airport improvements, border crossings), as well as marketing and human resource development.
- *Increase community involvement in activities.* Data collection/monitoring on a number of issues identified in the VA (invasive species, resource use, land use change) could drastically help to further management priorities. Frequent discussions between villagers and those managing projects within the site should be encouraged so that they are aware of the changing conditions of livelihood needs and participate in developing the solutions to deal with issues.
- *Data collection and sharing*. There are many projects occurring at any given time throughout the Ramsar site and the surrounding area. A data collection template could be distributed amongst project managers via the Lao Government to facilitate data sharing, consistency and avoid duplication of efforts. Overtime a RAMSAR database should be set up to store and manage all data from projects operating in and around Ramsar sites for continued use and sharing.
- Develop a recovery and conservation plan for turtle, bird and fish species, which may involve supported breeding and release programs of local native species (fish, potentially turtles). This would need to be supported by further studies and feasibility analysis and to ensure the

right conditions are employed for breeding and release events. It is reported that there was an attempt to release approximately 60 turtles in 2015 (confiscated through trade) (CAWA VA, 2017), but some turtles did not survive due to being released into the wrong habitat areas. If such activities are implemented again, a release plan should be developed. For example, minimizing transport stress at the time of release and helping the species to acclimate by releasing into complex natural cover (if present) rather than into open water could enhance survival (Kirkwood and Chilcott, 2012).

- Develop an extreme heat management plan. This could be simple education material that includes tips for villagers to take preventative measures to safeguard their health during high temperatures/heat waves. Several management plans have already been developed that have useful information applicable to low-income households (Ahmedabad Municipal Corporation, 2017; Lead Pakistan et al., 2017). It is important to consider that future climate could have a negative impact on the health of villagers and they need long-term preparations.

In addressing the considerations identified above for habitats, species and livelihoods/community vulnerability, a number of management recommendations have been made to support climate change adaptation and reduce baseline threats. Some additions have come from the VA validation conducted on 27th April 2018. Recommendations are presented in Table 8, and outline the specific vulnerable species/taxa group, resource, habitat, or livelihood affected, the main vulnerability or impact, and the recommendations and steps to be implemented.

Table 8. *Management recommendations to support climate change adaptation of vulnerable species/ resources, habitats and livelihoods*

	Habitat, species/ resource, or livelihood impact affected	Vulnerabilities/impacts to be addressed, or Aim of adaptation measure	Adaptation and management recommendations
Habitats & resource areas	Peatlands	Reduce degradation, extraction and encroachment	• Identify key areas of vulnerability and current levels of peat extraction for local use • Raise awareness amongst communities (i.e. on peatland importance, ecosystem services) and ensure extraction regulations are sufficient • Assess potential for restoration of degraded areas and support community protection of peatlands.
	Permanent Ponds	Reduce impact of increased temperatures/drying by limiting modification, resource pressure & water extraction	• Through community consultation identify permanent ponds that require increased protection to maintain their role as refuge habitats • Assess current levels of water extraction and habitat clearance around key pond habitat areas • Establish new conservation zones and buffer zones, and water extraction restrictions
	Freshwater marsh/grassland	Reduce impacts of invasive species, overgrazing and future encroachment	• Review extent of encroachment/disturbance along freshwater marsh edges • Identify restoration opportunities through reactivated/expanded re-vegetation programs • Target golden apple snail control in areas where marsh/grassland vegetation is most impacted • Conduct assessment on livestock impacts in sensitive areas, i.e Yellow-breasted Bunting grassland habitat/roosts (incl. around Nong Thamniap & Ban Kele area of BKN Marsh (see IUCN, 2014) and assess options to establish exclusion zones.
	Streams	Restrict clearing along riparian boundaries, assess impacts of water extraction/diversion	• Identify areas of riparian degradation and erosion concerns • Establish riparian boundaries to prevent clearing/encroachment. • Identify priority riparian areas for rehabilitation to support reduced erosion/flooding issues. • Ensure proposals for future hydrological modifications are assessed for their potential effect on natural stream flows, as well as livelihood benefits
	Flood forest; Terrestrial Forest	Reduce rates of conversion/resource extraction	• Re-evaluate current flood forest and terrestrial forest cover within the site, and the catchment, and identify potential areas for high risk future clearance • Undertake community consultation to ensure protection of important forest areas for ecosystem service

			• Plan and undertake restoration in degraded forest areas with indigenous/local species; ensure activities are undertaken systematically by local communities, with ownership a key part of success • Improve enforcement of regulations associated with timber and NTFP extraction, and/or update regulations to be more species specific. Assess status of Malva nut buying/selling group and if should be expanded to include other NTFPs.
Species	All vulnerable/ threatened &/or priority resource species	Ensure protection of refuge and breeding habitat & increase reproductive success of vulnerable species	• Identify and protect key nesting areas as well as refuge & roosting sites, for birds (incl. yellow breasted bunting) and turtles, through conservation zoning where applicable (assess needs for key frog breeding sites). • Ensure current regulations to restrict fishing during spawning periods are well known – assess if any key fish spawning areas need extra protections in place. • Assess options/feasibility for community supported breeding programs for vulnerable/endangered turtle species • Increase awareness/conduct community announcements during migratory/water bird breeding seasons, i.e. such as for Asian Open-bill – in order to reduce hunting and disturbance during breeding and increase awareness of species importance (see below under invasive species • Assess impacts on native snails from golden apple snail – Could be addressed as student research project)
	All resource species	Reduce over harvesting	• Undertake local market survey for all wetland resources and further research to fill key knowledge gaps on species vulnerabilities of little known but high priority resource taxa groups, frogs and snails. • Increase awareness/education programs on threats of over harvesting, a focus on turtle species by using Xe Champhone as a case study of future conditions. • Establish and increase patrolling programs and enforcement of harvesting/ hunting regulations - focus on mammals, birds, reptiles (see below for fish), as well as certain hunting practises such as the use of fire and dogs to locate animals. • Expand regulations/ conservation zones to include seasonal resource collection of high risk seasonal species/climate risk species, i.e. seasonal frog breeders, migratory bird species
Liv eli	Declining fishing security	Increase aquaculture production & reduce	• Improve/establish new fish conservation zones (Ban Phommalue, Phalai, Kele, Thopsok); and confirm regulations/boundaries of recently established FCZs.

