Climate Change Vulnerability Assessment Xe Champhone Ramsar Site, Lao PDR

Amy Scott, Colleen Cranmer, 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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Funded by the Food and Agriculture Organization of the United Nations (FAO) and Global Environmental Facility (GEF).

Published by:	IUCN Asia Regional Office (ARO), Bangkok, Thailand
Layout by:	IUCN Asia Regional Office
Citation:	Scott, A., Cranmer, C., Thongsavath, O., and, Xeuasing, K. (2018). *Final Report: Climate Change Vulnerability Assessment, Xe Champhone Ramsar Site, Lao PDR.* Vientiane, Lao PDR: IUCN. 93 pp.
Date:	May 2018
Funded by:	Food and Agriculture Organization of the United Nations (FAO) and Global Environmental Facility (GEF).
Cover Photo:	Transporting bamboo, Xe Champhone Ramsar Site, Lao PDR © Amy Scott
Back cover:	© IUCN/Lao PDR team
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Available from:	IUCN (International Union for Conservation of Nature) Asia Regional Office BRIDGE Programme 63 Sukhumvit Soi 39 Klongtan – Nua, Wattana 10110 Bangkok, Thailand Tel +66 2 662 4029 Fax +66 2 662 4387 Email address: asia@iucn.org www.iucn.org/resources/publications

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ACRONYMS

CAWA	Climate Change in Wetland Areas
CEPA	Community Education, Participation, and Awareness Focal Point
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
IRAS	Improving the Resilience of the Agriculture Sector
IUCN	International Union for Conservation of Nature
Lao PDR	Lao People's Democratic Republic
LEK	Local Ecological Knowledge
LMB	Lower Mekong Basin
MoNRE	Ministry of Natural Resources and Environment
MRC	Mekong River Commission
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
XCP	Xe Champhone Wetlands
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 priorities for mitigation and adaptation. The complexity of wetland systems in their diversity of habitats and species, as well as ecosystem services and resources for human populations, makes prioritising vulnerable areas challenging but also a critical process for future management. In order to address these concerns, a climate change vulnerability assessment was undertaken for the Xe Champhone Ramsar Site, in Southern Lao PDR, under the CAWA project - Climate Adaptation in Wetland Areas.

The Xe Champhone wetlands were designated as the Lao People's Democratic Republic (Lao PDR) first Ramsar site in 2010, with criteria for designation including provision of important habitat for threatened and migratory species, and beneficial ecosystem services for surrounding communities (Water Resources and Environment Administration [WREA], 2011). The habitats found in Xe Champhone and the communities that depend on them are considered vulnerable to the associated effects of climate change such as, increasing temperatures, changing precipitation patterns and increasing incidence and intensity of storms, episodes of drought, and flooding (International Union for Conservation of Nature (IUCN 2017b).

The Ramsar Strategic Plan 2016 – 2024 recognizes the important role that local knowledge and customary use of wetlands can play in achieving conservation goals (McInnes, 2017). With this in mind, the vulnerability assessment (VA) sets out to use a combination of local knowledge and scientific data to ensure the most accurate assessment can be made, to better understand future climate pressures on the Xe Champhone wetlands and the communities that depend on them.

1 DESCRIPTION OF THE WETLAND

1.1 Location and site description

The Xe Champhone Wetlands are located approximately 40km east of the city of Savannakhet. The total area of the Wetlands is 45,000 ha, (ICEM, 2012a), with the Ramsar site covering around a quarter of this area at 12,400 ha (Figure 1). While the greater wetland area reaches across four districts, Atsaphone, Atsaphantong, Champhone and Xonbuli, the Ramsar site boundary is located entirely in the Champhone District (Food and Agriculture Organization [FAO], 2016).

Seen in Figure 1, there are two core zones, one in the centre of the site and one in the south, covering 707 ha and 1580 ha respectively. The core zones include areas of higher conservation value (Quoi, 2017). An expanded boundary and core zones have been proposed to incorporate additional priority areas for conservation (Timmins, 2014).

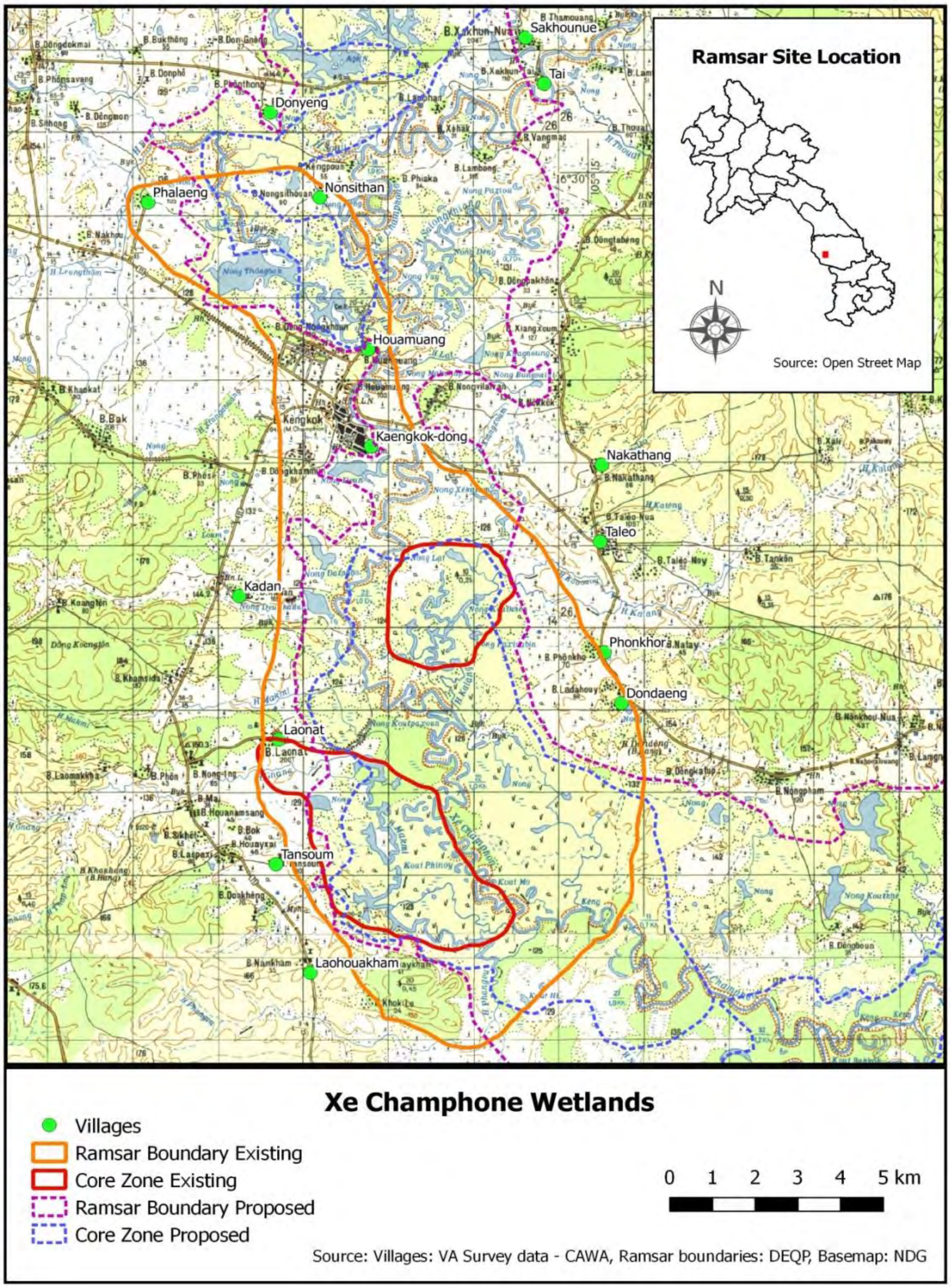


Figure 1. *Map of the Xe Champhone Wetlands, Proposed and Existing Ramsar Boundary*

1.2 Current and historic climate

The climate of the Xe Champhone is classified as a tropical savanna climate (Aw, under the Koppen Climate Classification). The low precipitation experienced in the dry season differentiates it from a tropical monsoon climate that is experienced in areas nearer to Vietnam (Am) (Arnfield, 2017). There are two distinct seasons, the dry season from November to early May and the wet season from May to October (ICEM, 2012a).

Temperatures range from a minimum low of 13ºC in January to a maximum high of around 39ºC in April. April is also the overall warmest month (av.29.28 ºC) and the coolest month is December (av. 22.25 ºC). Average total annual rainfall at the site is 1,478.5 mm (ICEM, 2012a). February has the lowest average precipitation (13.88mm), whereas August sees a substantially higher amount (349.33mm) compared to all other months (World Bank Group, 2018). Historic temperatures and precipitation (Figure 2) show the defined wet and dry seasonality experienced annually at Xe Champhone Ramsar site.

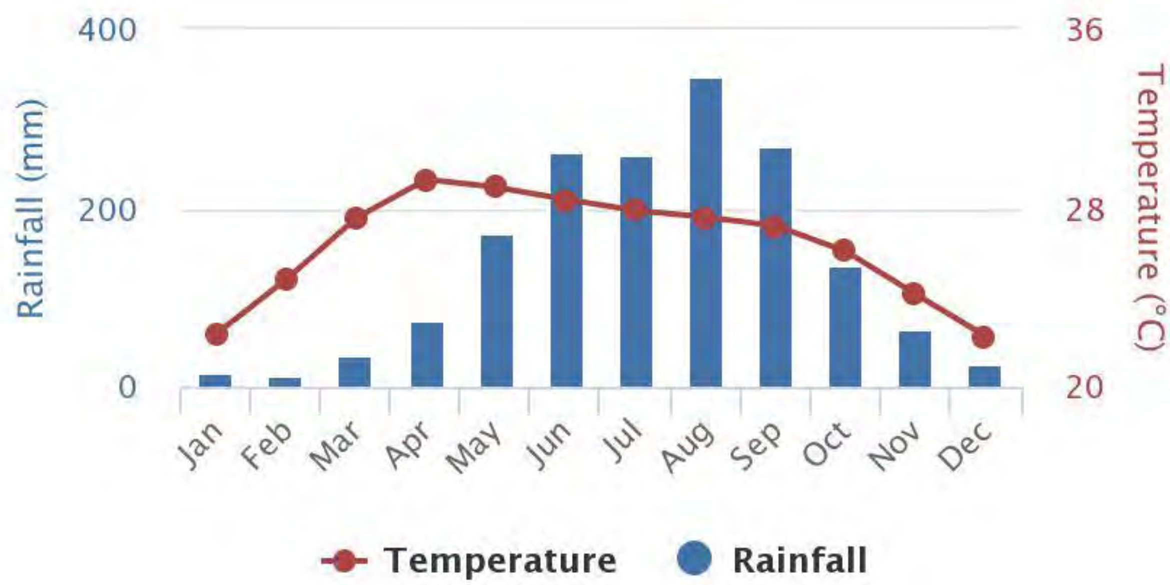


Figure 2. *Average Monthly Temperatures and Precipitation for Xe Champhone Wetlands 1901-2015 (World Bank Group, 2018)*

Champhone province is susceptible to the year-to-year volatility of droughts and floods brought on by El Niño and La Niña phenomenon. It is prone to experience record-breaking high temperatures during the month of April (Thirumalai et al., 2017) and in 2015-2016 a particularly intense El Niño cycle saw high April temperatures disrupt crop production throughout Southeast Asia, including in Champhone district. (Thirumalai et al., 2017).

1.3 Hydrological characteristics

The wetlands are fed by the Xe Champone River, that originates in the Annamite Mountain Range 200km to the north, and has a catchment area of 2640 km^2, covering the entire eastern part of Savannakhet province. There is only around a 10m elevation change between the north and south of the wetland area, resulting in a virtually flat plain crossed by this slow-flowing river even during high water level periods. The Xe Champhone drains out of the wetlands into the Xe Xangxoy River, which joins the Xe Banghieng River that ultimately flows into the Mekong (Lacombe et al., 2017; Wiszniewski et al., 2005). The hydrological recharge and discharge functions of the Xe Champhone wetlands are important for maintaining habitats and water resources for wildlife populations and local residents (ICEM, 2012a).

A number of irrigation schemes that have been implemented in the basin since the 1980s modify water flows throughout the wetland.. The biggest and most important man-made reservoirs are Ang Soui, Bak and Phai Jiew lakes, covering a combined area of about 3,000 ha (ICEM, 2012a). Water stored in these reservoirs ensures that a sufficient level is maintained in the dry season and can be drained into the Xe Champhone River when more water is needed (IUCN, 2017b), but which also results in modified hydrology and flow patterns.

The water level in the river reaches 10-15 metres in the wet season and can leave the area susceptible to flash floods (ICEM, 2012a). During the early wet season, flow is strong, but it slows later when backwater from the Mekong River arrives and flows against the river. Water levels in the Xe Champhone can drop to as low as 1.5 metres during the dry season when the river becomes disconnected in some places (IUCN, 2017b). During the wet season, groundwater can be found approximately 4-5 metres below the surface, whereas in dry times it can drop to 8 metres in some areas (ICEM, 2012a). High salinity levels are found in some parts of the wetland, with surface salt deposits occurring in low-lying areas, and saline ground water an issue for several villages.

1.4 Wetland habitats

The wetlands are composed of a mosaic of different habitat types, including perennial and seasonal rivers, freshwater lakes/ponds, reservoirs, oxbows, grasslands, and evergreen and flooded forests, interspersed with rice paddy fields (Claridge, 1996; Quoi, 2017).

There are three types of forests in the Ramsar site, covering an area of approximately 3700 ha (Quoi, 2017). Evergreen and semi-evergreen *Terrestrial forest* (found in higher terrains) and *Flood forests* occupying lower lying, flood prone areas. *Grassland* covers a small area of approximately 500 ha and can be found in between water bodies and in seasonally inundated and shallow water areas (Quoi, 2017). *Lakes, ponds, and oxbows* make up the remaining more permanent wetland areas, including areas of open water and vegetated marshes, characterized by an abundance of graminoids, and aquatic macrophytes (Quoi, 2017).

The habitat's connectivity changes throughout the wet and dry season as water levels fluctuate. In the wet season, lakes, oxbows, ponds and streams become interconnected creating a vast inundated floodplain area. During the dry season, many lakes and ponds are isolated from the Xe Champhone River and its tributaries.

Figure 3. *Habitats of the Xe Champhone. Clockwise from top left, River, Reservoir, flood forest and grassland*

1.5 Biodiversity

The Xe Champhone Ramsar area is considered to be a wetland with a high diversity of flora and fauna (Quoi, 2017). The wetlands are home to Laos' largest population of the Siamese crocodile (*Crocodylus siamensis*) which since 1996 has been on the IUCN Redlist as critically endangered (Bezuijen et al., 2012). They can be found throughout the wetland, but especially within the complex system of oxbow lakes, an important habitat type for the species (O. Thongsavath, pers. com.).

Table 1. *Species of conservation significance occurring in the wetlands*

Scientific name	Lao name	English name	IUCN Red List
Crocodylus siamensis	Khae	Siamese crocodile	Critically Endangered
Amyda cartilaginea	Pafa ong	Asiatic soft-shell turtle	Vulnerable
Heosemys annandalii	Tao houay kwai	Yellow headed temple turtle	Endangered
Heosemys grandis	Tao kee jap	Giant Asian pond turtle	Vulnerable
Indotestudo elongata	Tao phek	Elongated tortoise	Endangered
Malayemys subtrifuga	Tao sam san	Mekong snail eating turtle	Vulnerable

The wetland supports a number of reptile and amphibian species, including species of turtles, pythons, water snakes, and frogs. Five turtle (and tortoise) species are known from the site - Asiatic soft-shell turtle, Giant Asian pond turtle, yellow-headed temple turtle, and Mekong snail eating turtle (Table 1) - with all species listed as globally threatened on the IUCN Red list (Asian Turtle Working Group, 2000), and most declining in population and locally rare.

There are more than 50 species of fish belonging to over 10 families recorded in the wetlands. Many species are important for local livelihoods including, Giant snakehead (*Channa micropeltes*), Clown featherback (*Chitala ornata*), Bleeker's sheatfish *(Microneema bleekeri*) and Wallago catfish (*Wallago attu*).

Figure 4. *Species of Xe Champhone Ramsar Site. Clockwise from top left, Asiatic soft-shell turtle, Siamese crocodile, Mekong snail eating turtle, Wallago catfish*

An extensive biodiversity survey, primarily focused on birds, was carried out by Timmins (2014) to assess bird species of conservation concern in the Xe Champhone. It was found that a large number of wetland associated bird species that were expected to be present either have been extirpated or are now scarce (Timmins, 2014). However, a number of significant sightings were reported. A resident population of Black-headed Munia "Little Known" in Lao PDR was the most significant finding of the survey. Populations of Purple Swamp hen, Black Bittern, Cotton Pygmy-goose and Spot-billed duck in Xe Champhone are thought to be the largest and/or most concentrated in Lao PDR (Timmins, 2014).

The mammal fauna of Xe Champhone is depleted and species of major conservation significance are thought to be largely extirpated (Timmins, 2014). Species reported from the VA survey include several squirrel species, such as Palla's, variable and giant flying squirrel, a few civet species, including masked, large Indian, common palm civet, as well as crab-eating mongoose, wild hare, and a number of rodent species.

A rapid flora and habitat survey was undertaken in 2017, which reported a brief overview of the plant biodiversity that can be found in the Xe Champhone area. Identified were 127 plant species of 45 families, including, aquatic plants (19 species), ferns (2), herbs (42), lianas (8), palms (1), shrubs (12), and trees (43 species) (Quoi, 2017).

2 COMMUNITIES, LAND USE AND LIVELIHOODS

2.1 Communities and population

Champhone District has a population of 109,174, which has seen a 0.73% change per year since the last census took place in 2005 (City Population, 2015). Population density is estimated to be 102.5 people per square kilometre, which is high relative to the rest of Savannakhet and Lao PDR (City Population, 2015, ICEM, 2012a).

Sixteen communities within or in close proximity to the Ramsar boundary have been included in the CAWA vulnerability assessment. The total population of the communities surveyed is 19,611 (Table 2).

Table 2. *Village Demographics of Xe Champhone villages surveyed*

Village	Population	Male	Female	Households	Ethnicity
Dondaeng	1428	653	775	252	Phouthai
Dongmeuang	826	380	446	124	Lao loum
Donyeng	1014	504	510	176	Lao loum
Hoaumoung	678	333	345	120	Lao loum
Kadan	2180	1019	1161	312	Lao loum
Kaengkokdong	1788	865	923	336	Lao loum
Laohuakham	1109	560	549	213	Lao loum
Laonard	1479	750	729	224	Lao loum
Nakhathang	1632	834	798	220	Makong
Nonsithan	715	330	385	115	Lao loum
Phaleng	1039	500	539	152	Lao loum
Phonkor	900	440	460	162	Phouthai
Sakhounue	1668	795	873	296	Lao loum
Sakountai	1245	529	716	209	Lao loum
Taleo	1150	542	608	160	Phouthai
Tansoum	604	288	316	107	Lao loum

2.2 Land use and livelihoods

Agricultural production is the predominant land use type around the wetlands and within Champhone District. There have been dramatic changes over the past few decades of land use in Lao PDR, including in Champhone, which has included an intensification of agriculture (Timmins, 2014).

The main livelihoods of communities living in the Xe Champhone wetland are rice farming, fishing and livestock production. Rice farming is the principle livelihood activity and includes both rain fed and irrigated rice production (CAWA VA, 2017; IUCN, 2017b). Livestock production is the second most important livelihood activity, including large and small livestock species, and an important means for villagers to supplement their income and subsistence (ICEM, 2012a).

Collection and trade in fish and other wild resources is the main non-farming livelihood activity for villages surrounding the wetland. A wide range of plant and animal resources are sourced from the wetlands for both subsistence and income generation, through trade at local markets. Most villages obtain the vast majority of their food resources from the wetlands (CAWA VA, 2017).