	pressure on wetland aquatic animal resources	• Increase number of community fishponds – Identify best designs and support native fish stocking; Provide education on release, harvest rates and recovery plans for new introductions. • Establish vegetation in and around ponds to support native fauna and reduce drought/heat effects • Support research/pilot trials for breeding a wider variety of local species & different aquaculture methods. • Continue traditional and sustainable lum pa practises - i.e. maintaining fish for re-stocking
Water shortages	Identify/address reported water level declines; Reduce water resource pressure on wetland	• Identify/address causes of reported water level declines in the wetland - Assess baseline knowledge on water extraction across the site/catchment, status of aquifers, along with estimated current (and future) withdrawal/recharge rates – Initiate additional hydrological and topographical assessments (if required) • Identify best options for community water interception and storage to reduce future ecological impact on wetland and maximise storage • Increase water collection tanks and or support increased wells/ponds for villages identified at high risk from water shortage & with few sustainable options, i.e. Phak kha, Kele • Encourage water off-take from constructed community ponds rather than wetland areas • Consider Government policy to address infrastructure activities within the catchment, and Environmental Impact Assessment processes.
Increasing loss of traditionally cultivated rice (+ other crops)	Reduce impact of crop loss and need for irrigated rice cultivation	• Expand introduction of new flood and drought tolerant rice varieties, undertake consultation with villagers on the risks and benefits of options. • Research alternative climate tolerant crops with focus on new vegetable varieties and tropical tree crops, as well as market opportunities • Provide training in efficient irrigation, and cropping options to maximise water use and resource gain, including fish and rice systems, and community pond and vegetable growing. • Identify options for collaboration with the Department of Agriculture/Environment at Champasak University for student project work on these and other livelihood associated activities.

Invasive species, Golden apple snail, *Mimosa pigra.*	Reduce impact of Invasive species	• Ensure detailed mapping of *Mimosa pigra* extent and Conduct eradication program; Ensure long-term site monitoring (Ban Phommalue and Ban Phalai to undertake control works) • Conduct community consultation and rapid assessment of golden apple snail distribution within the Beung Kiat Ngong Ramsar site • Support widespread collection/control of snails and eggs, and link with training for improved options for harvesting snail meat (see below) • Provide training in cultivation/irrigation management to reduce snail impacts on crops • Raise awareness of fauna species that are natural enemies of golden apple snail, i.e. turtles, ducks and large water birds such as open billed stork (link with conservation program).
Restricted livestock production	Reduce incidence of livestock loss and villager labour	• Implement training program on improved husbandry/livestock care – particularly for large livestock • Advise on the building and maintenance of improved infrastructure for livestock • Testing and introduction of flood tolerant and 'golden apple snail tolerant' fodder varieties (ensure weed risk addressed) • Investigate increasing native fodder options, including shrub/tree forage species (link with restoration programs).
Dependence on wild resources	Increase alternative income generation and/or increased processing 'added value' of resources	• Research possibilities for adding value to wetland resources through increased processing, preserving or 'boutique' marketing options, for plant and animal resources, for example 'Ramsar rice', smoked fish, bamboo pickling/preserving, plus local crafts/weaving – Assess marketing opportunities in Pakse • Research, training and increased support in the use and processing of Golden apple snail, i.e. drying, smoking, fish meal, fertiliser – This could be addressed as a student project • Address expansion of sustainable tourism through an updated tourism assessment and re-assessment of past recommendations; Look at options to incorporate and reactivate the 'Emerald triangle initiative' – Ensure collaboration with all local businesses/tourism enterprises

7.4 Key considerations for implementation of recommendations

It is anticipated that under the CAWA project, implementation of activities linked to these recommendations will principally be undertaken by local communities facilitated by district government DONRE/DAFO with support from IUCN, FAO, and provincial, PoNRE and Central levels of MoNRE.

Effective capacity development is critical for positive climate change adaptation and long-term sustainability of wetland management. Programs developed need to be tailored for effective learning and uptake and on-going support and monitoring is critical. Capacity development and community ownership of adaptation should be key principals guiding the process.

Policy and regulation will play a key role in effective long-term implementation, with land use planning being critical for zoning of agricultural areas, resource collection areas and conservation zones, and enforcement of activities within these areas and within Ramsar boundaries on a whole. Land use planning for all villages should be undertaken to coincide with adaptation and management planning for the site.

Increased awareness of Ramsar and the boundaries of the site are important to ensure effective implementation of regulations and improved community perceptions. However, current and proposed boundaries should also be re-assessed, together with recommendations of additional priority habitat areas for inclusion (IUCN, 2014) and designation of buffer zones. Buffer zones are considered a priority to ensure the ecological integrity of the site is maintained, due to its small size. Potential to manage the site at the catchment scale should be assessed to ensure a landscape scale approach to management.

7.5 Conclusions

The vulnerability of the Beung Kiat Ngong wetlands is influenced by many factors, and while it is important to assess each area of vulnerability individually - species, livelihoods, and habitats - considering how they interact and depend on each other is crucial. Achieving effective adaptation planning and wetland conservation will depend on understanding the synergies between the three key areas of vulnerability and how this can strengthen overall management. In planning for adaptation, it is important to carefully assess the potential conflicts of developing solutions and competing vulnerabilities, i.e. ecological water to support habitat and resource areas *versus* access to water to support more secure or increased agricultural production. Finding solutions that balance the benefits to communities while supporting wetland conservation is essential for both ecosystem and community sustainability.