Other livelihood activities include handicraft production such as mat weaving, paid labour, rice wine production, vegetable growing and collecting Non Timber Forest Products (NTFPs) (IUCN, 2017b). In addition to the provision of resources, the cultural and natural features of the wetland attract around 9,000- 10,000 tourists a year, bringing in supplementary income for local people.

2.3 Governance (institutions, management bodies)

The key governmental departments involved in the 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), in keeping with the usual practice in Lao PDR (ICEM, 2012a).

At the provincial 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 3 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 are also established at the provincial and national levels.

There are many constitutional and statutory laws governing the use of land and resources in the Xe Champhone wetland. The Law on Aquatic Animals and Wildlife is the statutory law that most directly affects wildlife in the Ramsar site (Moore et al., 2013). The Water and Water Resources Law (1996) was updated in 2017 to include regulations for wastewater discharge permits, wetlands and water resources protection, ground-water management, and river-basin management. It also expands on prior regulations that stipulate hydropower use, including environmental flows and irrigation use (International Finance Corporation [IFC], 2017).

Local regulations are administered at the village or Khumban level. A number of community fish conservation zones are established within and around the Ramsar site to regulate fishing levels in village land use areas. Several crocodile conservation zones are also established in important oxbow habitats. In addition, there are a number of forests, and wetland areas believed to be scared places of guardian spirits that protect villagers; these sites are governed by customary law created by local communities and generally prohibit collection of certain resources and/or permit only traditional harvesting practises (Moore et al., 2013). It is within some of these protected areas that the Siamese crocodile is known to breed; therefore their survival in the area may very well be attributed to these traditionally established conservation systems (Bezuijen et al., 2013).

2.4 Gender, ethnicity and vulnerable groups

Gender

A gender survey was conducted by the CAWA team in January 2017 in several villages within the Xe Champhone wetland. The gender roles that men and women play are seen through their livelihood activities stemming from the traditional gender norms and values of each village (IUCN, 2017b). In the most prominent livelihood activity, rice farming, 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 the Xe Champhone is as follows:

Women's tasks: soaking and scattering rice seeds to create the seedling banks, transplanting seedlings to the rice paddy and 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, operaing 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 are also divided between men and women. For example, men fish for larger sized economically valuable fish found in the deeper parts of the wetland lakes using gill nets, cast nets, pole and hook and traps. Women collect fish using scoop nets, barrage nets, and lift nets, closer to shore in the shallower parts of the wetland (IUCN, 2017b). On the processing side, 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.

Ethnic groups

Three ethnic groups are present within communities surrounding the XCP Ramsar site. The most common group and dominant within lowland Lao PDR is Lao loum making up 12 of the villages surveyed; one village, Nakhathang is Makong and three villages, Ban Dondaeng, Taleo and

Phonkhor are Phouthai. The minority ethnic groups were not determined to be more vulnerable compared with the dominant Lao loum ethic group.

Vulnerable groups

Within villages a small proportion of families were identified as vulnerable due to poverty and potentially less resilient to impacts of climate change (IUCN, 2017b). Additionally, the declining proportion of young people staying in communities may lead to loss of knowledge transfer as well as labour, making villages in general more vulnerable to future changes. Urbanization is driving migration from rural areas in search of better economic opportunities (Mekong River Commission [MRC], 2010) and is a prevailing trend for both young men and women in Champhone (IUCN, 2017b). The quality of elderly villagers' livelihoods may decrease without the presence of the younger generation to support them, and they may also be at increased risk from extreme climate events (droughts, floods, extreme heat).

2.5 Current threats to wetland habitats and livelihoods

A number of main factors are identified to be threatening the current sustainability and preservation of wetland habitats and livelihoods:

- Species populations are at high risk with many species already extirpated from the area as resource demand grows. Most notably large mammals and large waterbird species are now observed in small numbers, or have disappeared (Timmins, 2014).
- Conversion of wetlands, forests and other habitats into agricultural land. Timmins (2014) highlights one of the greatest threats to the wetlands is the loss of floodplain grasslands to the expansion of agriculture
- Use of chemical fertilizers and pesticides on land around the wetlands (IUCN, 2011).
- Impacts of droughts and floods on communities and livelihoods (Hazarika et al., 2008).
- The increase in infrastructure projects, such as new weir/dam constructions and expansion of irrigation schemes.
- Invasive species, water hyacinth (*Eichhornia crassipes)* and giant mimosa (*Mimosa pigra)* have reached levels of dense infestation in certain areas of the wetland causing direct negative impacts (IUCN, 2017a).
- The invasive golden apple snail (*Pomacea canaliculata)* population has expanded throughout the wetland in recent years. They are of major concern economically as they have the ability to destroy rice crops (Carlsson & Lacoursiere, 2004).

3 CLIMATE PROJECTIONS FOR THE SITE

Amongst the Lower Mekong Basin countries, Lao PDR is one of the most vulnerable to the effects of climate change (MRC, 2014), and the Xe Champhone wetland area is no exception. It is predicted that across the Mekong Basin the mean temperature will likely increase by 0.79°C by 2030 (Eastham et al., 2008). The number of days over 33°C is predicted to increase by 19-65 days per year throughout the basin. A 5% (80mm) increase in annual precipitation across the Mekong basin is expected to occur, but some areas will see larger variations (ICEM, 2012).

For the Savannakhet region and Champhone district, under a middle range climate model (the A1B scenario), projections are for a 1.7°C increase in mean annual temperature by 2050, with a maximum increase expected mid-July (+2.25°C) and smallest increase during early December (+1.2°C). There is likely to be close to a 2°C increase in daily temperatures from April to June (IPPC, 2000; ICEM, 2012a).

An approximate 21% increase in annual average rainfall (i.e. 412mm) is predicted, with greatest increase expected at the end of the dry season in April/May. The rainfall increase will be experienced as more intense rainfall, rather than more rainy days (ICEM, 2012a). Located in a downstream catchment, the Xe Champhone area will also be at risk of the cumulative impacts of rainfall and runoff from the Mekong mainstream (Eastham et al., 2008).

General risks that have been identified across the basin (MRC, 2017) are:

- Higher peak flood levels resulting in significantly increased flood damages during extreme events
- Changing extremes of drought years causing lower flows and increased salinity affected agriculture
- Food security is expected to 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 also 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 has been undertaken with the aim to identify, and thereby mitigate, climate change vulnerabilities of communities and the wetland ecosystems they depend on.

4.1 Scope

The VA focuses 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 taken into consideration 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

An ecological response model was used 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, and baseline data helps to establish level of sensitivity. The potential impact is the combined effect of exposure and sensitivity when faced with a specific threat. For this assessment, estimated impacts have been decided 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. The CAWA team identified relevant stakeholders in the area to ensure that all parties would be included and involved in the assessment process; this approach provided a way to validate expert opinions and research. Throughout the process gender considerations were taken into account to ensure that the needs and perspectives of women were addressed. This included separate focus group discussions for women, and ensuring that there were women representatives on each VA team to administer the questions.

Sixteen villages were selected to take part in the assessment, four of which are often grouped together due to their close proximity to one another, Taleo-Phonkor and Sakhoune-Tai, and as such 14 villages were considered to be surveyed for data analysis purposes. The villages were chosen based on the criteria set out in the VA guidance notes. The criteria ensure that the selection includes:

- A representation of different habitat types within the wetland
- Villages located along or just outside 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.

Two local teams were formed to carryout the in-field assessment at the Xe Champhone Ramsar site. The teams used a printed out version of the tools as a template for field notes that were later transferred to a digital format in Microsoft Excel. The tool allows for a rapid assessment with clear and explicit guidance on the field information to be collected and analysed. The VA teams included representatives from government (DEQP, PoNRE, DONRE, DAFO, PAFO [Provincial Agriculture and Forestry Office]), village heads, community representatives and were supported by team leaders from IUCN and FAO, with experience in vulnerability assessment.

As part of the Village VA tool several additional activities were carried out with the villagers, other than the questionnaire. 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 communities to identify periods over a 12-month cycle when a particular wetland resource is being collected.

Figure 5. *Undertaking VA survey in village of Ban Nakhathang*

4.4 VA 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 completed 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 • Future climate • 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

Sixteen villages were selected to take part in the assessment, four of which are often grouped together due to their close proximity to one another, Taleo-Phonkor and Sakhoune-Tai, and as such 14 villages were considered to be surveyed for data analysis purposes. 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 August 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 early 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.

Besides the questeionnaire, several additional activities were carried out for the assessment, as part of the Village VA tool. 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.

VA validation workshops were conducted from 3-4 April 2018 to review and present the findings of the assessment to all XCP villages that participated in the surveys. 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 Xe Champhone Ramsar Site.

The habitat tool consists of a series of questions split into two major components a) habitat baseline risk, which assesses existing threats or limitations for the habitat, and b) habitat climate change vulnerability, which assesses threats from projected climatic changes. The baseline component has questions relating to habitat area, status and distribution at site level and in the Lower Mekong Basin (LMB), habitat maintenance requirements and resilience, significance of the habitat to keystone, flagship and resource species, and current threats to the habitat. Climate vulnerability looks at aspects related to a habitat's exposure, sensitivity and adaptive capacity to projected climatic changes and extreme events. Each question is scored (1-low; 2-moderate; 3-high risk/vulnerability) based on evidence sourced from literature and/or local knowledge base. The final score translates to a category ranging from low vulnerability, to very high vulnerability.

Six major wetland habitat types within the Xe Champhone site were identified through field surveys, expert consultation and review of previous studies. Habitats are classified based on their physical terrain morphology, hydrological characteristics/water regime and/or vegetation type.

Habitat descriptions:

- **Open wetlands:** Natural floodplain basins (encompassing 'ponds' and 'lakes', locally called 'nongs'), with large areas of open water and patches of aquatic vegetation. Highly variable hydrological regime with fluctuating water levels significantly influenced by season.
- **Oxbows:** Formed by isolated sections of old river channel, locally called 'Kouts.' Core areas are often permanent, deep and highly vegetated in water and on banks.
- **Reservoirs:** Semi-modified habitat, formed by previous impounding of streams/oxbows, permanent, relatively stable water levels, maintained by infrastructure. Aquatic macrophyte beds are common.
- **Rivers/streams:** Incorporates all flowing systems from small streams to large rivers, but the Xe Champhone River is the most significant representation of the habitat type within the Ramsar site.
- **Flood forest**: Characterised by forest area that floods seasonally for variable periods; Vegetation dominated by tree/shrub species, such as *Barringtonia spp*., and bamboo, *Bambusa* spp.
- **Grassland:** Seasonally inundated grassland dominated by grass species such as *Imperata indica*

While not assessed as a *wetland* habitat, terrestrial forest, as mixed evergreen forest/semi-evergreen forest (Quoi, 2017) is an additional key habitat of the Ramsar site. It is an important habitat utilized by communities for resources and a significant buffering habitat in higher elevations surrounding the wetland. Although severely depleted, it still exists in patches and some larger stands occur particularly in the southern section of the Ramsar site.

Table 3 identifies the most important values and ecosystem services that each of the habitats identified provides.

Table 3. *Key values and ecosystem services of Xe Champhone habitats*

Habitat	Key value/ecosystem service
Rivers/streams	Food & water resources/Migratory fish habitat
Oxbow	Water resource /Threatened species habitat
Flood forest	Fish nursery areas/Sedimentation buffering
Open wetlands	Food resources/Fish spawning grounds
Grassland	Grazing resource/Habitat for small mammals, birds
Reservoir	Food & water resources/Permanent fish habitat
Terrestrial forest	Erosion control/ground water regulation/ Food & timber resources

Table 4 displays final vulnerability ratings for baseline risk status, climate change vulnerability, and an indication of overall vulnerability for each habitat assessed. A range of ratings was identified, from low to high, across different habitat types. Table 5 shows scoring relative to categories assigned. See Appendix II for sample assessments with details of questions and scoring.

Table 4. *Assessed baseline risk status, climate change vulnerability and overall vulnerability of Xe Champhone habitats*

Habitat	Baseline score	Baseline Risk Status	CC vulnerability score	Climate Change Vulnerability	**Habitat Vulnerability (Baseline + climate change)**
Oxbow	2.3	High	2.2	Med	Mod-High
Open Wetland	2.2	Med	2.3	High	Mod-High
Reservoir	1.7	Low	1.7	Low	Low
Rivers/streams	2.3	High	2.4	High	High
Flooded forest	2.2	Med	1.9	Med	Med
Grassland	2.1	Med	1.6	Low	Low-Med

Table 5. *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**

5.1.1 Habitat baseline risk and threats

All natural habitats currently face significant pressure within the wetland area and catchment due to the high population living around the wetland dependent on it for its natural resources and involved in predominantly agricultural livelihoods. Baseline criteria are discussed in order of most at risk habitats.

High baseline risk: **'***Oxbows' and 'Rivers/streams'*

- **Oxbows** provide important habitat for the critically endangered and main flagstone species of the Xe Champhone wetlands, the Siamese crocodile, as well as several threatened turtle species. Oxbows, while existing across a moderate area of the site, face a number of significant baseline threats, including impacts from invasive species of water hyacinth and *Mimosa pigra*. Rice cultivation occurs on the margins of several important oxbow crocodile conservation zones and increased water extracted for irrigation is a threat, such as in Kout Xelat Kadan, Kout Khan and Nong Maehung oxbows.
- **Rivers/streams.** Baseline status of riverine habitat was assessed as high due to the significant levels of current erosion and sedimentation within the River, erosion of banks and riparian areas and sedimentation of deep pools and adjacent land (CAWA VA, 2017). This is a consequence of high rates of runoff exacerbated by deforestation and agricultural encroachment on banks and throughout the catchment. Additional threats include increasing water extraction from the river for irrigation, exacerbating low river levels in the dry season. The river is also regulated by several reservoirs that it passes through in the north of the site, altering natural flows (ICEM, 2012a). The Xe Champhone River has high importance to communities, it provides important economic fish species and is a major water source.

Moderate baseline risk: *Flooded forest, Open wetland and Grassland*

- Natural **open wetland** now covers a relatively restricted area of habitat within the wetland complex. It is threatened by expansion of rice cultivation on edges, encroaching further into wetland areas, and damaging sensitive fringing vegetation habitat, increased water extraction/pumping in the dry season, and closure due to invasive species (ICEM, 2012a) including expansion of *Mimosa pigra* in shallow edge areas.
- **Flooded forest** covers a moderate area of habitat within the wetland. It is principally threatened by forest clearance for expansion of rice cultivation (Meynell et al, 2014), land due to its moderate flooding depth, as well as timber extraction. Important keystone species include the flood forest tree *Barringtonia spp*, and while the habitat may not provide abundant resources, compared with other habitats, it plays an important role as a protection area and nursery grounds for fish.
- **Grassland**, is now restricted to only a small area of remaining intact habitat within the Ramsar Site and across the LMB (Quoi, 2017). It is subject to frequent conversion for cultivation and grazing and regularly burnt, to improve fodder quality, which can alter species composition and ecosystem function. It provides important habitat for small and ground dwelling bird species, reptiles and small mammals (Timmins, 2014).

Low baseline risk: *Reservoirs*

- **Reservoirs** occupy a large area of habitat across the wetland complex. As a semi-modified habitat type, assessment for baseline vulnerability is less relevant, but they have come to be an important habitat area for a number of species including many resource fish species and water birds. While water levels can be maintained to provide year round water supply, some threats to the current habitat value they provide are apparent. These include the expansion of water hyacinth and Mimosa on margins, and vegetation 'closure' as a result of reservoir water stability that is common in impounded waters or where flows have been restricted (Bunn & Arthington, 2002). Overall vulnerability is assessed as low, due to the large area of reservoirs within the Ramsar Site, and the ability to maintain water levels through infrastructure operation.

5.1.2 Habitat Climate Change Vulnerability

High Climate Change Vulnerability: *Riverine* and *Open wetland* habitats

Riverine habitats are expected to face increased frequency, intensity and duration of flood waters under climate change as a result of higher rainfall and flows, leading to increasing rates of erosion and sedimentation, further filling in deep pools and widening/reducing depth of the main XCP River channel. These impacts will be exacerbated by the effects of drought/El Niño events and projected increased temperatures and evaporation rates in April-May (ICEM, 2012a) that more rapidly and frequently dry out and disconnect rivers/streams including important deep pool habitats, a critical refuge for migratory fish species (Sokheng et al., 1999).

Open wetlands are expected to more frequently and rapidly draw down and dry under a projected hotter/drier late dry season, and suffer increased closure by expansion of invasive species into shallower waters. As a naturally shallow habitat, increased water temperatures and evaporation rates are expected to impact species particularly sensitive to poor water quality and/or that require longer inundation periods for successful reproduction, including white fish, bird and frog species. Increased sedimentation is expected with higher sediment loads being deposited on the floodplain, reducing depth of open wetlands and exacerbating impacts.

Moderate climate change vulnerability: *Oxbow and Flood forest.*

Oxbow climate change vulnerability is expected to be moderate with impacts associated with higher temperature and evaporation rates likely to be buffered by the deeper water of the habitat, particularly large oxbows. However, increased sedimentation is expected due to the habitat's proximity to the river and the expansion of water hyacinth and *Mimosa pigra* in dry years. Because oxbow habitats are confined to old river bends they are not being readily replaced. Landscape modification and hydrological management such as the building of dykes and dams prevent the flooding and river movement that helps to create oxbow habitats (PJ Meynell, pers. com).

Flood forest is expected to have a moderate vulnerability to climate change due to the natural flood tolerance of vegetation in this habitat, the moderate levels of drought expected, as well as the dense canopy that provides a buffer from increased temperatures. Changing temperature is suspected to effect reproduction of species such as *Barringtonia spp*. where flowering is known to be triggered by temperature (Meynell et al., 2014), and increased and extended inundation levels may limit regeneration of Bamboo species (ICEM, 2012a), a priority village resource. Flood forest habitat has the potential to shift to some extent with higher inundation levels, but could be restricted by slow regenerating species.

Low climate change vulnerability: *Reservoir* and *Grassland*

Reservoir habitat was assessed to have low climate change vulnerability due to water levels of reservoirs being managed via infrastructure to ensure they are maintained at a certain level and area for water supply. Reservoirs are likely to be the first habitat considered for protection during drought to preserve the water source, at the expense of other habitats i.e. streams/rivers, and new reservoir habitat can essentially be created by raising or building new dams/weirs. Moderate changes to water levels and warming of water as well as increased closure of open areas/expansion of invasive species are expected under extended dry periods (ICEM, 2012a) and increasing water stability.

Grassland is considered to recover quickly from extreme events due to fast regenerating monocot species and is relatively tolerant of drought, flood and high temperatures. Grasslands are also considered relatively tolerant of fire; fire frequency is expected to increase with higher temperatures and evaporation rates during late dry season periods. However, there is potential for habitat species composition to alter with change in drought, flood and fire regimes (Meynell et al, 2014).

Habitat VA summary:

Major baseline risks are associated with the clearing and conversion of habitats, such as grassland and flood forest, as well as agricultural encroachment and water extraction from oxbows, open wetland and rivers streams. Current threats of erosion and sedimentation are primarily within the Xe Champhone River and its deep pools. Invasive species are a current threat in oxbows, open wetlands and reservoirs.

Climate threats are associated with increased rainfall falling as more intense rain, leading to increased flash flooding, and exacerbated erosion and sedimentation issues. Loss of flood forest areas due to baseline threat may limit their protective role and lead to increasing sedimentation of oxbows and open wetlands. Increased temperatures particularly in the late dry season are expected to lead to increased and complete drying of pools and shallow wetland areas and increasing water temperatures affecting many species.

5.2 Village VA

The Xe Champhone 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-four resource types were identified as priority resources between men and women across the 14 villages, with the average top 10 resources for men and women highlighted in Figures 6 and 7. Resource rankings for all villages, disaggregated by gender, are presented in Appendix I. In some cases, more than one resource was identified at each ranking level.