Recommendations made have attempted to provide this balance with a priority focus on long-term sustainability of natural resources. Any potential livelihood impact on resources has been coupled with recommendations of alternative strategies, or mitigation options. However, support for key livelihoods of communities surrounding the wetland, principally agricultural production, is essential, and recommendations to improve efficiencies and reduce losses to climate change are addressed in parallel with supporting habitats, species and the critical ecosystems services provided by the wetlands.

ANNEX I: TOP 10 PRIORITY RESOURCES (MEN AND WOMEN) FOR EACH VILLAGE SURVEYED

	Bamboo shoot	Birds	Crabs	Eels	Firewood	Fish	Frogs	Green Algae 'Pham'	Grey Algae 'Thao'	Large mammals	Malva nuts	Mushroom	Rats	Rattan	Red ant eggs	Shrimp	Small mammals	Snail	Turtle	Vegetable	Wild Animal
Kele																					
Men			7	3		1	4					10	5			8		2	6	9	
Women	6	9		3		1	4					8				5		2	10	7	
Kiat Ngong																					
Men	6		9	2		1	8							7		3		4	10	5	
Women		6	5	2		1	8		10							4		3	7	9	
Nong Mak Ek																					
Men	7		9	3		1	5		8							6		2	10	4	
Women	8		7	2		1	6		9							5		3	10	4	
Phak Kha																					
Men	8		10	4		1	5					9				3		2	6	7	
Women	2		8	4		1	3					9				7	10	6		5	
Phalai																					
Men	8		9	5		1	3					4				6		2		7	10
Women	2	8		6		1	3			9	10					5		4		7	
Phapho																					
Men	7		8	2		1	4	6	10							5		3	9		
Women	7		8	2		1	3	6						9		4		5	10		
Phommalue																					
Men		6		3		1	4	9	10					7		2		5	8		
Women	6	8	9	2		1	4		10							5		3	7		
Thopsok																					
Men			9	2		1	4					7			10	6		3	8	5	
Women	8			5	6	1	4				7	9				3		2		10	

ANNEX II: EXAMPLE HABITAT AND SPECIES ASSESSMENTS

1a. Habitat baseline assessment: Peatland

Baseline Habitat Variables and Definitions				
Habitat name	Peatland			
Wetland name and location	Beung Kiat Ngong			
Variable	Score		Characteristics of the Habitat	Field Notes
1. How much of this habitat type is found in the wetland?	2	1 2 3	· The habitat covers large proportion of the wetland area · The habitat covers medium proportion of the wetland area · The habitat covers small proportion of the wetland area	Peatland covers a significant area of the main BKN marsh, and a number of smaller areas around the Ramsar site - moderate area of wetland (Quoi and Lo, 2015).
2. What is the habitat size trend in the last 50 years in this wetland?	3	1 2 3	· The habitat is increasing · The habitat is staying the same · The habitat is decreasing	Peatland habitat has decreased in wetland due to past peat extraction (Commercial extraction from 2006-2009) (IUCN, 2012).
3. What is the total geographic representation of the habitat within the region?	2	1 2 3	· The habitat common throughout the region · The habitat found in few places throughout the region · The habitat only found in this wetland	Peatland is only found in a few places of LMB, and BKN is major peatland site in Lao PDR (IUCN, 2012).
4. What is the habitat size trend in the region in the last 50 years?	3	1 2 3	· This habitat type is increasing in the LMB · This habitat type is the same in the LMB · This habitat type is decreasing in the LMB	Overall area of habitat in region has decreased due to peat extraction, degradation, fires etc
5. What is the relative vegetation diversity for this type of habitat?	2	1 2 3	· There are large number of plant species making up habitat · There is an intermediate number of plant species between large and small · There is a single species or few species predominate the habitat	Peatland has intermediate diversity of plant species with some areas dominated by just a few species and other areas quite diverse (Quoi and Lo, 2015).
6. Does the habitat normally require flood for regeneration?	1	1 2 3	· Flood is needed · Some flood is needed · Flood is not tolerated	Flood is important component of the habitat's natural water regime and peat requires prolongded inundation to be maintained
7. Does the habitat normally require fire for regeneration?	3	1 2 3	· Fire is needed · Some fire is needed · Fire is not tolerated	Fire not tolerated and is damaging to peatland systems
8. What is the degree of disturbance needed to maintain this habitat?	3	1 2 3	· High disturbance is needed · Modified · Undisturbed is needed	Undisturbed is needed
9. Are there flagship species in this habitat?	2	1 2 3	· No · A few · Many	Several significant turtle species use peatland areas
10. Are there keystone species needed to maintain this habitat?	2	1 2 3	· No · A few · Many	Several vegetation species may be considered keystone species of peatland in BKN marsh, one dominant/unique species is the fern, *Nephrolepis falcata* (Quoi & Lo, 2015).
11. Are there important economic species in this wetland?	2	1 2 3	· No · A few · Many	Several important economic blackfish species occur in peatland areas, including Channa spp (Pa Do/Pa Khor) & Clarias spp. (Pa Douk); important frog resource species also utilise peatland (CAWA VA, 2017).
12. Are exotic species a problem in this habitat?	3	1 2 3	· No · A little · Very serious problem	Golden apple snail is a seriois problem in habitat area
13. Are there threats to conversion of this habitat?	3	1 2 3	· No · Maybe · Yes	Peat extraction - past and ongoing small scale harvesting; Conversion for agriculture, fish ponds, i.e. clearing to maintain open water (IUCN, 2014; Quoi & Lo, 2015).
14. How does the habitat recover from recent extreme weather events?	3	1 2 3	· recovers fast · recovers slowly · does not recover	While from flood habitat generally recovers well, it may not recover from extreme drought and/or fire when areas of peat are damaged/destroyed.
15. Is the wetland currently protected?	2	1 2 3	· Yes · Protection status is being considered; Or under official protection but not well enforced · No	Protected under Ramsar convention & Xe Pian NPA, but regulations not fully enforced.
Total score	2.4			