5.2.1.a Priority resources

For all villages, both men and women identified fish as the number one resource (with just one exception being Ban Kadan women who identified fish as No. 2). And, overall women and men identified similar priority resources in their top 10, with *fish, snails, frogs, bamboo shoots, eels, shrimp, wild vegetables* and *crickets* all featuring in the average top 10 for men and women. Some differences were observed in the order of priority between men and women, with women scoring wild plants, including wild vegetables and bamboo shoots, higher than men. Women included mushrooms and crabs in their top 10, whereas men did not. This is likely to reflect the greater role of women in foraging activities such that they are the main collectors of wild plants and smaller aquatic animals such as crabs. Men, on the other hand, included water in their top 10 and this may be because they have a greater responsibility with securing village water sources and for the activity of pumping water (IUCN, 2017b). While only three villages identified water as a priority resource, water was given a high ranking of 2 or 3 by these villages. Water may not have been identified by other villages because resource discussions were more focussed around food resources, and as such water may have been overlooked as an important resource.

Sedges also scored higher for men, particularly for the villages of Laonard and Laohuakham where they were ranked 3 and 4 respectively by men. This may be because men have a greater role/spend more time in the physical collection of sedges (IUCN, 2017b) and these villages are also close to the reservoirs of Ang makmee and Phai jiew where sedges are common. Women may have scored them lower because sedges overall have limited economic value, being identified as mostly for household use. Men may be less aware of this as once they have cut and transported them, men aren't involved in sedge processing. Generally, women also manage the finances and are likely to have a greater idea of financial value of different resources (IUCN, 2017b).

While rankings and resources identified varied between villages, there weren't many resource types specifically unique to certain villages, one exception was *boiling salt* identified by Ban Phonkhor-Taleo as a priority resource, due to major salt deposits occurring only near these villages. While salt is used as a resource, it is also causing some land salinization issues in this area.

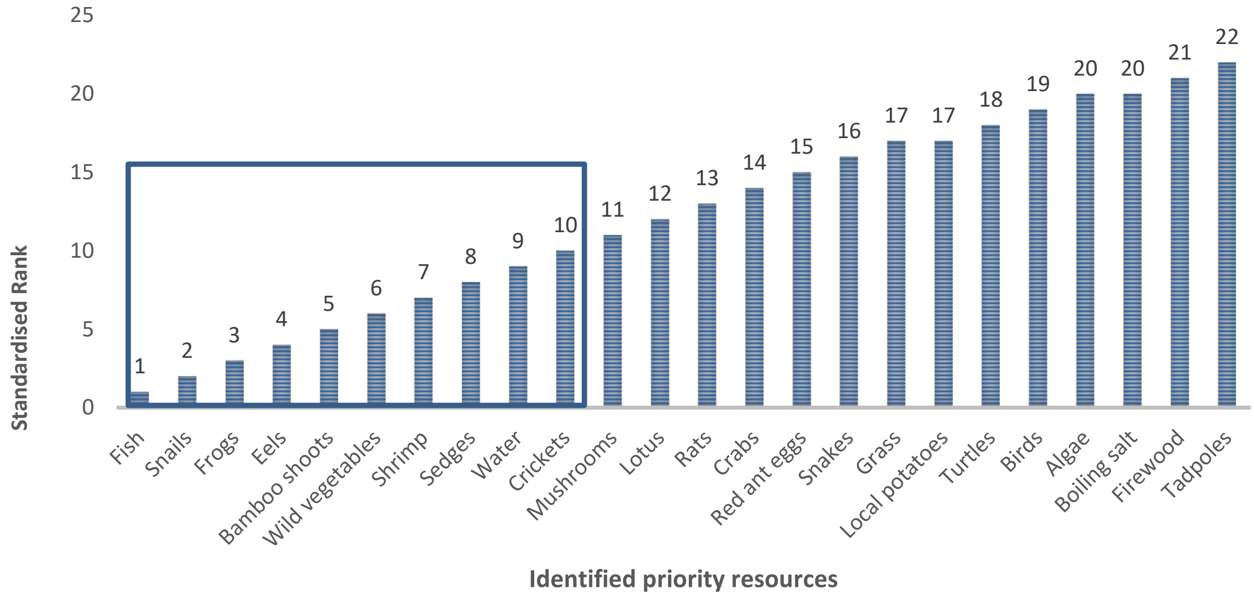


Figure 6. *Priority ranking of wetland resources (men)*

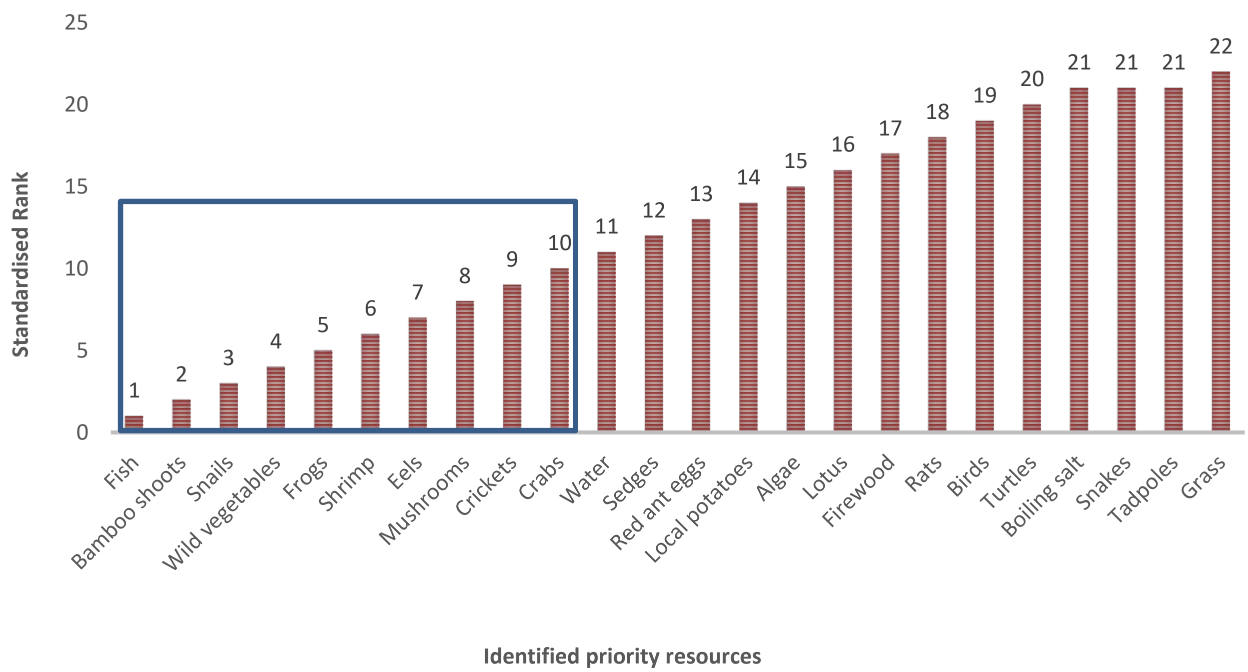


Figure 7. *Priority ranking of wetland resources (women)*

5.2.1.b Important species of priority resources

A number of important and/or key economic species were identified for priority resources:

- **Fish:** Species considered to have highest economic value include, Pa nang (*Micronema bleekeri*), Pa kod *(Hemibagrus filamentus*), Pa Phia *(Labio chrysophekadion*), Pa do, (*Channa micropeltes*), Pa Khao (*Wallago attu*), Pa tong dao (*Chitala ornata*), Pa tong kai (*Chitala blanci*), Pa Xeaum (Ompok bimaculatus), and Pa Lod (*Macrognathus sp.)* (CAWA VA, 2017). These species are sold at high prices at markets and highly sought after by fishermen (- men usually fish for these larger species).
- **Eels:** Compared to fish, eels have very low species diversity and resource use is restricted to a couple of species. The most commonly reported eel species utilised is Pa ein, the Asian swamp eel (*Monopterus albus*).
- **Snails/Molluscs:** A number of snail and bivalve mollusc species are collected for consumption including; Hoi pang (*Pila sp*.), Hoi tadeng (*Pila scutata*), Hoi Khee, Hoi Khom, Hoi lebma, Hoi xay and the invasive Golden Apple Snail/Hoi pak kuang (*Pomacea canaliculata*). Most highly valued species for consumption and sale are Hoi pang and Hoi tadeng (*P. scutata*) (ICEM, 2012a). Golden apple snail, although consumed, is less preferred than native species.
- **Invertebrates:** Of other invertebrates, one species/type of crab was identified, Ka Pou Na; two main species of cricket, Chi Lor (house cricket) and Chi Nai (short-tailed cricket); one ant species, Weavers ant, of which the eggs are harvested (red ant eggs); and one type of shrimp, locally called 'Koung'.
- **Frogs:** Two frog species are reported as most abundant and most utilised, Kob na (*Hoplobatrachus rugulosus)* and Kiat na (*Fejervarya limnocharis)*, with other species including Kiat leuang (*Hylarana lateralis*), Khan khak (*Duttaphrynus melanostictus*), Eung phao (*Glyphoglossus molossus*) and Eung Yang (*Kaloula pulchra*). The first three species can be found all year round, while the latter three are more seasonal and found predominantly during the wet season.
  - With respect to the animal resources identified by communities, fish, eels, frogs and invertebrates were ranked highest, compared with mammals, reptiles and birds. It's unclear if this is due to a preference for the aforementioned taxa, or if it is because the latter have become more scarce, and the earlier are still generally quite abundant. Village discussions, observations and previous surveys certainly indicate that the latter is likely the case (ICEM, 2012a; Timmins, 2014).
  - **Birds, turtles, mammals:** Although only identified in a few villages' top 10 resources, a brief discussion of species will be presented. For reptiles, turtles were the most mentioned resource taxa. Of the 4 species identified, only one species, the Mekong snail eating turtle (*Malayemys subtrijuga)*, is still sighted with any frequency. Many mammal species are no longer observed, and only a few species were identified to still be sourced for food, most commonly a number of rat species, several squirrel and civet species, such as Palla's squirrel and common palm civet, as well as wild hare. The villages of Nakhathang and Laohuakham have the closest proximity to forested areas and reported the highest mammal diversity. A range of bird species were identified as being sourced for food, with ducks and other water birds dominating. However, while moderate species diversity exists, overall bird abundance is low as reported by previous bird surveys (Timmins, 2014).

Wild 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*) Phakadon (*Careya sphaeica*), Pak Kayeng (*Limophila aromatic*), Phak nok (*Centella asiatica*), wild potatoes, water hyacinth flowers/Pak top .

- **Bamboo** is harvested predominantly for its shoots, which make up a large vegetable component of the local diet. The main species utilised is Nor Mai Phai (*Bambusa bambos*) with other species including Nor Mai Ka Sa, *Bambusa* spp.

Mushrooms: Over 20 species or types of mushrooms/fungi were identified from VA surveys. Only Lao names are available for most of these due to limited inventories of mushrooms and/or scientific names. Major utilised varieties include Hed La-ngok, Hed Than, Hed Din, Hed Puak, Hed Phor, Hed Wai and Hed Pok. Hed Phor is a particularly high value species with selling price per kilo reaching 50,000-100,000 LAK (CAWA VA, 2017).

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).

- Resources that are more important proportionally for their selling/economic value are bamboo shoots, eels, fish, frogs, mushrooms, shrimp and snails.
- Resources used proportionally more for subsistence than for their economic value, are birds, crabs, rats, red ant eggs, sedges, snakes, water, wild vegetables. Crickets were proportionally even across both use categories.

*Note: Proportion/percentage of use was not recorded for all villages and resources (i.e. it was not recorded for algae, salt, lotus, local potatoes or turtles). For these resources it is only indicated (Figure 5), whether it is or isn't used for subsistence and/or selling.

All resources are used and/or sold fresh, except where indicated, i.e. some fish is dried and fermented and made into padek for both subsistence/household use and selling; Sedges/reeds are weaved into mats. One village, Laohuakham pickles bamboo shoots for selling, and Dongmeuang village indicated that in a good season, surplus mushrooms are steamed and stored in the freezer for later consumption by some families (CAWA VA, 2017). Major uses of water identified were for irrigation of dry season rice, and for village and livestock water supply.

Not surprisingly, most of the resources identified to have more selling/economic value are also those identified as the top ranking resources. Figure 13 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 village.

Figure 8. *Some of the Priority Resources. Clockwise from top left, Fish, Vegetables, Snails and Crickets.*

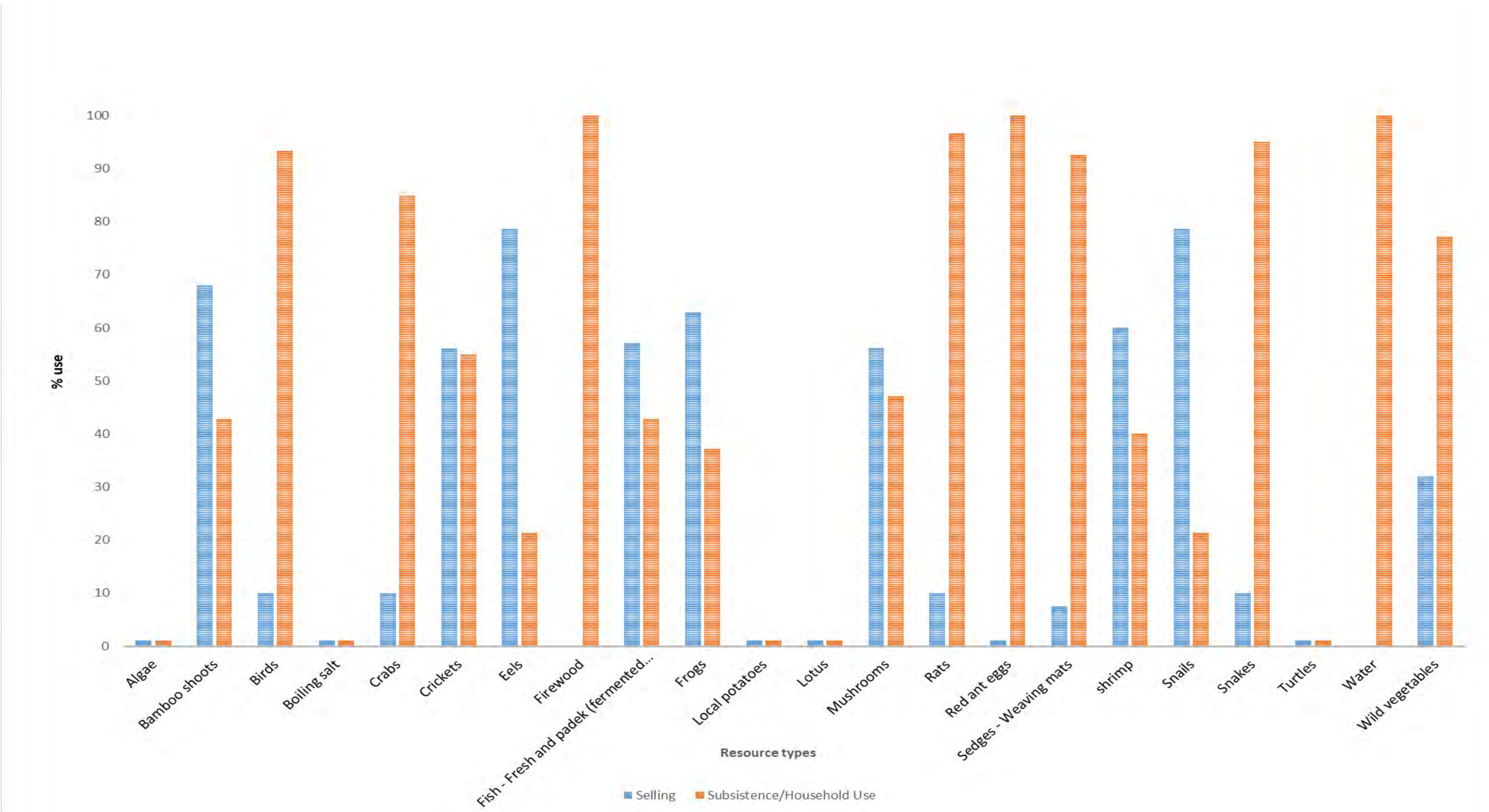


Figure 9. *Proportionate village use of different resource types*

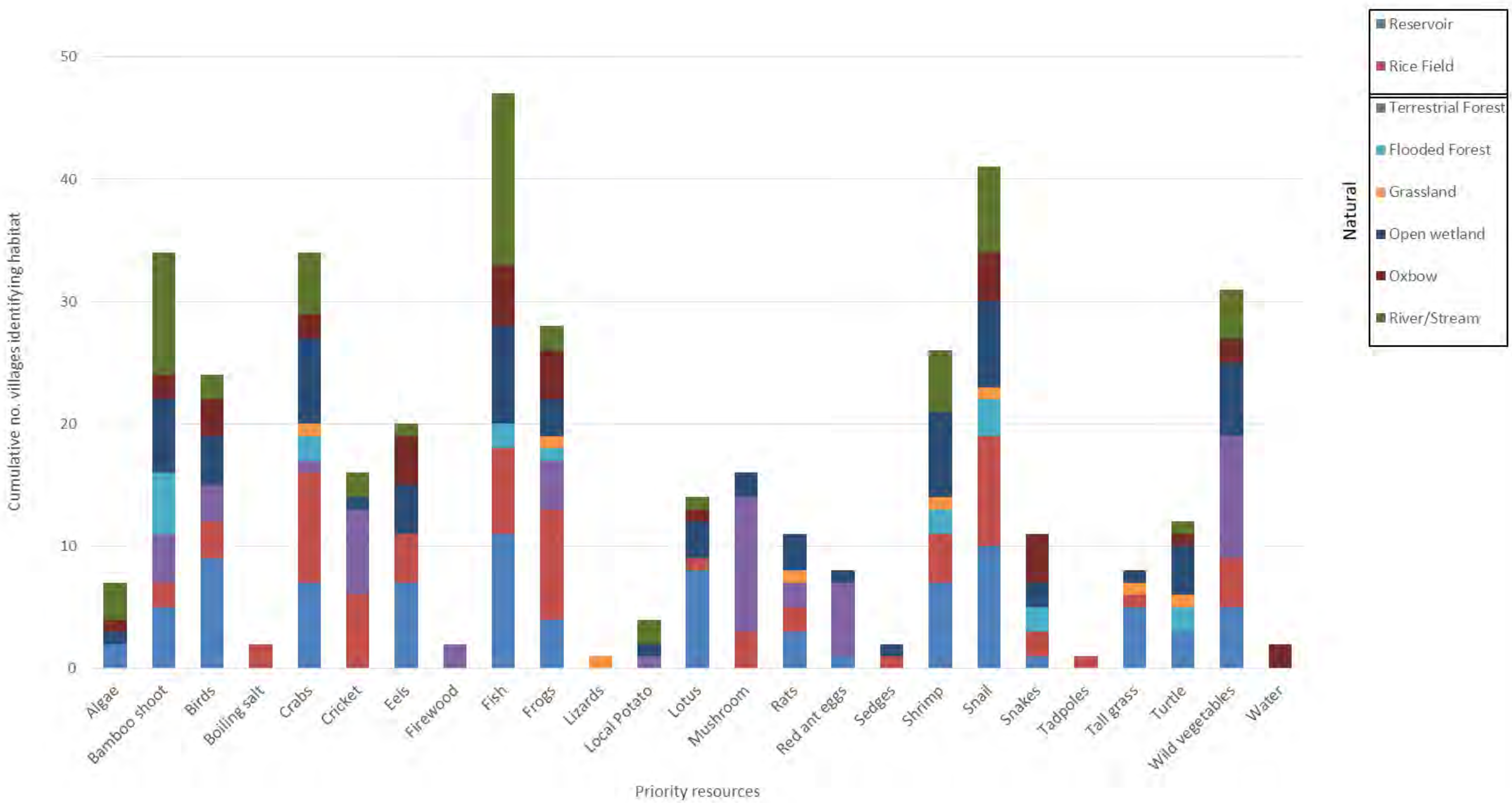


Figure 10. *Habitat areas utilized for collection of priority resources – natural and modified habitats*

5.2.1.d Key resource habitats / Village resource mapping

For each priority resource identified, villages were asked which habitat/s they collect the resource from. Some resources are collected primarily from only 1 or 2 habitat types whereas others can be found across several habitats (Figure10). The importance of different habitats for particular resources is reflected in how many times habitats were identified. In addition to the 6 key wetland habitats the additional habitats of terrestrial forest and rice fields are also included here as they were reported by villagers as important for resource collection. Rice fields are recognized as a modified habitat, together with reservoirs. Figures 11 and 12 show the important resource collection areas for six villages in the north of the site.

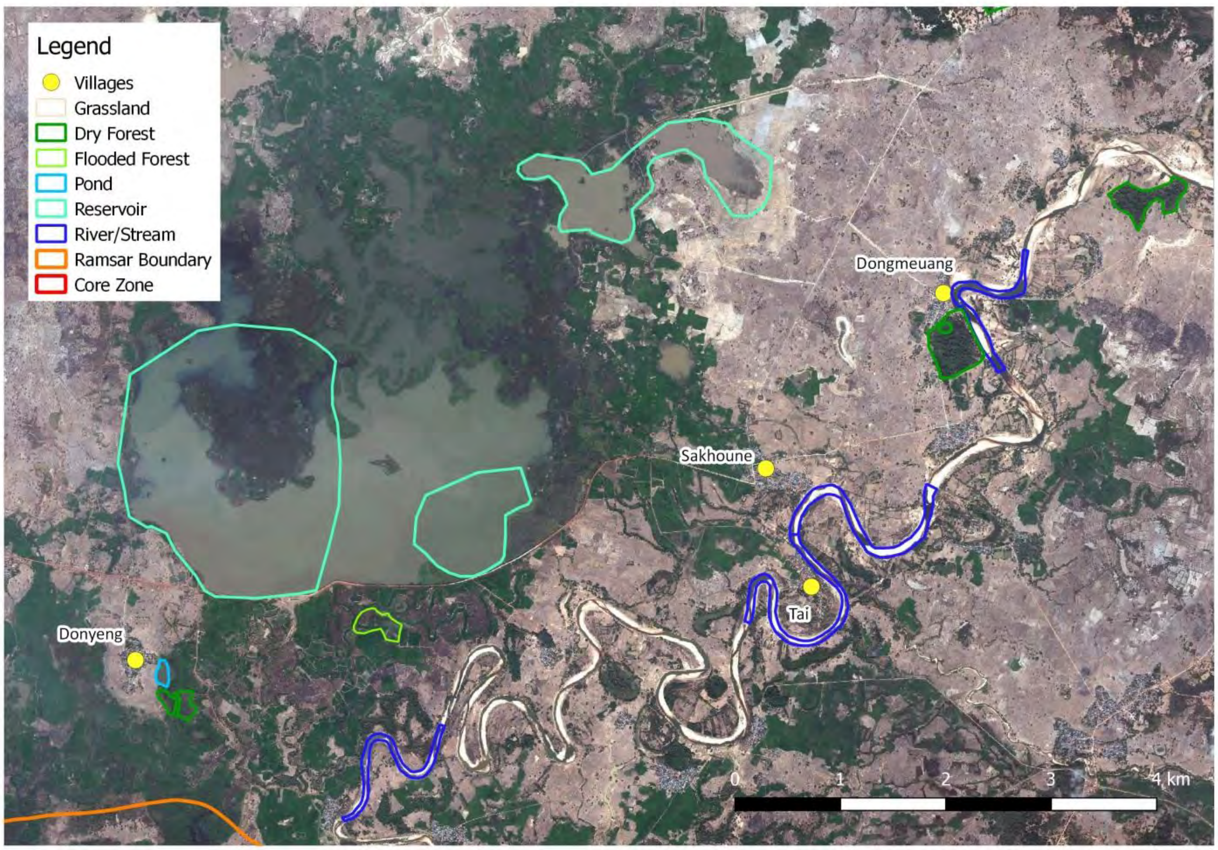


Figure 11. *Resource areas by village*

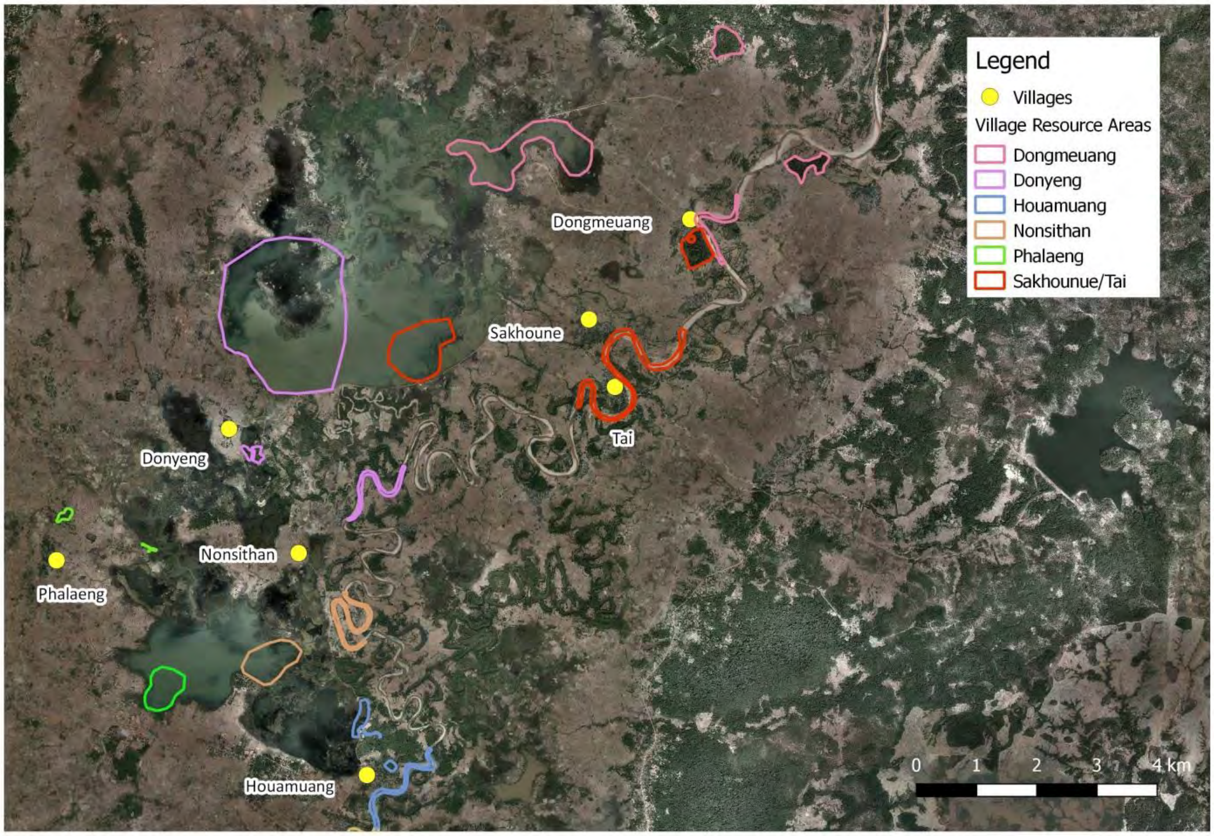


Figure 12. *Resource areas used by the 6 villages located in the north of the Ramsar Site. *Not shown, both Sakhoune/Tai and Dongmeuang use Monkey Forest as a resource area.*

Specific resources and the key habitats they are sourced from:

- For fish, rivers/streams were the most frequently identified habitat, followed by reservoirs, open wetlands and rice fields. Rice fields are not widely recognized as fish habitat but many small fish are harvested by women from rice fields and they make up a large proportion of subsistence fish consumption (IUCN, 2017b).
- Snails were collected across four main habitat types; reservoirs, rice fields, rivers/streams and open wetlands. While some species are found across several habitats, others are more restricted. For example, Hoi Kee, Hoi Xai and Hoi Lebma are mostly collected along the Xe Champhone River, whereas Hoi Peng, Hoi Khong, Hoi Joub, Hoi pak kuang (Golden apple snail) occur more evenly across open wetlands, reservoirs and rice fields.
- Crabs were identified most commonly from rice fields, followed by open wetlands and reservoirs.
- Bamboo shoots are mostly collected along river/stream banks, and secondly along edges of reservoirs, open wetlands and in flooded forest habitats.
- Wild vegetables are found predominantly in terrestrial forest, followed by open wetlands for aquatic species.

- For frogs, rice fields were identified as the most important habitat area for resource collection. Although a modified habitat area, seasonally inundated rice fields provide habitat free from large fish predators that would be more abundant in permanent wetland areas, and therefore are likely to provide good breeding habitat for species such as Kob na (*H. rugulosus)*, Kiat na (*F. limnocharis)* and Khan khak (*B. melanostictus*), more opportunistic species that can live in semi-disturbed habitats. Tadpoles are commonly harvested from rice fields for consumption. Secondary collection areas for frogs include oxbows, terrestrial forest and reservoirs. Terrestrial forest and dense edges of oxbows provide habitat for different species such as tree frogs, and ground forest dwellers such as Eung phao (*G. molossus*), that less commonly use modified habitat areas (Neang and Eastoe, 2010).
- Shrimp were identified most commonly from open wetlands and reservoirs.
- Eels and water birds, mostly duck species, are predominantly reported from reservoirs.
- Resources that were identified as being collected from only one main habitat type include mushrooms, red ant eggs and firewood in terrestrial forest, lotus in reservoirs and boiling salt in rice fields/degraded areas.

Based on the total number of reports from village surveys for all habitats and the resources found there, reservoirs were found to be the priority resource habitat, followed by open wetlands, rice fields, rivers/streams and terrestrial forest habitat (Figure 13).

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. For example, while rice fields are identified as containing more resources than rivers /streams it may be that a greater diversity of resources are found in rice fields but greater quantities or economic value come from rivers. Women also source more from rice fields and may have given a wider diversity of information than men, who predominantly fish in reservoirs, open wetlands and rivers. Nevertheless, it is clear that modified habitats do provide a considerable amount of resources for the communities of Xe Champhone. Rice fields are usually converted flood forest or open wetland habitat, and many of the reservoirs in Xe Champhone are highly vegetated and variable in depth providing habitat for many species, including important economic fish species and eels.

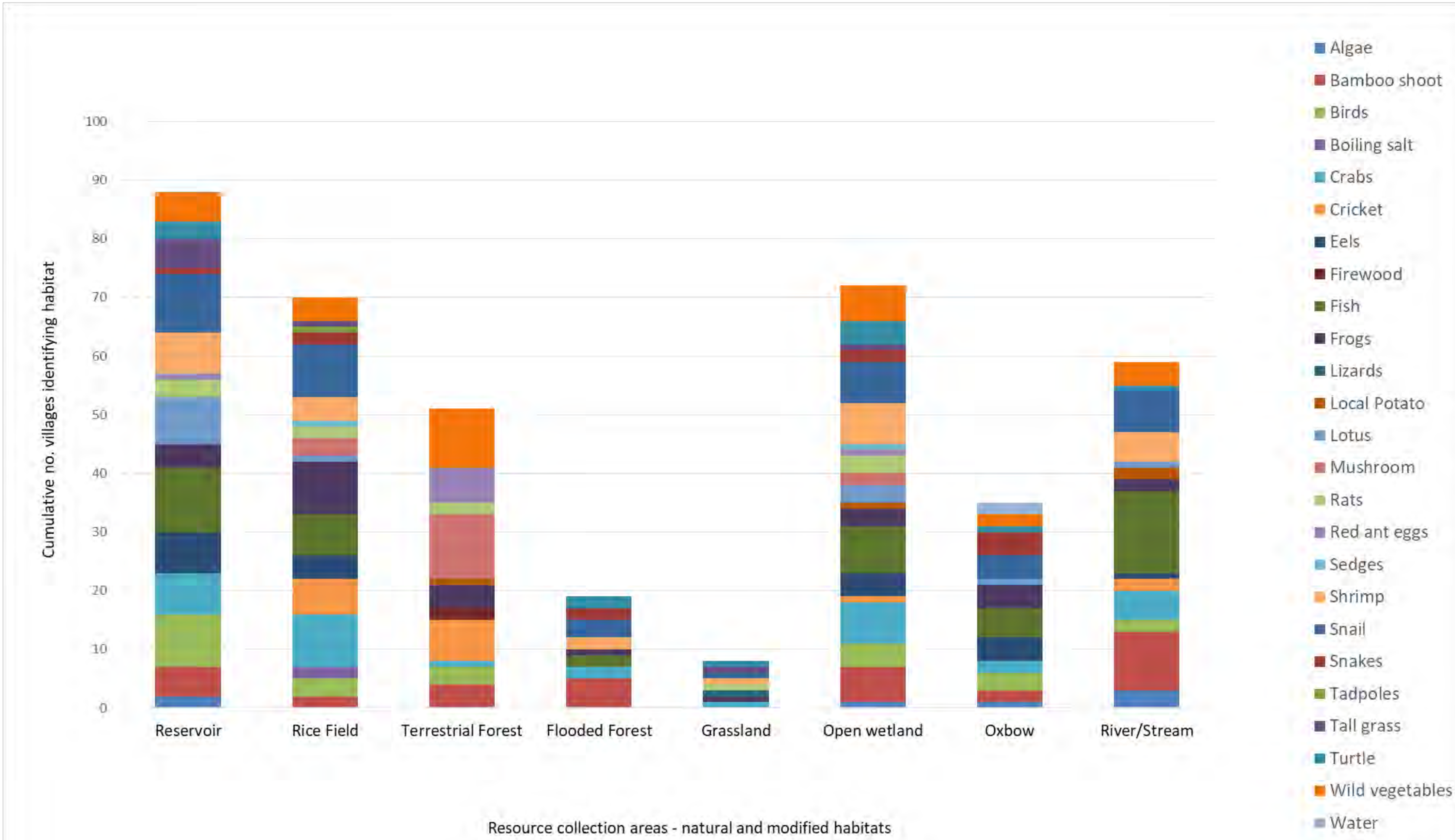


Figure 13. *Proportionate use of different habitat areas for village resource collection*

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. Results for men and women are displayed in Figure 15.

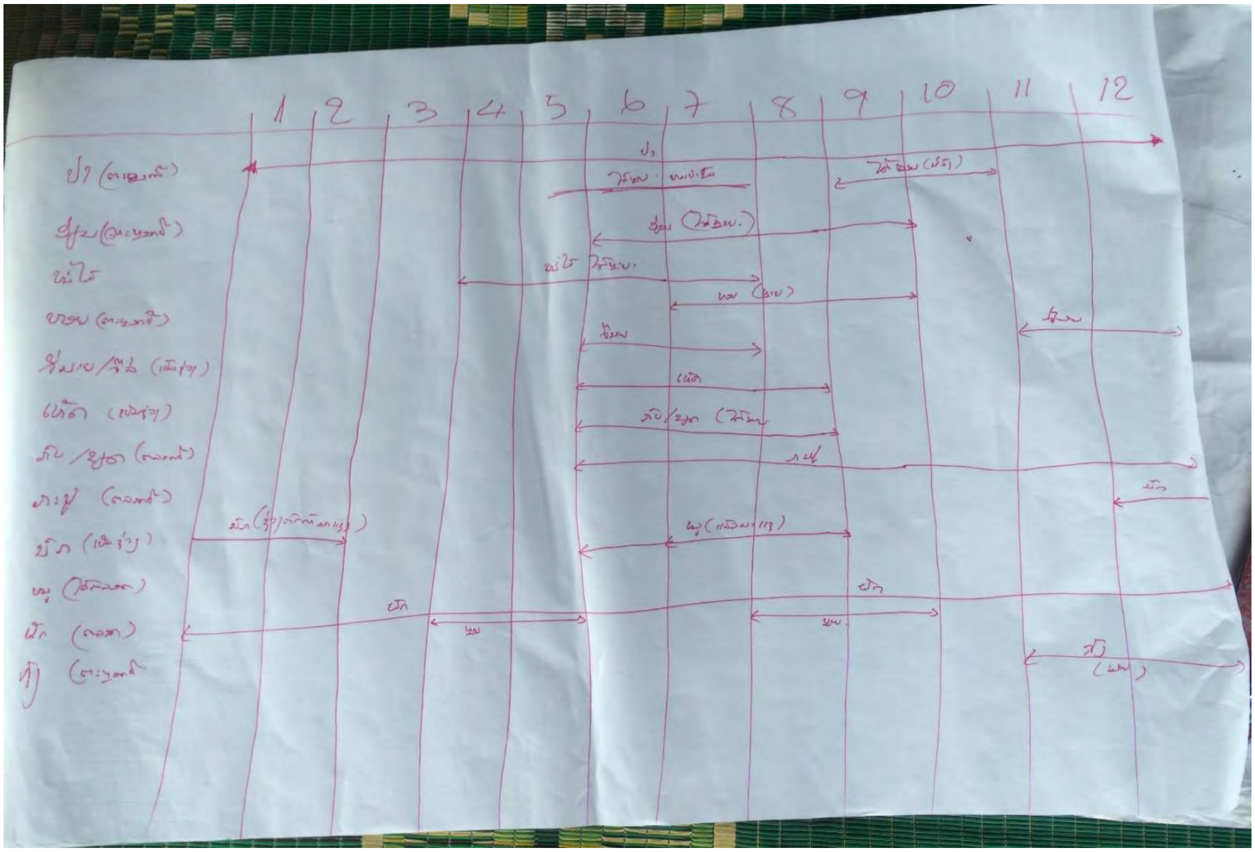


Figure 14. *Village seasonal calendar showing resources collected across different months of the year*

The most obvious factor amongst both men and women datasets is that the majority of resource collection occurs during the wet season, and predominantly in August. The resources that showed a major peak during the wet season period for both men and women were, snails, eels, bamboo shoots and shrimp; mushrooms, crabs and crickets also showed a moderate peak in collection for women during the wet season. Fish showed only a small peak but this is likely to reflect that fish can be found all year round in reservoirs, even though abundance in other habitats increases substantially during the wet season.

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. A comparison of responses of fish resource collection between men and women from the collective villages surveyed shows an agreement that fish is more abundant in July, August, September, and October, but that women's scores dip considerably during the dry season (December to April), whereas men's dry season scores were maintained higher. This is attributed to some villages where women cited fish availability in the dry season months as 'not available', while men of the same village said fish were available year round. The differing views of dry season availability of fish could be linked to women being less likely to contribute to fishing during the dry season versus the wet season when their capacity is needed. The men of each of the 14 villages surveyed said that in every month fish is either available or abundant. In comparison, only the women of 10 of the villages cited fish as available year round, while the women from Kadan, Sakhounue, Tansoum, and Nonsithan cited fish as unavailable during the dry season. These women are likely reporting only what they catch, rather than total village catch, i.e. what men also catch, because three of these villages are located near reservoirs where fish is available all year.

Bamboo shoot resources are noted by both men and women; however, the data shows that it is a higher priority resource to women. The men in Phaleng and Nonsithan villages did not reference bamboo shoots as a resource collected and none of the men in any of the villages said that bamboo shoots are collected in December, January, or February. This may reflect a similar trend to that of fishing, where women are the predominant collectors of bamboo during the dry season when the resource is less abundant.

Key observations:

- From the 14 villages interviewed, women recorded a higher amount of total resources and responses in each month and were always the high responders (possibly due to the data collection process, interviewer recorded more data).
- However overall patterns of cited resource abundance across the year were fairly consistent between men and women.
- Year round resources cited by both genders include: fish, snails, wild vegetables, shrimp, and eels
- Year round resources cited by women but not men: bamboo shoots, crickets, crabs, frogs
- Year round resources cited by men but not women: water, sedges
- July and August were cited as the months of highest resource abundance by women and men respectively.
- Water was cited by men as an important resource in all months whereas women only highlighted water as an important resource in April, likely reflecting when it is at its most limiting late in the dry season.