1b. Habitat climate change vulnerability: Peatland

Habitat Climate Change Exposure and Definitions				
Habitat name	Peatland			
Wetland name and location	Beung Kiat Ngong			
Variable	Score		Definitions	Field Notes
Threats: Climate and non-climate				
1. Is temperature change considered to be an issue	3	1 2 3	· Temperature change is not an issue. · **Temperature change is a moderate issue** · Temperature change is a serious issue	Increasing temperatures that results in more frequent drying of peatlands and/or fire is a serious concern that could lead to loss of peat habitat and acid sulphate soil issues, following reflooding (Meynell et al, 2014); Evidence of fires has been observed in peatland areas of BKN (Quoi and Lo, 2015).
2. Is exposure to drought an issue?	3	1 2 3	· Precipitation changes is not an issue. · **Moderate exposure to drought** · **major drought issues**	Exposure to drought is a significant concern for peatland areas with drying causing peat damage, and as well as affecting the water storage capacity of peatland (Meynell et al, 2014).
3. Is exposure to flood an issue?	1	1 2 3	· Flooding is not an issue. **Moderate exposure to flood** **Major flood issues**	Flooding is generally not considered an issue as inundation and regular flooding is important to maintaining peat habitats. Concerns arise if drying and rehydration after flooding leads to Acid sulphate soil issues (Meynell et al, 2014).
4. Is exposure to hydrological change an issue?	3	1 2 3	· Hydrological change is not an issue · **Moderate hydrological exposure** · Major hydrological exposure	Increased evaporation rates are a major concern to increased drying of peatlands (Meynell et al, 2014).
5. extreme weather events - droughts, typhoons and high winds?	3	1 2 3	· Extreme weather is not an issue · **Moderate exposure to extreme events** · major exposure to extreme events	Even a moderate increase in El nino's/ extreme drought events are a significant concern to peat drying beyond recovery, as well as increasing the risk of fire that severely damages peat deposits.
Exposure				
7. How much of this habitat type will be exposed to **changing hydrology** and hydraulics (i.e. flows)?	3	1 2 3	· <75% · >25% and <75% · >25%	Changing hydrology in the form of increased evaporation rates leading to increased drying of peat expected to affect all habitat area.
8. How much of this habitat type will be exposed to changes in extent, depth and duration of **inundation** from rainfall?	2	1 2 3	· <75% · >25% and <75% · >25%	Moderate declines in rainfall projected, and moderate exposure to changes expected for peat habitat.
9. How much of this habitat type will be exposed to changes in **sediment** washed down from the watershed, resulting from soil erosion changes?	2	1 2 3	· <75% · >25% and <75% · >25%	Peatlands occur in low lying depositional areas and there is potential for increased exposure to sediment with increased stream flow washed down from the catchment.
11. Will baseline stress be increased by the new climate in the LMB?	3	1 2 3	· pretty sure they will not · 50/50 chance · pretty sure they will	Peat harvesting and water extraction are current baseline stresses - Water extraction expected to increase under climate change and increased peat removal to buffer livelihood impacts from climate change.
Sensitivity				
13. Is the habitat generally **Heat** tolerant?	2	1 2 3	· The habitat has tolerance to a broad thermal range · Intermediate · The habitat has narrow thermal range	Peatland moderately heat tolerant, i.e. regularly exposed to high temps but increased drying/fire is a risk (Meynell et al, 2014).
14. Is the habitat generally tolerant to flooding?	1	1 2 3	· The habitat has tolerance to flooding · Intermediate · The habitat has narrow tolerance to	Peatland is considered tolerant to regular flooding
15. Is the habitat generally tolerant to drought?	3	1 2 3	· The habitat has tolerance to drought · Intermediate · The habitat has narrow tolerance to	Not tolerant of extended drought, that leads to drying of peatland; Development of acid sulphate soils after drying a risk (Meynell et al, 2014). .
16. Are flagship species likely to be affected by climate change?	3	1 2 3	· The flagship species are tolerant to climate change · Intermediate · The flagship species are not tolerant to climate change	Several turtle species assessed as highly vulnerable to climate change and occur in peatland areas
17. Are keystone species likely to be affected by climate change?	2	1 2 3	· The keystone species are tolerant to climate change · Intermediate · The keystone species are not tolerant to climate change	Keystone species of peatland in BKN marsh include the fern, *Nephrolepis falcata. S*imilar species *Dipazium esculentum* assessed as moderately vulnerable to climate change (ICEM, 2012).
18. Are important economic species likely to be affected by climate change?	1	1 2 3	· The economic species are tolerant to climate change · Intermediate · The economic species are not tolerant to climate change	Main economic species, i.e. black fish spp.such as snake head, Channa spp.,. and catfsh, Clarias spp, and eels, considered relatvely tolerant of effects of climate change (Meynell et al, 2014).
19. Is the habitat generally tolerant to sediment increase?	1	1 2 3	· The habitat has tolerance to a broad sediment range · Intermediate · The habitat has narrow sediment range	Sediment increase not considered significant concern at BKN (generally small forested streams) and peatland expected tolerant to small sediment increases
20. Is the habitat generally tolerant to soil erosion?	1	1 2 3	· The habitat has tolerance to soil erosion · Intermediate · The habitat has narrow tolerance to soil erosion	Erosion not considered an issue for peatland
Adaptive capacity				
23. Does the habitat have resilient vegetation assemblages?	2	1 2 3	· Annual vegetation – grasses, reeds and water plants with rapid generation times · Intermediate between High and Low, also include species that have seeds that remain · long-lived trees and shrubs with slow germination and slow generation time	Vegetation is mixed in different areas of peatland at BKN and overall vegetation assemblages have 'Intermediate' resilience: At Beung Papeo, Ban Kaelae vegetation is dominated by forest trees, shrubs and some species of Cypraceae. Reed (Phragmites karka); In the main BKN marsh vegetation is dominated by seasonal graminoids plus shrubs (Sesbania etc.) and wood trees; Near Ban Phapho, grassland predomiantes, particularly species *Imperata cylyndrica* and Nephrolepis falcata; Near Ban Topsok vegetation is dominated by various species of grasses such as Polygonum tomentosu, Stenochlena palustris, Colocasia esculenta, Cyperus sp., ect
24. Are invasive species likely to increase with climate change?	3	1 2 3	· pretty sure they will not · 50/50 chance · pretty sure they will	Mimosa pigra likely to spread further by flooding, increasing in shallow, warmer waters; Golden apple snail expected to increase as tolerant of poor water quality and some drying (CABI, 2017).
25. Does the habitat have traits that will allow it to bounce back from the new extremes/maxima/minima due to climate exposure?	3	1 2 3	· pretty sure it can · 50/50 chance · pretty sure it cannot	Increased drought/high temps/evaporation rates that lead to increased drying and more frequent fires means habitat is less likely to bounce back; Development of acid sulphate soils also results in permanent habitat damage;
26. Is there adequate space for change. i.e. is there suitable adjacent water, terrain and soils to allow expansion or "movement" of the habitat?	3	1 2 3	· There are large areas of suitable land or · Intermediate between High and Low · There is small or no areas of land or water suitable adjacent to the wetland for expansion or movement of the habitat.	Peatland habitat is considered non-renewable and not able to expand.
27. Are there physical barriers (natural or man-made) that might prevent expansion or "movement" of the habitat?	3	1 2 3	· There are no barriers. · There are some barriers · There are major barriers	Peatland habitat is considered non-renewable and not able to expand.
28. Could this habitat be a existing or future refuge or other species?	3	1 2 3	· pretty sure it will not · 50/50 chance · pretty sure it will	There is evidence that peatland could be an important refuge habitat due to its superior water holding capacities and dense vegetation cover.
30. Are biological thresholds exceeded for this habitat, e.g. for keystone species ?	No		**No** **Don't know** **Yes = Very Vulnerable**	
Total score	2.3			
Highly Vulnerable	2.3			