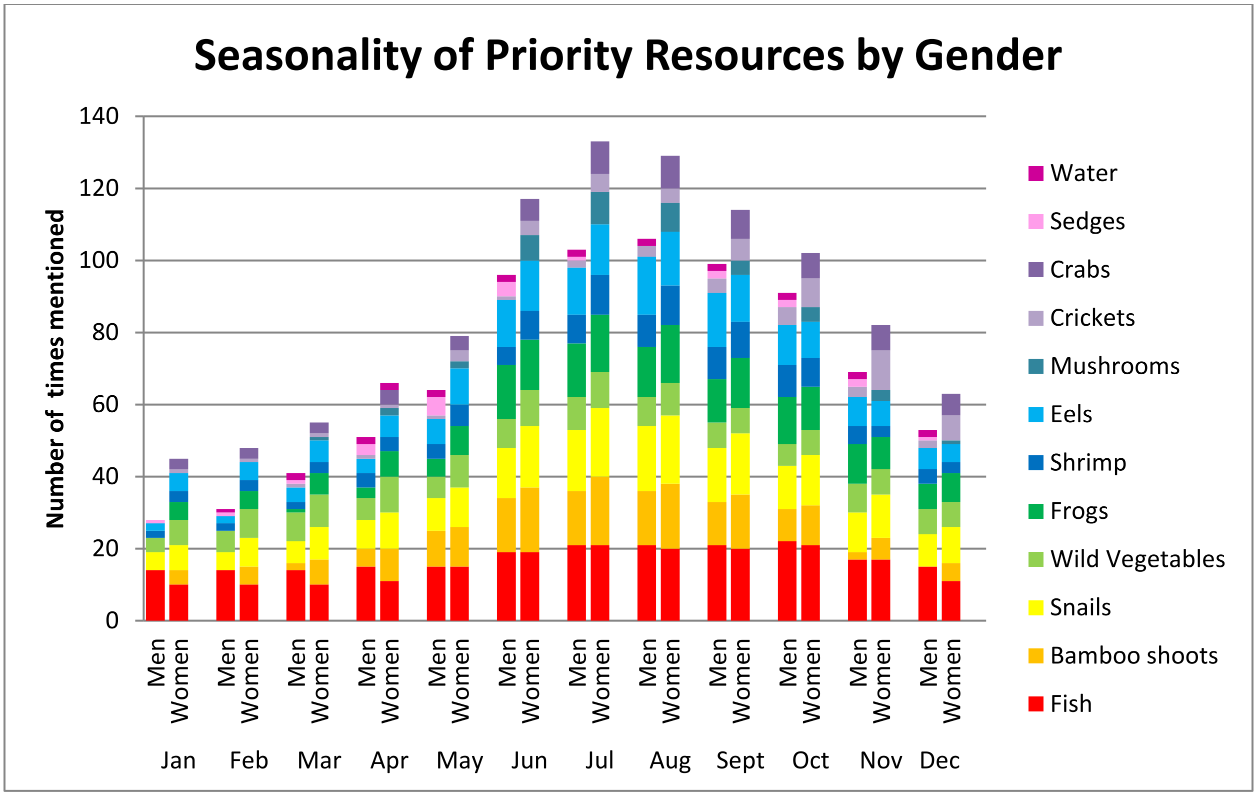
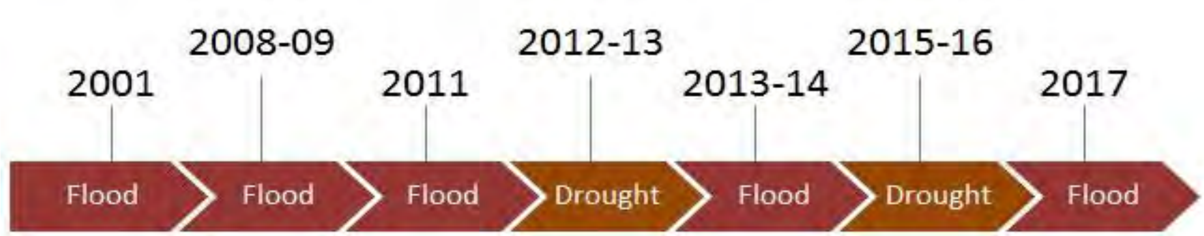


Figure 15. *Seasonality of priority resources by gender*

5.2.2 Historical climate timeline and observed effects

Villagers identified a timeline of memorable climatic events of flood, drought, storms, and extreme heat. Drought and flood were 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 drought and flood.



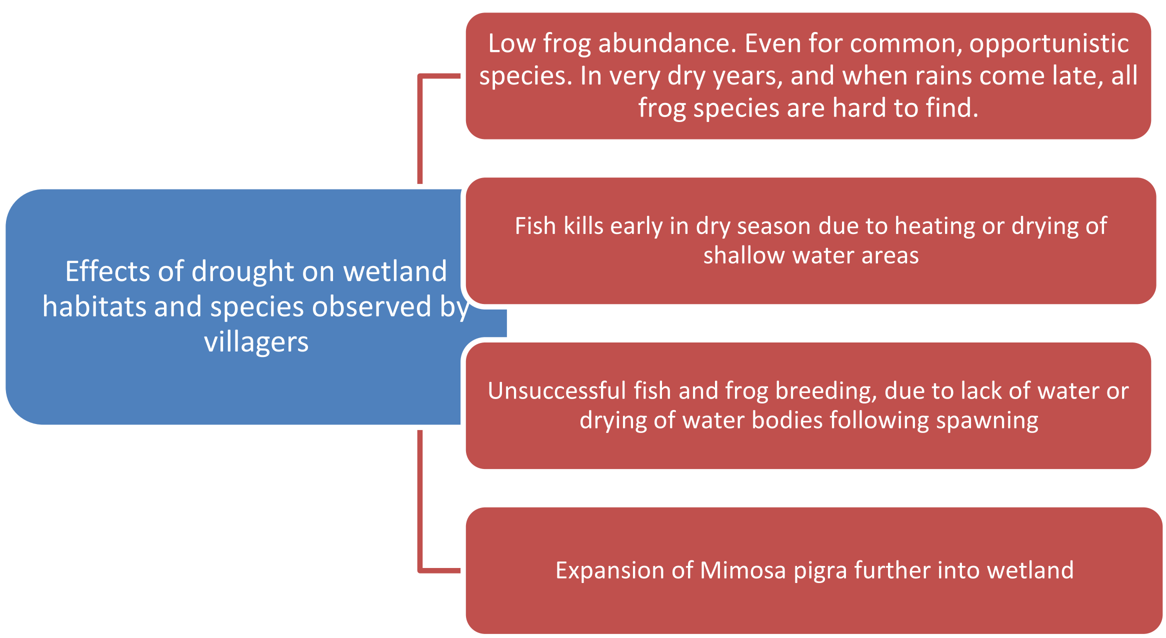
Villagers were also asked about their observations with respect to impacts on the wetland from climatic extremes. Overall, for both flood and drought, villagers indicated that the wetland and species are generally quite resilient to extremes, particularly of flood, and usually recover fairly well from such events. However, a number of negative observations of both climate extremes were identified. Some observations are further discussed in more detail in section 5.2.3.a where they relate to specific impacts identified.

Drought

Drought, as identified by communities, is when there is an extended dry period during the wet season and/or a below average wet season rainfall. It was identified by villagers to occur on average approximately every 5 years, but twice in the most recent 5 years, and less in the preceding 10 years. The most recent drought was reported in years 2015-2016, which coincided with a region wide severe El Niño event (Thirumalai et al., 2017). Low wet season rainfall was recorded, and villagers indicated that drought conditions extended from one wet season to the next. They said the drought year of 2016 was one of the worst they had seen. The years 2012-13, were also identified as significant drought years by a number of villages.

One village, Phaleng, said they don't experience severe drought at all and some women's groups, Dondaeng and Dongmeuang, said they don't experience drought, while men's groups of the same village said they did. Drought may be observed more by men due to the differing roles that they undertake. For example, two of the primary responsibilities of men are to source/pump water and care for large livestock (IUCN, 2017b), both livelihood tasks where major drought effects would be very apparent. It seems that while all villages recognize and experience flood, drought is more dependent on the particular setting or situation of the village as to whether they recognize it occurring and experience the effects.

Several observed effects of drought on wetland habitats and species were reported:

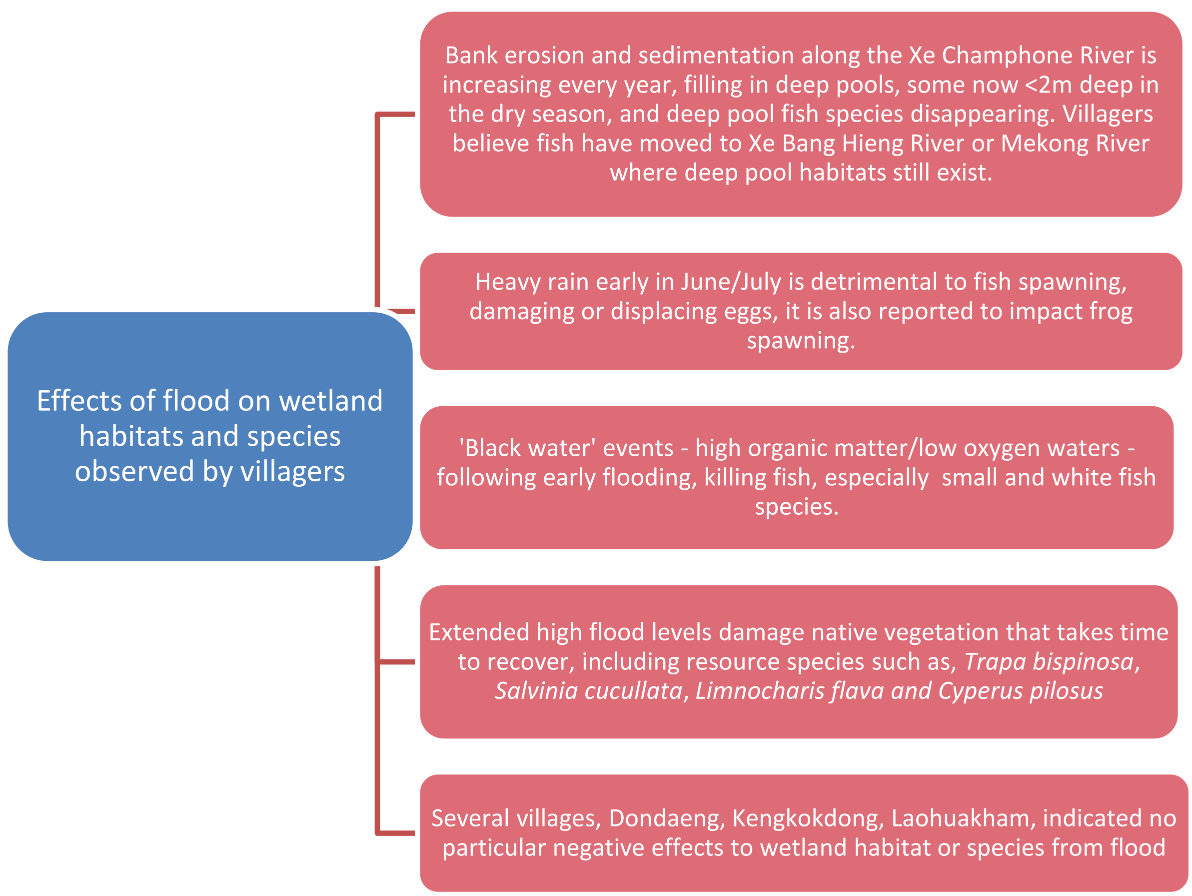


Flood

Major flood was reported to have occurred in a number of years over the last 2 decades, in 2001, 2008-9, 2011, 2013-14, and 2017, on average once every 3 years.

Significant flood is identified as occurring when flooding is prolonged for several weeks and rainfall is well above average for the wet season. Normally villagers' paddy fields are flooded yearly but high levels only last for a few days. In 2017, the area got hit by heavy rains, 3 times continuously, with each rain period lasting for about a week, leading to weeks of extended flooding.

Several observed effects of flood on wetland habitats and species were reported:



Storms and Extreme heat

Storms were reported to occur in 2005 and 2014, the latter being identified as Nok-Ten storm, causing flooding with strong winds, in 2014. Approximate frequency of major storms is every 10 years. Only two villages, Dondaeng and Dongmeuanag, reported storms to have occurred. The effects of storms on wetland habitats and species have only been noted as damage to trees, including along the Xe Champhone River. Extreme heat was only identified for the year 2016, but no specific effects on wetland habitats/species were noted by villagers.

5.2.3 Climate impacts on communities

Villagers were surveyed with respect to the main impacts they experience from the climatic events identified above. Most impacts identified were attributed to two climate variables, flood and drought, with a few additionally attributed to extreme heat and storms.

The impacts identified could largely be classified into; impacts on agriculture (separated by impacts on crops and livestock); impacts associated with natural resources or invasive species and; impacts associated with erosion and/or infrastructure, and impacts on human health.

5.2.3.a Impacts by different climate variables

Flood

By a considerable margin, the most frequently identified impact of flood was damage or loss of rice crops, reported by 100% of villages. The secondary most identified impacts of flood, reported by at least 50% of villages were; *Loss of land for livestock*; *Damage to roads and infrastructure*; *Erosion of banks/water way edges*, and; *Livestock disease* (large & small species).

Additional impacts reported by three or more villages were sedimentation of farmland and loss of fish from community ponds. Flood impacts reported by less than three villages include; expansion of golden apple snail, poor water quality and damage to bamboo plantings, and crops, other than rice (see Figure 16 for all flood impacts reported).

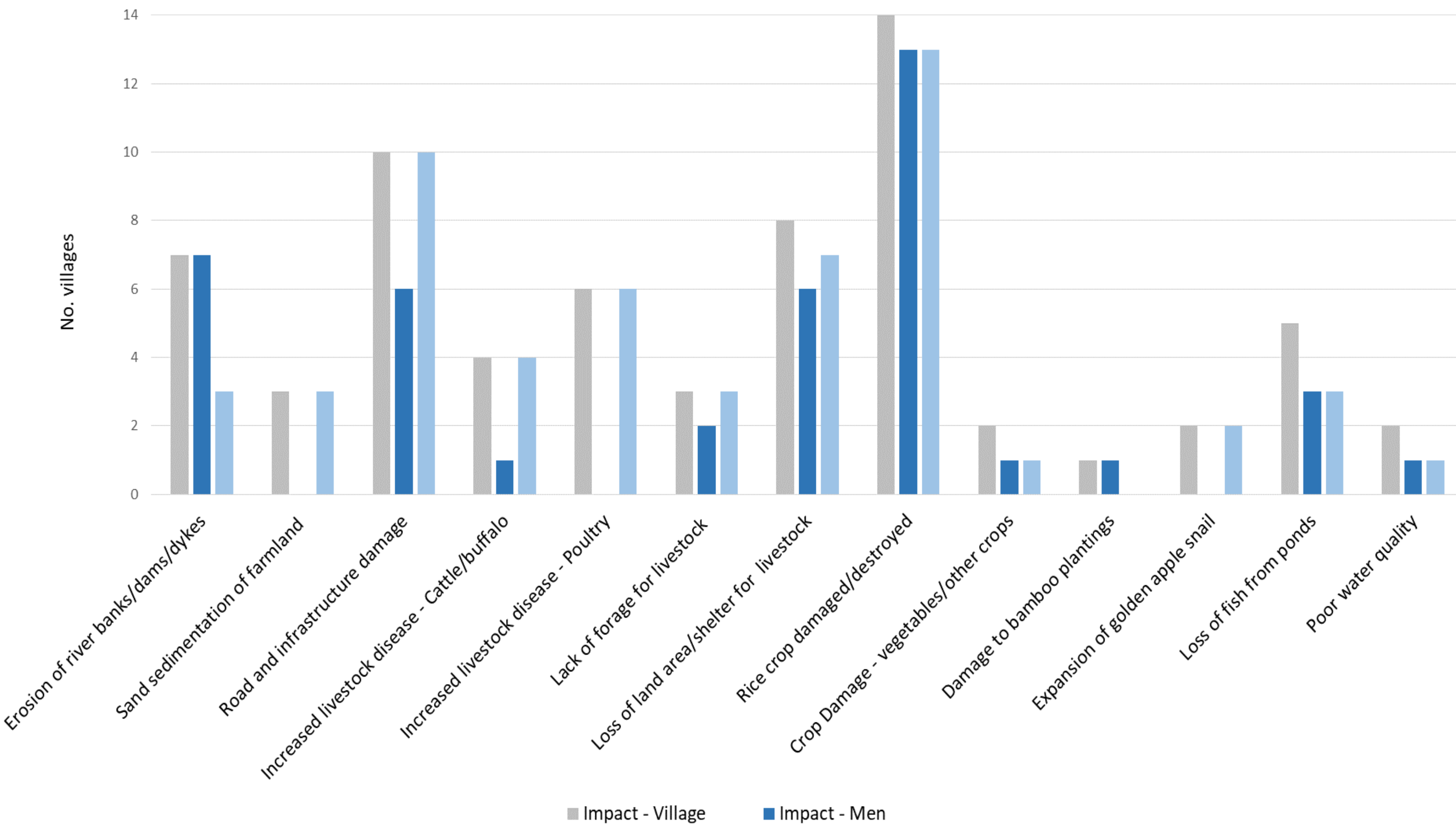


Figure 16. *Identified impacts of flood – by village and gender*

Drought

Three major impacts of drought were identified by the majority of villages (50-100%), these were; *Crop damage or loss*, of both rice and other crops such as vegetables*; Increased livestock disease*, predominantly large livestock; and, *Lack of water for livestock and/or human use.*

Additional impacts reported by 3 or more villages include, *Decreased water quality*, *Insufficient water for rice cultivation*; *Decreased fish catch*, and *Expansion of Mimosa pigra*. Impacts reported by less than three villages include decline in wild vegetables and lack of forage for livestock (Figure 17).

However, drought impacts overall were less frequently reported than flooding impacts, with several women's groups not reporting any drought impacts, i.e. Phaleng, Dongmeuang, Dondaeng.

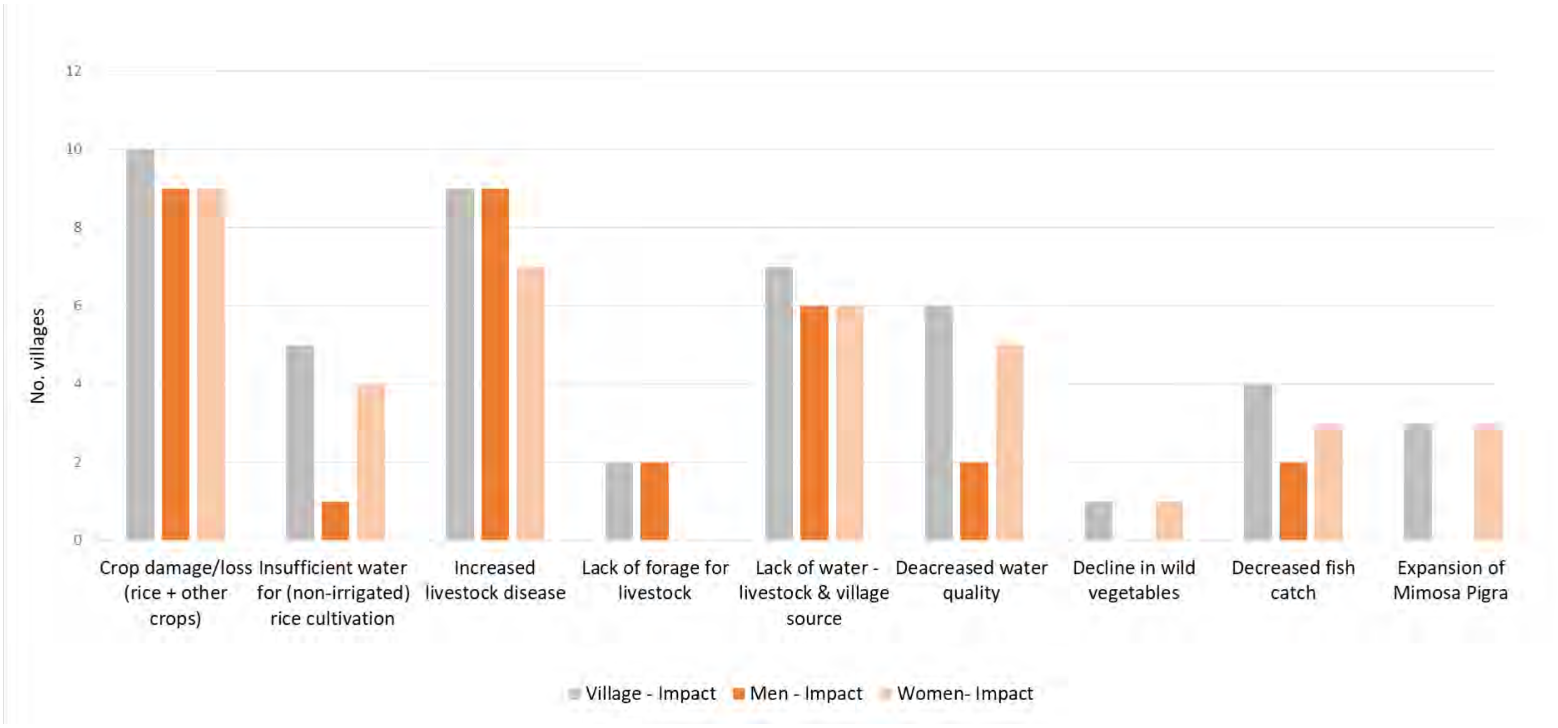


Figure 17. *Identified impacts of drought – by village and gender*

Extreme Heat & Storms

Extreme heat impacts were only specifically identified by the men's group of one village, Laohuakham. Two impacts reported were human health issues and increased livestock disease.

Storm impacts were identified by two villages, Dondaeng and Dongmeuang. Dongmeuang identified damage to trees and houses/infrastructure from strong winds that included three collapsed houses and about 20 houses with loss of metal roofing sheets from a storm in 2005. Other impacts, and impacts identified by Dondaeng village, were mostly associated with flooding following the storm, and have been incorporated under the 'flood' impacts discussion.

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. Detailed accounts are provided here, which is considered important due to the large site and number of villages with diverse and location specific impacts.

5.2.3.b Impacts by livelihood/key area of concern

Agricultural impacts

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

By a considerable margin, the most frequently identified impact of flood was damage or loss of rice crops, where floodwaters inundate rice crops and high levels remain for several weeks killing rice plants. This was identified by both men and women in all 14 villages. Wet season rice production is the major consistent agricultural activity undertaken by communities around the Xe Champhone wetlands (IUCN, 2017b). Loss of annual rice crop is a significant cost to livelihood, household, and village economic status (ICEM, 2012a).

The years of 2011, 2014, and 2017 were years where the flood inundation period was extended and rice crops were largely lost. Villagers of Ban Taleo indicated that even flood tolerant rice varieties (introduced under IRAS project) did not survive 21 days of inundation in 2014. In 2017, heavy and continuous rain from May until August led to widespread and long-term flooding, with Dondaeng village reporting damage of 100 ha of rice.

During *drought*, crop damage occurs when there is insufficient natural rainfall to maintain healthy crops, and/or lack of available water for irrigation. Insufficient water to commence rice production is also an issue. Both rice and other crops, such as vegetables, were reported as impacted by drought. Vegetables feature more prominently in reports of drought, whereas flood crop damage is predominantly rice.

In the drought of 2012-13, various vegetable crops were lost, including chilies, cucumber, sweet potato, beans, watermelon, cassava, and pumpkin, as well as crops, such as peanuts and rattan. Several villages also lost rice plants when no rain fell for a period greater than three weeks during the wet season.

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

When serious flooding occurs it inundates large areas of low-lying land where livestock normally reside. Access to grazing areas is lost and there is little dry land for shelter. Depending on the duration of flooding, grass and natural forage may be killed and take time to regenerate, and animals will be forced to congregate together in small areas. Some villages have large livestock populations, but few high elevation areas, so it is a significant issue, particularly if floods are extended as they were in 2017 (as reported by Nakhathang village). While loss of grazing area is identified as a major impact of flooding, lack of forage availability was also identified to a lesser extent, by two villages, Nakhathang and Kaengkokdong, as an impact of drought.

Impact: Increased livestock disease

An overall increase in livestock disease and death under climate change is projected globally, with warmer and wetter conditions increasing the incidence of heat-related and infectious diseases (Forman et al, 2008).

Increased livestock disease reported as an impact following flood, is likely to be influenced by several factors including, lack of quality forage, exposure of livestock to weather extremes, and increased contact by animals in a confined space (Gleeson, 2002). Foot and mouth disease (known locally as ‘Pak peuy long lep’) was the most frequently reported disease for cattle and buffalo after flooding and stomach conditions were reported by some villages, i.e. villagers of Ban Kadan indicated it was caused when livestock fed on contaminated grass. Poultry disease was reported by almost half of all villages with Fowl Cholera and New Castle Disease indicated as the two most common diseases in the district (PAFO pers. com.). Some loss or death of poultry as a direct result of flash flood waters was also reported.

Livestock disease as a major impact of *drought* was reported predominantly for large livestock, cattle and buffalo. All livestock types have been included together for drought impacts, as poultry disease was minimally reported for drought compared to flood.

The main cattle and buffalo diseases reported as an impact of drought were both foot and mouth disease, and Hemorrhagic Septicemia (locally called 'Phayad Khor tip'). These are two serious diseases occurring in the district and the cause of most livestock deaths (DAFO pers. com.). A number of villages (incl. Kadan, Tansoum, Phonkhor-Taleo, Sakunue-tai) reported significant deaths of cattle and buffalo during the drought of 2012-13, particularly during extreme heat in April-May. While villagers mostly identified disease as an impact of drought, extreme heat appears also significant, and one village, Laohuakham, specifically identified livestock disease as an impact of extreme heat.

It appears that flood is generally a greater contributing factor for disease in poultry, and drought/heat causes a higher incidence of disease in larger livestock. Greater poultry disease associated with flooding may be due to domestic ducks being more commonly kept during the wet season to synchronize with rice production and food resource availability, and with ducks known to play a key role in the persistence of avian influenza (Gilbert et al., 2008).

Erosion and infrastructure impacts

Impact: Damage to roads and infrastructure

Roads, and road infrastructure such as bridges, are often damaged as a result of flooding. The impact is exacerbated by old and poor infrastructure, and roads being unsurfaced and easily eroded. Government road maintenance and emergency repair services are limited in the district, extending the impacts on communities. Road damage restricts travel to markets, schools and places of employment, affecting community's social and economic capacity. Accidents are also reported to occur more frequently during floods. In 2011, four bridges between Taleo and Keangkokdong were destroyed by flooding from the "Nok Ten" storm; repair time was lengthy, severely affecting the communities of Ban Taleo and Phonkhor.

Additional infrastructure damage was reported to buildings, including houses and rice storage huts from floods in 2011 in the village of Dongmeuang, close to the XCP River, as well as storm damage to about 25 houses in 2005.

Impact: Damage from erosion to banks, dykes & dams

In addition to road damage, erosion of riverbanks and banks built to protect rice fields from flooding was identified as a significant impact. Damage to constructed banks, earth dams and canals, rather than natural riverbanks, were more often reported, likely due to the direct influence on livelihoods. However, for villages such as Dongmeuang in close proximity to the Xe Champhone River, direct impacts of river bank erosion were reported, including along the Dong Ling Monkey forest boundary. Other key sites of erosion damage include Kout Khan Dam identified by Taleo-Phonkhor, and Ang Makmee dike identified by Laonard. Phaleng and Nonsithan indicate damage to canals as main impact.

Impact: Sedimentation damage of farmland

Sedimentation damage to farmland results from the deposition of eroded materials or sand from the Xe Champhone River onto rice fields; this covers productive soil and restricts capacity to plant crops, reducing productivity. It was reported as an impact by three villages, Dongmeuang, Nakhathang and Laonard, which have their rice field closest to the Xe Champhone River and/or key points of sediment run-off.

Resources and invasive species impacts

Impact: Decreased fish catch/loss of fish from ponds

Impacts on fish resources include both fish loss from community ponds during drought and flood, and declines in fish populations from natural wetland areas during drought.

Loss from ponds during flooding occurs when inundation by floodwaters allows fish, purchased and stocked by villagers, to disperse and be lost. This was noted as an impact for five villages. For drought, while impact on fish availability was identified as a main impact by four villages, it was mentioned more in the general discussion of impacts on habitats and species. In natural wetland areas, for example, open wetlands like Nongdern and Nong-ngoua, reduced fish catch was reported when low water levels and drying led to fish becoming rare for a period of time, specifically Pa Soi *(Barbichthys nitidus*). Change in rainfall patterns is a suspected threat to this species, supporting villager observations. It is also a species reliant on natural floodplain systems and does not persist in reservoirs, common in Xe Champhone (Huckstorf and Freyhof, 2011).

Extended dry periods early in the wet season (June/July) are reported by several villages to lead to mass death of small and white fish species, when the waters of recently inundated shallow wetland areas heat or dry out (O. Thongsavath pers. com). Women of Nakhathang, reported that during past drought (~2012-13) the open wetland Nong Paengdeng dried to very low levels, fish disappeared, and it took 3 years for fish to return and populations to recover (A. Sipasong pers. com.). Decreases of important large economic species such as *Wallago attu, Channa micropeltes, Chitala omata*, were reported by villagers when drought led to drying of deep pools in 2013 and 2016. Impacts on community ponds, included the drying of ponds in Ban Kadan in 2012 & 2016, when no rain fell for over a month during the wet season, affecting mostly aquaculture species.

Impact: Lack of water resource

Lack of water or drying up of water sources during drought was identified as an impact by half of all villages, with main effects being insufficient water for livestock and/or village use. Water sources that dried included wells, community ponds and wetland areas. For example, in the drought of 2016-17 the main wells and water source of Nakhathang completely dried.

Impact: Poor water quality

Poor water quality refers mainly to water for consumption with several villages reporting available water sources not being suitable for drinking during drought periods, including general water quality or water being too salty, i.e. Ban Hoaumoung.

Poor water quality during flood due to sedimentation by floodwaters and run-off, was less reported and only identified as a short term/temporary impact by two villages, compared with drought where the impact can persist for an extended period towards the end of the dry season.

Impact: Decline in other resources - wild vegetables

Other than fish and water resources, few other specific climate impacts on resources were identified. One exception was a decline in wild vegetables due to drought reported by women of one village, Laonard. The impact identified particularly for this village may indicate the higher importance of wild vegetables to Laonard from an economic perspective and reflects the larger proportion of wild vegetables sold by this village compared to the average, i.e. 40% compared to average for all villages 0-20% (Refer previous figure 9).

Impact: Expansion of Invasive species

With respect to invasive species, one impact of flood reported is the expansion of golden apple snail (*Pomacea canaliculata*), and for drought, the expansion of serious weed, giant mimosa, *Mimosa pigra.*

Golden apple snail (*Pomacea canaliculata)*

Expansion of golden apple snail as an impact of flood was reported by only two two villages, Laonard and Phaleng. It is currently not reported as a major impact in Xe Champhone, as villagers indicated that while it is present, it has not yet had widespread impacts on livelihoods. For example, other villages such as Laohuakham said it has been found in Phai Jiew Reservoir for the past 1 or 2 years, but does not commonly occur in paddy fields. With respect to drought, general observations from villagers of Donyeng, were of the species being tolerant of drought and increasing during drought, with eggs frequently sighted while native species declined. *P. canaliculata* is reported as more tolerant to different environmental conditions compared to native species *Pila scutata* (Chaichana and Sumpan, 2015).

The species has potential to have a significant future impact in Xe Champhone wetlands. Previous studies have shown *P. canaliculata* to have a serious impact on aquatic vegetation, causing major loss of plant biomass as well as affecting water quality, and leading to significant ecosystem changes (Carlsson and Lacoursière, 2005). Impacts are already being observed at Beung Kiat Ngong Wetlands.

Giant mimosa *(Mimosa pigra)*

Expansion of *Mimosa pigra* as an impact of drought was reported mostly with respect to its expansion into rice fields and therefore affecting cultivation. In addition, its expansion was also reported along Bak and Soui Reservoir edges and within oxbows, such as Kout Xelat Kadan. It can expand during extended drought because decreased water levels allow it to invade new areas that were previously too deep for it to establish, but once established it can withstand deeper inundation. Although villagers did not identify its expansion as an impact of flooding, flood assists spread via seed dispersal (Rijal and Cochard, 2016). The projected more frequent and extensive floods come with the risk of spreading the species more widely in the Xe Champhone wetlands (ICEM, 2012a).

Influence of gender on reporting of impacts

While many impacts were relatively evenly reported by men and women, some were reported more by one gender or the other. In regards to flood the impact of bank erosion was more frequently reported by men, whereas sedimentation of rice fields, poultry disease and expansion of golden apple snail were only reported by women. This is likely due to men being more frequently involved with physical/construction work such as repair of erosion damage, and women being responsible for tasks such as the planting of rice seedlings, the care of poultry, and foraging resource collection, which includes harvesting of snails (IUCN, 2017b).

There were few major differences in reporting of drought impacts by men and women, but exceptions were that women more often identified insufficient water for rice cultivation and only women identified expansion of *Mimosa pigra* as a drought impact, whereas only men identified lack of forage for livestock as an impact of drought. Again, these reporting differences appear to reflect both the differing roles of men and women, i.e. men are responsible for providing forage for large livestock, and women are responsible for planting rice seedlings and resource collection in shallow wetland areas where *Mimosa pigra* is most common and likely to be noticed. Differences may also reflect some additional impacts for individual villages, as identified above where only one or two villages identified a particular impact, such as Laonard women identifying a decline in wild vegetables that may be a localised impact.

Overall, major impacts that significantly affect livelihoods and economic situations, such as loss of rice crops to floods, 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 tasks they are most responsible for.

The three most widely and consistently reported impacts of climatic events:

- Damage and loss of crops due to both flood and drought
- Effects on livestock production, through loss of grazing land/shelter (flood) and increased disease (drought & flood).
- Damage to roads, infrastructure and banks, dams or dykes (flood).
- **All these impacts were reported by over 50% of villages and up to 100% for flood damage to rice crops.**

Agricultural impacts VS ecological impacts

Overall and by a significant margin, the greatest climatic impacts reported by villages were on agricultural productivity, whereas very few impacts, and by few villages, were reported for impacts on wild resources and or environmental impacts, i.e. only a few villages identified decreased fish catch, water shortages, and expansion of *Mimosa pigra* and golden apple snail. Additionally the latter three impacts, when they were reported, were linked to their effect on agriculture or livelihoods, i.e. water shortage on livestock and Mimosa and golden apple snail impact on rice fields. While villages did share observations of effects on habitats and species, they didn't identify them as the main impacts on livelihoods. Such that, except for reduced fish population during dry periods, villages did not identify major climate impacts specifically on species or habitats of the wetlands. This may reflect both a relatively resilient wetland ecology to climatic extremes (when baseline threats are excluded), and/or a strong focus and reliance on agricultural livelihoods by communities.

5.2.4 Current and future coping strategies

Due to a range of impacts identified and several coping strategies further identified for each impact, impacts have been categorized and the discussion will largely focus on the major coping strategies for each impact. Coping strategies have been numbered to indicate the highest number of responses/villages identifying the strategy (refer Appendix IV for figures showing all coping strategies).

Following a discussion on current coping strategies for a particular impact, villagers were asked whether they would employ a different coping strategy in the future. Over 85% of reports by villagers indicated a continued use of the same or a similar strategy to that which is currently being used. Considering how few current strategies were highlighted to have high success (figures 19 and 20) this indicates a high rate of continued use of strategies with only average success, as identified above.

However, 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. Future strategies indicated and/or improvements on current strategies are outlined below (combining all climate variables).

5.2.4.a Coping strategies for agricultural impacts: Cropping

Impact: Damage/loss of crop (rice + other crops)

Coping strategy 1: Irrigated dry season rice irrigation	Future Strategy
For the major reported impact of flood, 'loss or damage to rice crop', the most frequently reported coping strategy (85% of villages) was to undertake irrigated rice cultivation in the dry season. Similarly, for drought, pumping of water from wetland and/or practicing dry season rice cultivation was also identified as a coping strategy for crop loss or where there was 'insufficient water to plant rice crop'. For this strategy, success was reported as average to high.	• Same strategy - Continue/ increase dry season rice cultivation - Jan - May. This was highlighted most for villages with land near the XCP, reservoirs or oxbows. Ban Taleo-Phonkhor indicated a future strategy to continue irrigation rice near Kout Khan Oxbow and develop new areas along the River, and Donyeng, to continue cultivation by pumping water from Soui Reservoir

Coping strategy 2: Re-plant crops	Future Strategies
This is reported to have an average to high success rate, as long as the loss was early in the wet season and the crop could be replanted early enough for the crop to mature at the right time. For loss of crops to drought (both rice, and vegetable crops or other crops such as rattan, groundnuts, cassava) to 'replant crops' was the major reported coping strategy and was scored as overall average success.	• Same strategy - Continue to re-plant the same crops • Increased use of flood/drought tolerant rice varieties and drought tolerant vegetable varieties.

Coping strategy 3: Alternative/secondary crops	Future strategies
Reported to have an average-high success for flood, and average success for drought. Increases in cultivation of secondary vegetable crops that can be grown in the wet season include vegetables, such as corn, pumpkin, beans and chili. Several villages also identified planting different rice crop varieties, tolerant of flooding as a current coping strategy, as well as crops that consume less water such as soy beans, cucumber, cassava, maize, and watermelon.	• Same strategy - Continue to plant secondary/alternative crops • Re-plant crops and pump water from the wetland. • Improve the canal from Phai Jiew Reservoir to the paddy fields to irrigate during drought or dry season.

Less reported strategies for crop loss

- Extension of rice fields and/or encroachment further into wetland was identified as an additional strategy for drought. After losing rice crop during the 2015-16 drought, the villages of Ban Taleo and Phonkhor expanded irrigated rice at Koutkhan oxbow and Nonglath open wetland, and extended rice paddies further into the wetland.
- Widening and improving the canal system to bring more water to rice fields was highlighted as an additional strategy for drought.
- Finding or renting new areas of land at higher elevation to plant rice crops was identified as an additional strategy for flood. However, suitable land plots are rarely available

5.2.4.b Coping strategies for agricultural impacts: Livestock

The different coping strategies for impacts on livestock (drought and flood), and the frequency that strategies were reported, are outlined below. All strategies were reported as overall 'average' success.

Impact: Loss of land area/shelter (flood)

Coping strategy 1: Move livestock	Future Strategies
Movement of livestock away from flooded land is often to areas close to the village, such as school or temple grounds or community forests. Elevated areas are limited and as such forage/grazing availability is also limited.	• Same strategy, but do so earlier, before flooding. Follow news reports on upcoming weather to stay informed of when flooding may occur.

Impact: Lack of forage for livestock (flood and drought)

Coping strategy 1: Harvest fodder	Future Strategies
Hand harvesting of forage by villagers (grass, rice straw/husks, tree/bamboo foliage) - Large labour effort if floods last for several weeks. *Two villages (Kaengkokdong and Nakhathang) identified harvesting for lack of forage during drought	• Similar strategy, stock fodder (collect straw, harvest grass and banana tree leaves). • During the validation workshop Ban Kadan expressed that they would like to grow more grass specifically for fodder.