2a. Species baseline assessment: Giant snakehead/Pa Do (*Channa micropeltes*)

Species Baseline Conservation Status Worksheet						
Species name	**Channa micropeltes**					
Wetland name and location	**Xe Champhone**					
Variable	**Adult Score**	**Juvenile Score**	**Egg/Seed Score**		**Characteristics of the Species**	**Comments**
1. What is the **population** size within the LMB?	1	na	na	**1** **2** **3**	· With in LMB the species is common · Intermediate between Large and · With in the LMB the species is rare	The population size is unknown, however it is a common species throughout the LMB. It has a wide distribution and it is widely cultivated throughout southeast Asia (Allen, 2012).
2. What is the **populations trend** in the LMB in the last 50 years?	2	na	na	**1** **2** **3**	· The population is increasing · The population is staying the same · The population is decreasing	The population trend is noted as stable and it is a common species throughout its range (Allen, 2012).
3. What is the **geographic range** size in the LMB ?	1	na	na	**1** **2** **3**	· The species is widespread in the basin · Intermediate between Large and · The species is within a small/restricted range	The species has a very wide distribution throughout Southeast Asia, ranging from the lower Mekong (Lao PDR (including tributaries such as the Xe Bang Fai; Kottelat 1998), Thailand, Cambodia (including the Tonle Sap lake and river) and the Mekong delta in Viet Nam), the Chao Phraya and Maekhlong (Thailand) basins (Allen, 2012).
4. What is the **range size trend** in the LMB in the last 50 years?	2	na	na	**1** **2** **3**	· The range is increasing · The range is the same · The range is decreasing.	Data pertaining to the species range in the last 50 years is scarce. The population is currently stable.
5. Can the species **reproduce** fast?	2	na	na	**1** **2** **3**	· Many offspring, many times a year · Many offspring, once a year · few offspring once a year.	There is little information about the species incubation and fecundity. The spawning occurs in November and December and females spawn 2000-3000 eggs (Piazzini et al. 2014). They spawn in waters where vegetation has been cleared by the adult fish and are furiously protected by their parents.
6. Is the species a generalist or specialist?	1	1	na	**1** **2** **3**	· Generalist · Intermediate · Specialist	A generalist species, can occur in a range of freshwater habitats, lowland rivers and swamps, as well as deep water bodies and can be found in canals (Kottelat, 1998). They are an obligate predator, feeding on smaller fishes, amphibians, invertebrates and terrestrial insects (Seriouslyfish, 2017).
7. Does the species need a lot of habitat?	2	2	2	**1** **2** **3**	· Requires a small habitat · Requires a moderate habitat · Requires a large habitat	Information on migratory habitats is scarce. The species is capable of short overland migration and inhabits lowland rivers, swamps, and deep water bodies (Allen, 2012). It nests in cleared vegetated areas, the extent to which is not documented. Based on limited information it is determined that they require a moderate amount of habitat, therefore a score of 2 is assigned. Further information on migratory range is needed to have a complete assessment on habitat needs.
8. Is the species able to disperse?	2	2	2	**1** **2** **3**	· Can move long distances easily · Can move short distances easily · Can not move very far.	It is known that the species is at least able to move short distances easily, as it can migrate overland if necessary. Long distance movement for the species is not documented. The species eggs move after spawning, they rise in the water column, but are kept in one place after that, guarded by the parents, even after hatching (Courtenay and Williams, 2004).
9. How does the species survive current floods?	2	2	2	**1** **2** **3**	· Recovers fast · Recovers medium · Recovers slow	The species is moderately adapted to survive floods, it prefers standing or slow flowing waters, but also inhabits deep pools (Courtenay and Williams, 2004). Increased sedimentation from flooding poses a risk of filling in their deep pool habitats. The eggs of the species may be at risk to extreme flood events, they are nested in an area that has been cleared of vegetation (Courtney and Williams, 2004). Depending on the severity of the flood event the spawning ground can be at risk of being washed away, hurting the chances of egg survival.
10. How does the species survive current droughts?	2	2	2	**1** **2** **3**	· Recovers fast · Recovers medium · Recovers slow	The species prefers deep waters (Kottelat, 1998), and can move to these habitats to recover during times of drought. There is little information specific to the species ability to adapt to droughts. The Channa genus does have the ability to breath air when necessary (Olson et al. 1994), and other channa species will burrow to the bottom of mud lakes, canals and swamps during the dry season (Phen et al. 2004). It is unconfirmed as to whether or not the Channa micropeltes is capable of doing this so a score 2, moderate recovery from droughts is assigned.
11. Are there threats to survival from humans use?	3	3	3	**1** **2** **3**	· The species has low value · The species has medium value · The species has high value	The species genus is one of the most important groups of freshwater food fish in tropical Asia (Benziger et al., 2011). Juveniles are sold is the aquarium fish trade as pets, and the species is commonly offered as a food item by street vendors (Forese et al. 2012). Some Asian cultures believe this species helps to heal the body, it is consumed as a therapeutic for wound healing as well as reducing post-operative pain and discomfort (Benziger et al., 2011)
12. Are there threats to survival from non-humans interactions?	2	2	2	**1** **2** **3**	· Is not affected · Is slightly affected · Is highly affected	Generally considered to not be threatened across its range, but likely to be impacted locally by habitat loss (Allen, 2012).
13. Does the wetland have effective management?	3	3	3	**1** **2** **3**	· Highly effective · Moderately effective · Not very effective	Designated Ramsar site and some fish conservation zones in place, but regulations not fully enforced in many areas.
14. Does the species have a national conservation status?	1	1	1	**1** **2** **3**	· Not priority · Priority · High priority	Not nationally listed as a 'priority' species in Lao PDR
15. Does the species have a IUCN Redlist status	1	1	1	**NA** **NA** **1** **2** **3** **4** **5**	· Not evaluated · Data deficient · Least Concerned · Near Threatened · Vulnerable · Endangered · Critically endangered	Listed as 'Least Concern': IUCN Redlist
Average score	**1.8**	**1.8**	**1.8**			

2b. Species climate change vulnerability: Giant snakehead/Pa Do (*Channa micropeltes*)

Species climate change analysis worksheet

Species name	**Channa micropeltes**				
Wetland name and location	**Xe Champhone**				

Variable	Adult Score	Juvenile Score	Egg/Seed Score	Score and definitions	Comments
Threats from climate change					
1. Is temperature change considered to be an issue	2	2	2	1 - Temperature change is not an issue. 2 - **Temperature change is moderate** 3 - Temperature change is a serious issue	The species has a variable water temperature range, some accounts cite the range as much as 20 to 30 degrees Celsius (Seriouslyfish 2017), or a more conservative estimate of 25 to 28 degrees Celsius (Phen et al. 2004). The LMB is predicted to experience an increase of 0.7 degrees Celsius by 2050 (Hoanh, 2010). Air temperatures in the cooler, dry season average in the mid-twenties (MRC, 2010), an additional degree increase may not impact the species ideal temperature range, however, drier conditions from increased temperatures may degrade the size of its habitat, therefore a score of 2, 'moderate' is assigned.
2. Is drought likely to be an issue?	2	2	2	1 - Precipitation changes is not an issue. 2 - **Moderate threat to drought** 3 - **major drought issues**	The species is likely to be moderately impacted by seasonal droughts, it's spawning takes place during the dry season (Piazzini et al. 2014). Excessive periods of drought may dry up the small, densely vegetated streams where the species spawn(Kottelat, and Widjanarti, 2005).
3. Is increased flooding likely to be an issue?	2	2	2	1 - Flooding is not an issue. 2 . **Moderate threat of flood** 3 . **Major flood issues**	Increased flood levels or frequency are identified as a moderate threat to adults or juveniles; flooding could cause a loss of their preferred habitat of standing or slowly flowing water (Phen et al. 2004), sedimentation from flood events also poses a risk. The eggs are considered to be at a moderate threat to flooding as the spawning grounds are found in small streams with dense vegetation (Kottelat, and Widjanarti, 2005) which may not be fully protected against strong flood surges.
4. Is exposure to hydrological change an issue?	2	2	2	1 - Hydrological change is not an 2 - **Moderate hydrological changes** 3 - Major hydrological changes	Hydrological changes will cause moderate issues for the species. The species prefers deep water bodies (Phen et al. 2004), increased evapotranspiration caused by the increased temperatures predicted in the basin (Eastham et al. 2008) could cause a loss of their deep water habitats. Change in hydrological flows could effect the seasonal migration of fish and the flow of fish larvae, impacting fish stocks (TKK, 2009).
5. Extreme weather events - typhoons and high winds?	2	2	2	1 - Extreme weather is not an issue 2 - **Moderate risk of extreme events** 3 - major risk of extreme events	Moderate risk of increased extreme drought, i.e. El Niño events although infrequent can be severe and increased/complete drying of refuge pools and potentially disconnecting migration routes may impact populations and breeding success.
Exposure to climate change					
7. Are microhabitats or refugia available to reduce exposure to temperature change	2	2	2	1 - Temperature exposure is not an issue. 2 - **Refugia are available** to buffer impacts 3 - There is **little option** for the species to find shelter in refugia	For adults and juveniles refugia are available, the species prefers deep pool habitats that help to reduce exposure to extreme temperatures. The upwards limit of the species preferred water temperature is 30 degrees Celsius (seriouslyfish, 2017). There is no available information of ideal temperature conditions for the eggs. Spawning occurs during November and December (Piazzini et al. 2014) during the Lower Mekong Basin's cooler months, therefore it can be assumed the best conditions for the eggs are on the cooler end of the species water temperature tolerance. Spawning in vegetative waters may provide shaded protection from exposure to increased temperatures.
8. Are microhabitats or refugia available to reduce exposure to drought?	2	2	2	1 - Precipitation changes is not an issue. 2 - **Refugia are available** to buffer impacts 3 - There is **little option** for the species to **find shelter in refugia**	The species can inhabit a depth of up to 100m (Phen et al. 2004), and prefers deep, cool pools. These habitats may be at risk of degradation depending on how frequent and intense the droughts are. Annual precipitation is predicted to increase in the basin (MRC, 2005), possibly creating more refugia for the species.
9. Are microhabitats or refugia available to reduce exposure to flood?	2	2	3	1 - Precipitation changes is not an issue. 2 - **Refugia are available** to buffer impacts 3 - There is **little option** for the species to **find shelter in refugia**	Adults and juveniles are likely able to seek refuge in deep pools during floods. The eggs may have little option to find shelter from floods as the spawning grounds are in small streams, largely unprotected except by vegetation. Flood exposure may destroy the spawning grounds and wash away the eggs.
10. Are microhabitats and refugia available to reduce exposure to hydrological change?	2	2	3	1 - Hydrological change is not an issue 2 - **Refugia are available** to buffer impacts 3 - there is **little option for the species to find shelter in refugia**	An increase in hydrological flows could provide an increase in refugia for the species, expanding the floodplains that they live in. Increased river flows could alternatively cause a loss of habitat, due to increased sedimentation, filling their deep pool habitats. Eggs are deposited in small streams during the dry season and would therefore be at risk if hydrological flows increase.