Coping Strategy 2: Purchase fodder	Future Strategy
Purchasing of fodder was only identified by one village, Kaengkokdong (both men and women), with dried grass identified as the fodder type purchased. Costs of fodder were not recorded, but the average success score applied indicates costs are not sufficiently high.	• Same strategy - Continue to purchase fodder

Impact: Increased livestock disease

Coping strategy 1: Vaccinate animals	Future Strategies
For large livestock, principally cattle and buffalo, vaccination is the main coping strategy and was identified as mostly successful by women and average success by men. Success largely depends on vigilance, if a regular yearly vaccination regime is implemented it is more successful. Vaccination of livestock is usually undertaken through government vaccination programs.	• Same strategy – but ensure vaccination is undertaken earlier in season and is regular/ongoing • Seek medical treatment • Request training to improve knowledge on livestock care

Coping strategy 2: Use traditional medicine	Future Strategies
For poultry the main traditional methods used were, chopping and soaking *Tinospora crispa* stems, a bitter locally growing vine, ('Kheua khaohor') in water, and the other to mix chili with rice husks and feed. For cattle/ buffalo, to make an infusion by boiling a bark of a tree known locally as Ton Kheng (*Dialium cochinchinesnsis*) to treat foot injuries; and using the fruit, Mak feung (*Averrhoa carambola*), to treat mouth injuries. Average success was reported for traditional medicine in bovids.	• Same strategy - Continue using traditional medicine • Vaccination • Ask local government (DAFO) for support

5.2.4.c Coping strategies for erosion and infrastructure impacts

Impact: Road and infrastructure damage

Coping strategy 1: Limit/use alternative travel	Future Strategies
When roads are damaged and transport impeded, the first coping strategy identified by villagers is to find alternative transport such as boats, and limit the use of motorized vehicles. Some villages reported a coping strategy of just limiting all non-essential travel.	• Same strategy - Continue to limit travel/use boats • Purchase bigger boats for village to improve travel options • Receive government support for repair of roads

Coping strategy 2: Repair roads and infrastructure	Future Strategies
Communities undertake road repair because government repair of roads is limited and can take a long time to eventuate. 'Community repair' is also the main coping strategy identified for other infrastructure damaged such as buildings, including houses, rice storage huts etc.	• Same strategy - Continue to repair damage when it occurs

Coping strategy 3: Receive government support	Future Strategy
Villages reported that sometimes government provides materials for communities to repair buildings or infrastructure damaged by floods and/or storms. For example, for storms in 2011, Dongmeuang village reported that the district administration office provided materials including metal roofing sheets, timber and nails, with labour contributed by villagers. Ban Dondaeang cited in the validation workshop that they would like support for improving the road to Talung reservoir.	• Same strategy - Continue to seek government support

Impact: Erosion of banks/water way edges

Coping strategy 1: Repair erosion damage	Future Strategies
Dongmeuang village repaired erosion along the XCP River bank with the installation of sand bags and logs. Repair of damage was scored as average success because while repair is often successful it can also be costly and is not a long-term solution as impacts occur again with the next major flood. Some villagers reported there was 'no strategy' to deal with the long-term impact of erosion.	• Continue repair, but with greater monitoring, of flood/erosion damage to dykes/dams • Build additional dyke at Koutpeng oxbow to prevent further damage at Ang makmee from flooding. • Re-vegetate when repairs complete

Coping strategy 2: Re-vegetation	Future Strategy
The only coping strategy that scored as 'mostly successful' was planting of vegetation for erosion	• Same strategy - Continue planting vegetation for erosion control

control, reported by Phonkhor-Taleo and Nakhathang. Vegetation used includes mostly bamboo, *B. bambos*, and with *Pandanus tectorius* (local name Teuy) and 'Siew' trees, identified as alternative effective species.	

Impact: Sedimentation of farmland

Coping strategy 1 Abandon land	Future Strategy
When farmland is damaged as a result of sedimentation, abandoning land and/or looking for new land next season was the main reported strategy. It was given a low success score as it results in loss of livelihood, and because it is difficult and expensive to acquire new land in the area.	• Same strategy – villagers indicated that no other feasible option

Coping strategy 2: Remove sand	Future Strategies
Two villages identified that they 'remove sand' using macro tractor machinery, with moderate success. This was identified as a strategy only for households that were better off financially in the villages of Dongmeuang and Laonard. In Nakhathang, the other village affected by sedimentation, mechanized sand removal was reported as usually too costly to be employed.	• Same strategy - Continue to remove sand from land • Create a dyke at Kout-Peng or build additional spillway to reduce runoff to rice field and Ang Makmee Reservoir

5.2.4.d Coping strategies for resource & invasive species impacts

Impact: Loss of fish/Reduced fish catch (from community ponds & wetland)

Coping Strategy 1: Re-stock fish	Future Strategies
The main reported strategy for loss of fish from community ponds resulting from flood was to wait until water levels recede and then re-stock ponds with new juvenile fish. Fish are usually obtained from a fish farm or breeding facility, such as Pakbor fishery station in Savannakhet, administered by PAFO. However success of re-stocking was reported as average to low, due to cost and travel to purchase new fish and economic impact of loss.	• Same strategy - Continue to re-stock but release fish in June to optimize survival

Coping Strategy 2: Improve infrastructure	Future Strategies
Repair or improving ponds after flood is identified as a second strategy, with improvements including the building of dykes or erecting nets around ponds to prevent fish loss. With respect to loss of fish from ponds due to drought/drying, expanding or deepening ponds was identified as a strategy, as well as planting	• Dig deeper, bigger ponds, and plant trees along the pond to keep water cool.

vegetation around ponds for shading. This strategy was also reported as average success, though while it assists to maintaining fish, there are costs and significant labour involved.	

Coping Strategy 3: Various	Future Strategies
Other strategies for loss of fish from both ponds & wetlands (during drought) include, grow secondary crops; utilise dead fish to make padek; move fish to deeper pools; find employment; and sometimes 'no strategy' to deal with the impact (All 1 village).	• No other strategies to deal with fish decline identified

Impact: Lack of water/drying of water source

Coping strategy 1: Build new well/pond or expand	Future Strategy
Both wells and ponds are built by villagers. Sakhounue-Tai village said they dug their well over 20 - 30 m deep to reach good water to pump for village use and gardens. Nonsithan village had a community pond built with support by the IRAS project, with the aim to provide a water supply but also to raise fish for use during the dry season. Ban Taleo-Phonkhor and Houamoung deepen their ponds to have water for pumping to rice fields during drought periods.	• Same strategy - Continue to build new wells/ponds

Coping Strategy 2: Harvest rain water	Future Strategy
Several villages, including Nonsithan, Taleo-Phonkhor and Sakhounue-Tai, indicate they harvest rainwater using tanks. Small tanks were supplied to communities with support from the IRAS project in 2012-15, with 2-4 tanks per family used. The tanks have a filter on the top and collect water to be used during the dry season, for up to several months, which families use for household use and cooking.	• Continue to harvest rainwater

Coping Strategy 3: Find new water point	Future Strategies
Nakhathang village (women) indicated that when their wells dried in 2016-17 they had to walk long distances to queue at other wells to collect water. Other villages collected water from various locations; villagers from Sakhounue-Tai collect water from the XCP using baskets and tractors, Nakhathang women collected water from Nonglom oxbow to water animals, and Donyeng and Ban Houamoung collected water from Soui and Bak reservoirs.	• Dig a pond • Harvest rainwater • Continue to locate new water points

Coping strategy 4: Build dyke across stream	Future Strategy

Two villages, Kaengkokdong and Nakhathang, indicated that they build dikes across streams to dam and hold water during dry times. Depending on the site and timing there is potential for some negative effects on the movements of fish and other aquatic species with this strategy.	• Same strategy - Continue with building dykes seasonally

Impact: Poor water quality

Coping strategy/s: Treat water/Buy drinking water	Future Strategy
Treatment was identified as predominantly to boil water, and drinking water was bought from a local factory, at 5000 kip/ 20 litre bottle (2 villages). Compared to drought, villagers indicated the impact of flood on water quality is usually only temporary. All coping strategies concerned with poor water quality were identified to be of average success	• Same strategy - Continue buying/treating water, often only a short-term issue

Impact: Golden apple snail expansion

Coping strategy/s: 'Collect snails/feed rice husks	Future Strategy
Distribution of rice husks in areas where snails are observed is reported to kill snails when they feed on them (Ban Laonard); Collecting snails for consumption was reported as average to low success as snails are always increasing in number, but feeding rice husks was identified as a mostly successful and effective technique.	• Continue with same strategies – no other options

Impact: *Mimosa pigra* expansion

Coping strategy/s: Control and use as goat fodder	Future Strategy
The main strategy reported was to control the species in rice fields by cutting plants down before commencement of the wet season as a control measure. One village identified that goats will eat *M. pigra* and as such a strategy is to use it as a fodder. While the control techniques can be successful in a localized manner, both strategies were scored as low success as overall the species continues to expand.	• Same strategy - Villagers believe if they are vigilant they can control the spread of Mimosa

* For the impact 'decline in wild vegetables' (1 village) current and future coping strategies were to 'economise'.

5.2.5 Success ratings of current coping strategies

Flood coping strategies

Overall very few flood coping strategies were identified as ‘mostly successful’ by all respondents (8% men/13% women). Most strategies had average success (89% men/72% women) and a proportion were low success (15% women/3% men) (Figures 19 and 20). Low success strategies were mostly reported when villagers did not believe there were many options to deal with impacts such as increased poultry disease, expansion of invasive species, and the loss of rice crop late in season. More successful strategies identified included, practicing irrigated dry season rice cultivation, growing secondary crops and vaccinating livestock.

Drought coping strategies

Of the drought coping strategies a very low percentage, were identified as ‘mostly successful’ (none by men, 4% by women), the vast majority were identified as ‘average success’ (100% men/86% for women) and a proportion were identified as ‘not very successful’ by women (10%) (Figure 18). The few drought strategies identified as ‘mostly successful’ were similar to those identified for flood, practicing irrigated dry season rice cultivation and pumping from wetland. ‘Low success’ strategies were, finding a new water point and a few occasions where ‘no strategy’ was identified.

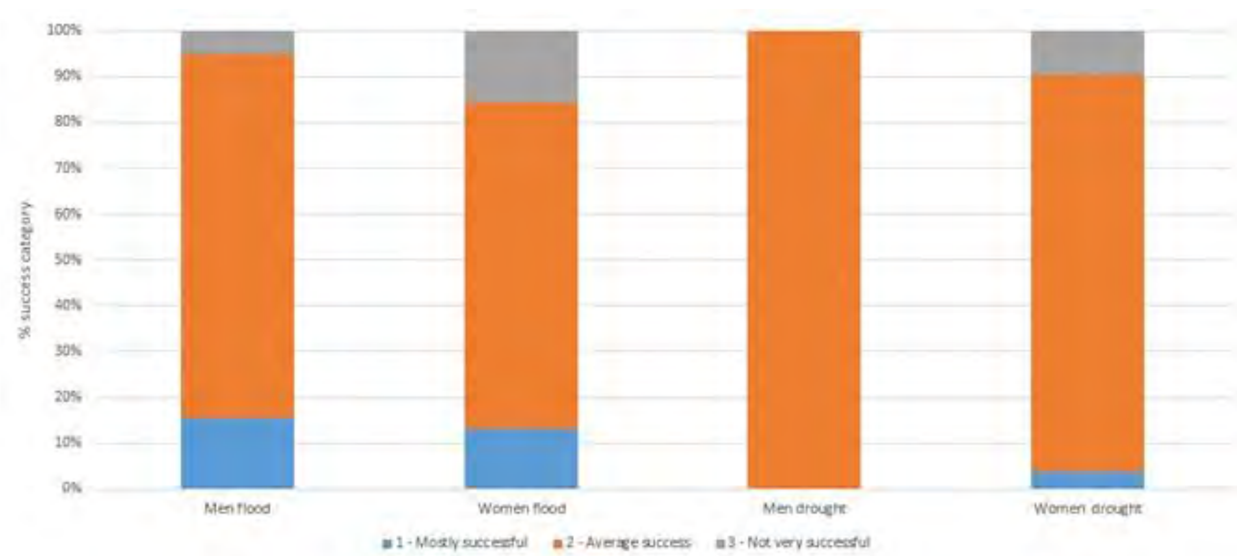


Figure 18. *Success of flood and drought coping strategies (men & women)*

Overall women identified more of both ‘mostly successful’ and ‘not very successful’ coping strategies than men, whereas men reported more average success strategies than women (Figures 19 & 20). This may be because women have overall broader household and livelihood roles and responsibilities than men, and as such may offer a greater variety of responses overall. Supporting this, they also reported more impacts and coping strategies than men. Some variability in questioning technique by interviewers may also have played a role in differences observed.

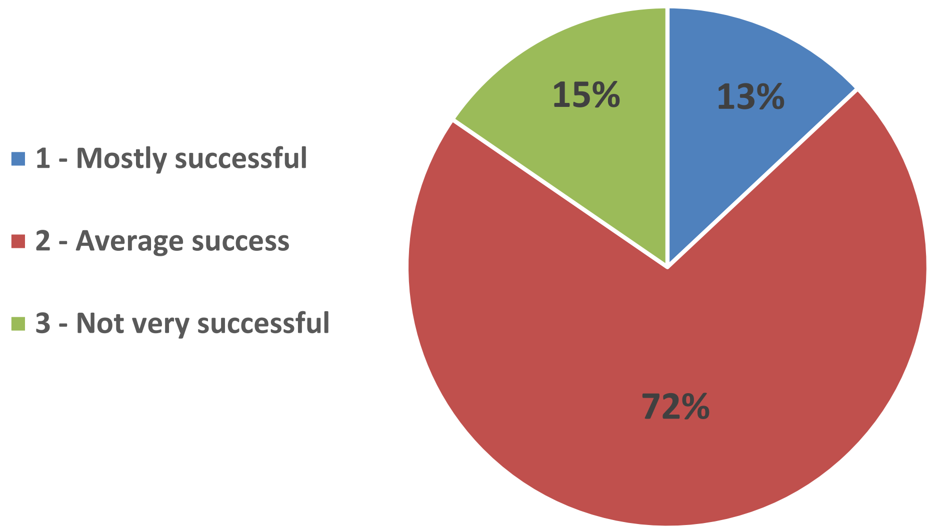


Figure 19. *Overall success of coping strategies (women)*

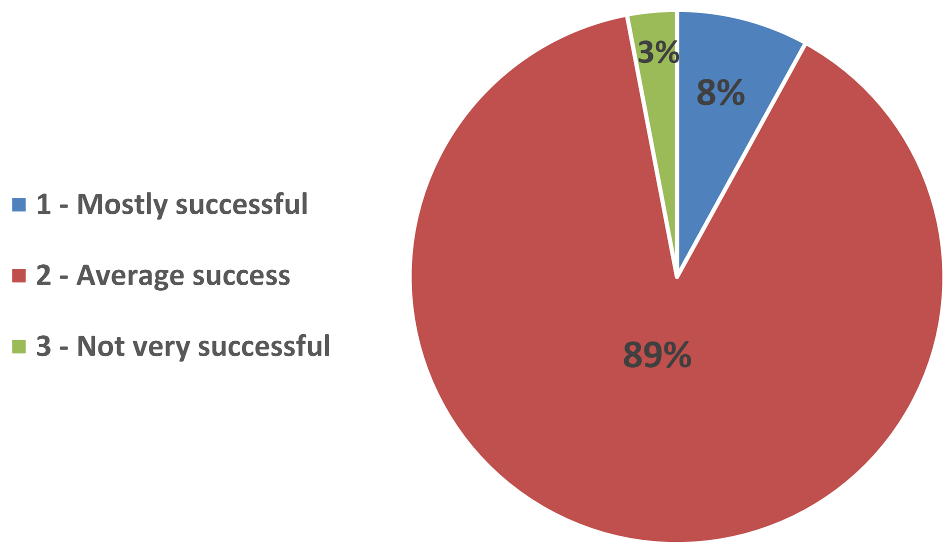


Figure 20. *Overall success of coping strategies (Men)*

5.2.6 Current management and community recommendations for future management

Communities are involved in various conservation and management activities across the wetland complex, whether implicitly implied or due to cultural reasons. Current community management and future recommendations for each village are outlined in Appendix IV.

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

- The main management area of involvement by most villages is related to fish conservation zones, with all villages except Dongmeuang, Kaengkokdong, Dondaeng, involved in current management of one or more designated Fish Conservation Zones (FCZs). While Kaengkokdong does not have an official FCZ, it does have spiritual/sacred oxbow areas where fishing is prohibited.
- Most villagers identified additional general fishing regulations administered at the district level for sustainable management, that prohibit the use of illegal fishing gears in all water bodies, including electro fishing, explosives/dynamite, poison and large nets.
- Hunting using guns is prohibited in all areas
- Monitoring of water levels and erosion damage in Bak and Phai jiew reservoirs is undertaken, respectively, by Ban Houamoung and Tansoum
- Four villages are involved in the management of crocodile conservation zones with various levels of input into management (Tansoum, Kadan, Kaengkokdong, Taleo-Phonkhor).
- Several villages provide protection for forest resources through spiritual/sacred status of forests, Nakhathang and Dongmeuang; or under community forest regulations, Dondaeng; and aquatic resource protection in sacred oxbows lakes, Kadan and Kaengkokdong.

Future community recommendations for management include:

- Continue with current management as it is viewed as generally effective
- Expansion or establishment of new fish conservation zones
- Developing new regulations to protect fish at spawning times and during droughts
- Expansion of crocodile conservation zones and restricting water extraction from oxbows

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; and reproductive requirements and characteristics, i.e. opportunistic or strongly seasonal/linked to climatic cues.

As per habitat VA, 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 literature or local knowledge base. The final total score relates to a category ranging from low vulnerability to very high vulnerability, see Table 8.

5.3.1 Species selection

Five species were selected to be assessed for species 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 across projects.

The five species selected for the Xe Champhone VA assessment, include species from reptile (1 species), amphibian (1 species) and fish (3 species) taxa. The species and justification for their selection are outlined below:

- *Crocodylus siamensis* (Siamese crocodile/ Khae Nam Jout): IUCN Redlist Critically endangered species; a flagship species for the Xe Champhone site; and a keystone species as a top order predator.
- *Glyphoglossus molossus* (Blunt-headed Burrowing Frog, Eung Phao): IUCN Redlisted as 'Near threatened'; Identified as at risk of over exploitation; and, XCP communities identified its abundance to be strongly seasonal, affected by climatic extremes, and in decline.
- *Micronema bleekeri* (Bleeker's sheatfish, Pa nang) , *Osteochilus melanopleurus* (Pa nok) *Wallago attu* (Wallago catfish, Pa Khao): Identified by XCP communities as priority economic resource fish species, and with observed locally declining populations

Fish dominate the species selection for assessment as the wetlands is a renowned and highly productive site for fisheries, due to the presence of the Xe Champhone River as an important habitat and migration route for large migratory species (ICEM, 2012a; Sopha and Sharp, 2013). Fish was also the number one resource identified by communities, fishing is a key economic livelihood activity, and fish species were noted most frequently by communities in discussion on species population declines.

Species for selection also focused on fauna and in particular vertebrate species due to the majority of priority resources being of animal origin and targets for over exploitation are often vertebrates.

With respect to taxa groups not selected, four turtle species identified from the site, would have been considered for assessment but have been previously assessed; Elongated Tortoise/Tao Pek (*Indotestudo elongata*), Asiatic softshell turtle/Pa fa ong (*Amyda cartilaginea*), Yellow-headed temple turtle/ Tao Houay kwai (*Heosemys annandalii) and* Mekong snail eating turtle/Tao sam san (*Malayemys subtrijuga*) (ICEM, 2012a; Meynell et al., 2014).

Other key species important for the Xe Champhone site and previously assessed, include, *Barringtonia spp.,* a keystone plant species of flood forest habitat (ICEM, 2012ab); several snail species, including native species, *Pila scutata* (Hoi tadeng) and Pila sp. (Hoi peng), and invasive species, Golden Apple Snail (ICEM, 2012a); water bird species, Spot-billed Duck (*Anas poecilorhycha*) (ICEM, 2012a); frog species, Kiat leuang (*Rana lateralis)* and Kop na (*Hoplobatracus rugulosus*); fish, Pakheung (*Hemibagrus Wyckioides*) and Paphia (*Labio chrysophekadion*), and the Rhesus macaque, *Macaca mulatta*, of the Monkey Forest (Dong Ling), a flagship species for the Champhone District.

Results of these assessments of locally important species from previous studies will be used to inform additional discussion in the summary section.

It should be noted that while Siamese crocodile was one species that had also been previously assessed (ICEM, 2012a) it was considered to warrant an additional updated assessment, as a key flagship species for the site.

5.3.2 Species VA results

For the five species assessed in this study, summary results of assessments showing the categories of baseline risk status, climate change vulnerability and overall vulnerability identified for each species are presented in Table 6.