11. Are microhabitats or refugia available to reduce exposure to extreme weather events?	2	2	3	1 - Extreme weather is not an issue 2 - **Refugia are available** to buffer impacts 3 - there is **little option for the species to find shelter in refugia**	Extreme events common the LMB such as drought would leave little refugia for the eggs. Adults and juveniles are able to breath above land for short periods of time in shallow, muddy floodplains which provides them protection from extreme drought in their current habitat (Courtenay and Williams, 2004).
Sensitivity to climate change					
13. Does the species have a wide **heat** tolerance ?	2	2	2	1 - Tolerant to a broad range 2 - Tolerant to an intermediate 3 - Tolerant to a narrow range	Information is lacking on the details of their heat tolerance. Their ideal temperature range is 25 to 28 degrees Celsius. Moderate heat tolerance expected for all stages based on stress impact studies done on other species in the genus, temperatures around 36 degrees Celsius will cause increased stress (Purohit et al. 2014). Temperatures in the Mekong basin currently range from 30 to 38 degrees Celsius in March and April, basin wide temperatures are predicted to rise by 0.7 degrees Celsius (MRC 2010), which will increase the risk of exposure to temperatures out of the species comfort range.
14. Does the species have a wide **precipitation** tolerance?	2	2	2	1 - Tolerant to a broad range 2 - Tolerant to an intermediate 3 - Tolerant to a narrow range	Species considered to have intermediate precipitation tolerance as it naturally occurs in a climate with extreme rainfall but as an aquatic species is highly reliant on constant presence of water.
15. Does the species have a wide **hydrological** tolerance?	2	2	2	1 - Tolerant to a broad range 2 - Tolerant to an intermediate 3 - Tolerant to a narrow range	Species has a moderate hydrological tolerance, it does not depend on the rainy season for migratory cues but does spawn in vulnerable stream habitats.
16. Is the species sensitive to **associated risks** from other species?	1	1	1	1 - Tolerant to a broad range 2 - Tolerant to an intermediate 3 - Tolerant to a narrow range	No known risks from other species, it is quite aggressive in nature and protects its eggs furiously against predators. Older juveniles have been observed to form large aggregations to reduce the threat posed by predators (Seriouslyfish 2017).
Adaptive Capacity					
17. Does this specie have **reproductive traits** that will allow it to bounce back from the new climate exposure	2			1 - pretty sure it can 2 - 50/50 chance 3 - pretty sure it cannot	50/50 chance it will bounce back from the new climate. Information on exact life cycle and age of maturation is unclear. The Channa genus quickly reaches a juvenile stage (Nico, 2004), further details on their fecundity is unknown. They lay an average amount of eggs (2000-3000) (Piazzini et al. 2014) once a year in the dry season.
18. Does this species have **habitat traits** that will allow it to bounce back from the new climate exposure	2			1 - pretty sure it can 2 - 50/50 chance 3 - pretty sure it cannot	50/50 chance; moderate habitat traits that would allow it to bounce back from a new climate exposure. Eggs are deposited in a vulnerable habitat, but the adult and juvenile species can survive well in a variety of habitats, and even on land for short periods of time.
19. Is the population big enough and with enough **genetic diversity** to withstand the new climate exposure?	1			1 - pretty sure it can 2 - 50/50 chance 3 - pretty sure it cannot	The species observed heterozygosity (genetic variability) is the same as its expected heterozygosity, and is average compared to a group of 420 miscellaneous fish species heterozygosity (Phen et al. 2004). The species has a disjunctive distribution, it inhabits both Southeast Asia and southwest India (Ebanasar, 1995). Its range and genetic diversity allows for a score of 1, it will most likely be able to withstand a new climate.
20. Does the species have **behaviour** that will allow it to adapt to the new climate?	2			1 - can acclimatize to the new climate 2 - intermediate between High and 3 - has little ability or opportunity to acclimatize	The species has the ability to breathe air but are only able to do so in muddy or swampy areas. This ability allows it to survive when water levels are low or in stagnant water where there is minimal oxygen they are able to take small gulps of air. Migratory patterns due to environmental changes is not fully known, therefore it is assigned a score 2, some behaviour will allow for adaptation.
21. Is there sufficient **habitat connectivity** to allow organisms to reach appropriate habitat/climate	2			0 - pretty sure it can 1 - 50/50 chance 3 - pretty sure it cannot	Unconfirmed; habitat connectivity between streams, rivers, and floodplains is needed for species movement. Changes in regional hydrology and climate may significantly alter their ability to move.
22. Is there **adequate time** to allow an individual to develop adaptive changes?	3			0 - pretty sure they will 1 - 50/50 chance 3 - pretty sure they will not	Considered unlikely that there is time for species to develop adaptive changes due very specific seasonal migratory/behavioural patterns in response to hydrological cues/flooding etc.
23. Will baseline stress be increased by the new climate in the LMB?	3			1 pretty sure it will not 2 - 50/50 chance 3 pretty sure it will	Most likely baseline stress will increase due to hydrological changes, increased temperatures and loss of habitat.
26. Are biological thresholds exceeded for this species ?	1			**No** **Don't know** **Yes = Very Vulnerable**	Not yet considered exceeded, future habitat degradation will likely impact local populations.
Total score	2.0	2.0	2.1	**Average Confidence**	

ANNEX III: CURRENT WETLAND MANAGEMENT AND FUTURE RECOMMENDATIONS IDENTIFIED BY EACH BEUNG KIAT NGONG VILLAGE

Village	Resource/Issue	Current management	Future Recommendations
Kele	Fisheries	• Villagers are only permitted to use traditional gear for fishing •Village part of the BCC project involved in patrolling/monitoring activities for Xe Pian NPA.	•Establish a Fish conservation zone (FCZ) in Nong papeo yai
Kiat Ngong	Fisheries Water quality Land/Forest Resources	•FCZs established at Nong Lak, Nong Hong Seng and Nong Ta Koune •Prohibited: use of toxins/ electrofishing; fishing in spawning season (June-July) •Burning of land/forest not allowed •Village part of the BCC project involved in patrolling/monitoring activities for Xe Pian NPA.	•Stricter law enforcement for those caught fishing during spawning season (reported that offenders are only given a warning) •Continue/improve monitoring of the wetland and the Xe Pian NPA •Increase technical training and tools for monitoring
Nong Mak Ek	Fisheries Water quality	•FCZ at Beung phud Prohibited: use of toxins/ electrofishing; fishing in spawning season (June-July); & during drought.	•Continue/increase monitoring of wetland •Increase technical training and tools for monitoring •Add additional information to the sign boards around the FCZ to increase awareness •Stricter law enforcement for those caught fishing during spawning season (reported that offenders are only given a warning)
Phak kha	Fisheries	•The villagers only fish from their community pond every 2 to 3 years to allow for fish population to grow. It is a community conservation area managed by locals instead of by official written regulations. •Only traditional fishing gear permitted	•Continue to monitor fish population and observe restrictions
Phalai	Fisheries Mammals/ wildlife	•FCZs established in Vangmon and Nonglom, •No electrofishing allowed •Guns prohibited for hunting •Village part of the BCC project involved in	•Re-activate/Improve old Vangmon FCZ (Ban Phalai) – (identified as an issue during validation) •Continued use of regulations is expected to be effective

		patrolling/monitoring activities for Xe Pian NPA.	
Phapho	Fisheries Land/Forest Resources	•FCZ established at Vang Kae •Fishing restricted in streams and ponds during spawning season (June-July); & drought periods •Burning of land/forest not allowed •Village part of the BCC project involved in patrolling/monitoring activities for Xe Pian NPA.	•Stronger enforcement of fishing laws, villagers noted only a warning has been given to violators. •Continue to monitor wetland, Increase technical training and tools for monitoring •Add additional information to the sign boards around the FCZ to increase awareness
Phommalue	Fisheries Land/Forest Resources	•FCZ established in Nong Lom •Burning of land/forest not allowed •Prohibited: use of toxins/ electrofishing; fishing in spawning season (June-July)	•Stronger enforcement of fishing laws, villagers noted only a warning has been given to violators. •Continue to monitor wetland, Increase technical training and tools for monitoring •Add additional information to the sign boards around the FCZ to increase awareness
Thopsok	Fisheries Land/Forest resources	•FCZ established in 2011, led by District authorities, with formal written regulations. •Village conservation forest established in 2011, activities allowed include collecting NTFPs like mushrooms, bamboo shoots, vegetables. Hunting of wildlife and logging are totally prohibited. •Regulations set up to manage the harvest of malva nuts; for example, only fallen nuts are allowed for collecting. Prohibited to harvest by burning and/or cutting of trees •Only traditional fishing gear can be used for fishing •Village part of the BCC project involved in patrolling/monitoring activities for Xe Pian NPA.	• Assess/maintain water levels to improve FCZ in Ban Thopsok (identified as in issue during VA validation) •Continue to monitor conservation zones and enforce regulations •Establish consistent regulations amongst villages

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INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

ASIA REGIONAL OFFICE
63 Sukhumvit Soi 39
Klongtan - Nua, Wattana
10110 Bangkok, Thailand
Tel +66 (2) 662 4029
Fax +66 (2) 662 4387
www.iucn.org/asia