In considering overall vulnerability, Siamese crocodile was assessed as the most vulnerable species with 'very high' vulnerability; the fish, *Wallago attu*, was assessed to have 'Medium-high' vulnerability; two species, Blunt-headed Burrowing Frog (*Glyphoglossus molossus*), and Pa nok (*Osteochilus melanopleurus*), to have 'medium' vulnerability, and one species, Pa nang (*Micronema bleekeri*), to have 'low-medium' vulnerability.

Table 6. *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)
Crocodylus siamensis (Siamese crocodile, Khae Nam Jout)	2.7	Very High	2.7	Very High	Very High
Glyphoglossus molossus (Blunt-headed Burrowing Frog, Eung Phao)	2.1	Med	2.1	Med	Med
Micronema bleekeri (Bleeker's sheatfish, Pa nang)	1.8	Low	2.1	Med	Low-Med

Osteochilus melanopleurus (Pa nok)	1.9	Med	2.0	Med	Med
Wallago attu (Wallago catfish, Pa Khao)	2.1	Med	2.3	High	Med-High

A summary discussion highlighting the main justifications for vulnerability assessed is presented below for the five species, firstly addressing 'baseline risk status' and then 'climate change vulnerability' for each species - the two components that make up the overall vulnerability rating identified above. See Table 2 for scoring scale and category intervals, and Appendix II for sample assessments with details of questions and scoring.

5.3.3 Baseline risk and threats

'*Very High*' baseline risk species:

Crocodylus siamensis, Siamese Crocodile

The Siamese crocodile has a small fragmented population and decreasing range. It has a global conservation status of 'Critically endangered' (Bezuijen et al., 2006) and Lao PDR national status of 'At risk ' - Category I. It requires a large combined habitat and migration area, due to seasonal migration movements (Simpson and Bezuijen 2010), and as such is prone to loss of habitat connectivity. It has specialized habitat and nesting site requirements with a preference for oxbow habitat and specific vegetation types. Although parental care is afforded (Whittaker, 2007), its reproductive output is limited and egg viability often low (O. Thongsavath pers. com). Its core habitat area in XCP is under significant threat from water extraction, agricultural encroachment and expansion of invasive species, water hyacinth and *Mimosa pigra*.

'Moderate' baseline risk species:

Glyphoglossus molossus (Eung Phao, Blunt-headed Burrowing Frog)

G. molossus is listed on the IUCN Redlist as 'Near threatened' (IUCN), with population declining, due to local overharvesting/trade (Van dijk and Cha-nard, 2004). It is a species largely restricted to forest habitat, uncommon in modified habitats (Inger and Colwell, 1977; Zug et al., 1998). It is likely to require a relatively small habitat area, but continued loss of habitat is occurring due to forest clearance and agricultural conversion. It produces large numbers of eggs but often only at a single breeding event each season, restricting its reproductive potential (Heyer, 1976).

Osteochilus melanopleurus (Pa nok)

This species has a wide distribution range and large population throughout the LMB (Vidthayanon, 2012), but is reported to be decreasing in the Xe Champhone area. It is considered adaptive to a wide variety of habitats including impounded waters and will spawn opportunistically during favourable conditions (flood, food availability) (Syandri and Azrita, 2015). The species has a short incubation period of 1 to 2 days (Nasution and Nuraini, 2014). Overfishing occurs due to its high economic value; it is locally consumed and processed into fermented products (Vidthayanon, 2012). Threats of habitat degradation from increased infrastructure projects along the Mekong have been identified. Despite the adaptive nature of the species, the weight of associated baseline threats place it as having a ‘moderate’ risk.

Wallago attu (Pa Khao)

W. attu is listed as ‘Near threatened’ (IUCN) with a declining population in some areas of its range due to overfishing (Ng, 2010), including within Champhone where it is identified by all communities as becoming rare. As a migratory species, it requires a large connected habitat area. It is principally a single season spawner, which restricts its reproductive potential. It displays habitat specializations, requiring shallow grassland areas for spawning, and deep pools as dry season refuge (Sokheng et al., 1999), which are currently declining in the Xe Champhone River (ICEM, 2012a).

‘Low’ baseline risk species:

Micronema bleekeri (Pa nang)

This species is commonly found in the LMB (Ng, 2012), but is reported to have a locally declining population. It is a generalist species, and utilizes a wide range of freshwater habitats such as tributaries, floodplains, deep pools and the Mekong mainstream (Baran and Baird, 2003). The species can produce large numbers of offspring (Poulsen, 2000), but is heavily fished as a source of food and highly utilized in the fish trade, with increasing market demand in Vietnam. Overall lack of management and overfishing has led to a decrease in the species population (Long et al. 2008). Migratory cues are thought to rely heavily on water level thresholds and can be affected by hydrological change (Poulsen, 2000).

Species Baseline Risk summary:

For fish and frog species the principal threats are over exploitation, and while the baseline threat risk was moderate overall for these species it was high for human threats associated with resource use, and the threat is significant on a localized scale. For fish, more sophisticated fishing equipment is contributing to increased catch, and dams and infrastructure blocking streams or thoroughfares, such as Phai Jiew weir, impedes seasonal migration and movements (ICEM, 2012a). For the frog species *G. molossus,* its short term emergence and limited breeding opportunities, coupled with over harvesting at this key time, is likely to restrict breeding success (Van dijk and Cha-nard, 2004). Villagers also identify that this species does not display capture avoidance behaviour and is easily collected (O. Thongsavath pers. com.).

Habitat loss/degradation is particularly an issue for the Siamese crocodile, *C. siamensis*, forest dwelling frog, *G. molossus* and deep pool specialist fish such as *Wallago attu*. For the Siamese crocodile, the principal permanent habitat oxbows are threatened by invasive species, agricultural encroachment, habitat loss on edges of oxbows and water extraction, as oxbows are key pumping sites.

5.3.4 Climate Change Vulnerability

'Very High' climate change vulnerability:

Crocodylus siamensis (Siamese crocodile/ Khae Nam Jout)

For Siamese crocodiles, the major expected impacts are on eggs and reproduction. Temperature during incubation influences egg development and the sex ratio of hatchlings, known as Environmental Sex Determination (Lang and Whitaker, 1989). Changes in the sex ratio could significantly influence population viability of an already restricted population. Increased flood levels or altered seasonality may lead to flooding of nests and damage or loss of eggs (Bickford et al., 2010). Hatchlings emerge in June-July (Platt et al., 2006) and projected increase in early wet season rainfall could pose risks to nests. For adults, habitat degradation due to expansion of invasive species, increased closure and increased water extraction during prolonged drought, is likely to be exacerbated under climate change. Reduced habitat connectivity for movement/migration during drought is also a risk and limits reproductive opportunities (Bezuijen et al., 2006). The El Nino event of 2015-17 may have had such an effect, few crocodiles were seen during this period and were reported again only during the high flood levels of late 2017 (CAWA VA, 2017).

'High' climate change vulnerability:

Wallago attu (Pa Khao)

One of the biggest expected impacts on this migratory fish species is the increased drying of dry season refuge pools due to projected increased temperature, evaporation rates and decreased rainfall in April-May (ICEM, 2012a). Increased sedimentation and shallowing of pools due to higher river flows and increased erosion of the river channel and suspension of upstream sediments would exacerbate this issue. Potential warming of shallow spawning areas (Sokheng et al., 1999) and decreased water quality of deep pools with higher temperatures. It is also at risk from more frequent disconnection of migration routes with higher temperatures and increased evaporation rates.

'Moderate' climate change vulnerability:

Micronema bleekeri (Pa nang)

As with *Wallago attu,* the degradation of critical floodplain and deep pool habitats from hydrological changes, increased temperatures, evapotranspiration and sedimentation is expected to be a significant issue for *M. bleekeri*. Moderate tolerance is expected as the species is considered a habitat generalist utilizing a range of habitat types and subsisting on a wide variety of foods (Poulsen, 2000). The species is well equipped to adapt to increased precipitation; however, migratory cues may be disrupted from changes in timing of seasonal flooding. Increased drought conditions may cause migration routes to become potentially disconnected (Poulsen, 2000).

Osteochilus melanopleurus (Pa nok)

While habitat changes are expected *for O. melanopleurus* it is identified to have high water temperature tolerance (Mardani, 2014) and not to be as reliant on threatened deep pool habitat. Moderate risk of habitat degradation and reduced connectivity due to drought and changing hydrological conditions is likely. The species depends on floodwaters for moving into areas of flooded terrestrial vegetation for feeding (Rukmini, 2017). While higher risk to juvenile hatching and survival from extreme drought conditions is expected, increased precipitation may expand its flood plain spawning habitats (Syandri and Azritai, 2015). The species is expected to have more breeding opportunities than other species, as reproduction is opportunistic and not specifically linked to seasonal cues or flood timing (Syandri and Azrita, 2015).

Glyphoglossus molossus (Blunt-headed Burrowing Frog, Eung Phao)

Increased temperatures, higher evaporation rates and change in rainfall patterns are the greatest concern for this frog species under climate change. Tadpoles/ metamorphs are at highest risk if small breeding pools heat up or dry out prematurely. As an early season breeder, and often single season breeder (Rowley & Altig, 2014), reproductive success is threatened by projected 'false starts' to the rainy season, when drought periods follow early rains. Small metamorphs that do not undertake burying behaviour are likely to be affected by increased evaporative water loss. Breeding within a forest habitat may provide some buffering against temperature extremes, and the ability of adults to bury/aestivate during dry times affords them significant adaptive capacity.

Species Climate Change vulnerability summary:

The greatest climate change impacts for species overall are a change in rainfall seasonality, increased temperatures and increased river flows and sedimentation. Projected changes in rainfall timing/seasonality could; impact Siamese crocodile breeding, if nests are flooded earlier in season; influence seasonal migration cues for migratory fish, particularly *W. attu* and *M. bleekeri;* and dry out breeding pools prematurely for the frog *G. molossus*. For fish reliant on the Xe Champhone River, loss and drying of deep pools is the main concern.

Eggs and juveniles of frog and reptile species are expected to be more affected than adults, such that adult Siamese crocodiles may persist in permanent oxbows, and adult frogs can survive underground during dry periods. For fish species, however, adults may be more impacted, due to their migratory and dry season refuge habitats being under threat.

Baseline threats will exacerbate climate change vulnerability and add pressure to species that may otherwise have adapted to moderate climatic changes, i.e. pressure on wild resources will increase as livelihood impacts such as crop loss, become more frequent, and water extraction and dry season cultivation increases to compensate for losses.

5.3.5 Previously assessed additional species/taxa of interest for the Xe Champhone site

In order to expand the application of knowledge on species vulnerability at the Xe Champhone site, the vulnerabilities for a number of other species and taxa previously assessed are summarized here. It includes additional flagship, keystone and resource species, of turtles, birds, snails, frogs, and mammals adding to the fish, frog and crocodile species assessed for this project.

Turtles

Five species of turtles (and tortoise) have been identified at XCP. All are IUCN Red Listed as Vulnerable or Endangered. Four of these species *Indotestudo elongata*, *Heosemys annandalii*, *H. grandis* and *Malayemys subtrijuga* (locally called Tao sam san) have been assessed to have high vulnerability, and *Amyda cartilaginea* medium vulnerability (ICEM, 2012a; Meynell et al., 2014; IUCN, 2018). Turtles are considered flagship species at XCP, particularly *A. cartilaginea* due to it spiritual and tourism status at Turtle Lake. Turtles are also resource species.

Baseline threats are similar for all species with hunting, including egg collection, continuing to be the highest threat (Timmins, 2014). As a terrestrial species, *I. elongata* is also threatened by forest loss, with very infrequent sightings of this species now in the Xe Champhone Ramsar site but still reported occasionally (O. Thongsavath pers. com). For *A. cartilaginea*/Pa fa ong, genetic drift is considered an additional baseline threat for the small isolated population in Turtle Lake (ICEM, 2012a).

Climate change risks for turtles include increased temperatures particularly at the end of dry season, change in seasonality and irregular distribution of rainfall during dry season, and increased drought (Meynell et al., 2014). Increasing temperatures are expected to affect egg development and sex ratio of hatchlings similarly to the Siamese crocodile. As little as one degree change can alter the sex dominance of a clutch and potentially lead to skewed population sex ratios (Meynell et al., 2014). Change in the seasonality of rainfall could lead to nest flooding and dryer and hotter periods at the end of the dry season and to increased drying of refuge areas. Egg incubation periods are long for all turtle species (Meynell et al., 2014) increasing the chance that impacts will be experienced.

Pa fa ong, *A. cartilaginea* was previously assessed as having moderate vulnerability at Xe Champhone wetlands (ICEM, 2012a) primarily due to the protection that the species is afforded at Dondaeng spiritual turtle lake. However, temperature effects on eggs and reproduction are still expected to be similar as for other species, and for individuals existing away from Dondaeng the vulnerability to hunting is likely to be higher. Ongoing water quality issues in the Turtle Lake are also a significant concern. There have been a few sightings of the species in the Xe Champhone River in the last few years, and with nesting previously reported on sand bar areas (ICEM, 2012a) making them highly vulnerable to changes in flood height and timing.

Rhesus macaque, *Macaca mulatta*

The Rhesus macaque is considered a flagship species in XCP due to its cultural status at Dong Ling, the spiritual monkey forest, and from a tourism perspective. The species was assessed to have a moderate baseline vulnerability and low climate change vulnerability (ICEM, 2012a). Its natural forest habitat has declined but as a highly adaptable opportunistic species, the population is surviving on resources outside the forest. Natural food availability is limited leading to human-wildlife conflict issues from food and crop raids in nearby settlements. The species is not likely to be significantly affected by climate change effects due to its intelligence and adaptability. Monkeys can cross the river to feed in other sites in the dry season or find alternative food sources.

Snails

Two important resource snail species *Pila scutata* (Hoi tadeng) and *Pila sp*. (Hoi peng) were found to have a moderate tolerant to climate change (ICEM, 2012a), but *P. scutata* had an overall greater vulnerability due to its preference and therefore higher demand for sale and consumption. Impacts of increased temperatures on breeding of *P. scutata/Hoi tadeng* and continued exclusion of *Pila sp./Hoi peng* by golden apple snail under climate change, are already being observed. *P. canaliculata* has been suggested as the cause of the decline of the native Asian species of freshwater snails, including native apple snails in the genus *Pila*, perhaps via competition (Halwart, 1994a).

Frogs

Two additional frog species, *Hylarana lateralis* (Kiat leuang) and *Hoplobatracus rugulosus* (Kop) were identified to have medium vulnerability to climate change, rising to high vulnerability when other threats were considered (ICEM, 2012a). Similarly for *G. molossus*/Eung Phao, major baseline threats are over harvesting for both species, and loss of habitat to forest conversion for *H. lateralis*. Climate change threats include loss of pond habitat and potential breeding failure due to dry periods after some rains in early wet season.

Water birds

Of bird species previously assessed, most notable for the site is the spot-billed duck (*Anas poecilorhycha*) (ICEM, 2012a). The species has a large range but a small population, and is increasingly rare in the study site. The species is considered highly vulnerable due to a combination of climate change impacts and baseline threats including hunting and habitat loss. Major impacts are on its open water habitats that are declining in area, due to a closing trend, exacerbated by decreased water levels in recent droughts and increased water stability. Shallower, open water habitat has already declined and increased sedimentation and evaporation under climate change, meaning fewer open wetlands/ponds will be available to this species (ICEM, 2012a). Similar effects are expected for other species reliant on open wetland habitat, such as cotton pygmy-goose. Water birds such as herons, egrets, ibis, and other waders that feed on wetland edges, in paddy fields or amongst vegetation, are likely to be less effected from loss of open water foraging habitat, including the wood snipe, *Gallinago nemoricola* (ICEM, 2012a), but may be impacted by increased encroachment and loss of wetland edge vegetation.

6 SUMMARY OF VULNERABILITIES

The habitat, livelihood and species vulnerability assessment data from the preceding sections has been summarized and is presented to give an overview of the main findings

6.1 Summary: Habitat vulnerability

Key finding: Riverine habitats, followed by open wetlands and oxbows were assessed to have the highest baseline risk and climate change vulnerability. Other habitats face important individual threats.

River/streams: High Vulnerability

Riverine habitats were identified as the overall most vulnerable habitat type at XCP Ramsar Site, with high vulnerability to baseline risk and climate change.

- High current rates of erosion and sedimentation in the Xe Champhone River and projected increased flood frequency and intensity under climate change. Deep pool habitat is at high risk.

Open wetlands and oxbows*:* Med-High vulnerability

Open wetlands and oxbows were assessed as the second most overall vulnerable habitats.

- Oxbows were assessed to have high baseline risk status due to water extraction, invasive species expansion/closure, and sedimentation expected to be exacerbated under climate change.
- Open wetlands were assessed as highly vulnerable to climate change due to their shallow nature at risk from increased temperatures, more frequent drying, and sedimentation, as well as baseline agricultural encroachment.

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.

- **Grassland** and **flood forest** face significant baseline threats as a result of habitat clearing/disturbance and agricultural encroachment for expansion of rice fields and grazing areas.
- While **reservoirs** were assessed as overall low vulnerability, as a modified and maintained habitat, they have become important habitat areas, i.e. Phai Jiew reservoir, for a number of key species and community resources. The main threats to the habitat are expansion of invasive species and continued vegetation 'closure'/loss of open water areas, likely to be exacerbated by extended dry periods under climate change.

- In addition to key wetland habitat areas assessed terrestrial **evergreen forest** habitat is considered at significant baseline risk from clearing/logging. Large areas of tall evergreen forest have been cleared around the village of Laohuakham close to the Phai Jiew dike to grow cassava and other crops. Terrestrial forest provides important ecosystem service to prevent erosion, run-off, and sedimentation and the remaining evergreen forest is a priority for preservation.

6.2 Summary: Community/livelihood vulnerability

Priority resources & resource collection areas

Twelve key wetland resources (Table 7) were identified making up top 10 men and women's resources.

While no resource is identified as entirely vulnerable as each resource type can comprise many species with differing vulnerability, a few priority resources are considered more vulnerable overall due to their high priority status:

- **Fish**, **frogs and snails,** as top three priority food resources, susceptible to overharvesting
- **Water**: Water shortages have been identified during drought and expected to be an increasing issue under climate change and with increasing dry season rice cultivation

Five priority resource areas were identified, some classified as natural habitats and some semi-modified habitats:

- **Open wetlands, rivers/streams,** and **terrestrial forests,** were identified as priority 'natural habitat' resource areas,
- **Reservoirs** and **rice fields** were identified as priority 'semi-modified habitat' resource areas.

> Of these priority resource areas, *open wetlands* and *rivers/streams*, were identified to be both highly vulnerable habitats and important resource areas.

Table 7 summarizes the five key habitat/resource collection areas and the priority resources reported for these areas

Table 7. *Key resource collection areas for priority resources*

Men/Women top 10 resources	Natural habitats			Modified habitats	
	Open Wetlands	River/ streams	Terrestrial forest	Reservoir	Rice fields
Fish	■	■		■	■
Snails	■	■		■	■
Frogs					■
Eels				■	
Bamboo Shoots		■			
Wild Vegetables	■		■		
Shrimp	■			■	
Sedges	■				■
Water	■	■		■	
Crickets			■		
Mushrooms			■		
Crabs	■				■

Climate impacts and coping strategies

Table 8 summarizes the major climate impacts, current coping strategies and success ratings, and key future coping strategies. Major impacts were associated with crop loss and restrictions to livestock production, followed by erosion and sedimentation damage, water and resource shortages and invasive species impacts.

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

Table 8. *Summary of current coping strategies, success ratings, and future coping strategies*

Livelihood	Impact	Coping strategy 1	Av. Success	Coping strategy 2	Av. Success	Coping strategy 3	Av. Success	**Future strategies**
Cropping	Crop damage/loss (rice + other crops) (F,D)	Practice irrigated dry season rice cultivation (F)		Replant crop (F,D)		Grow alternative/ secondary crops (F,D)		• Expand rice fields further into wetland • Dig pond for irrigation • Re-locate/find new land
Livestock	Lack of land area/shelter and fodder (F,D)	Move livestock to higher ground (F)		Feed dried rice straw/Harvest fodder (F,D)		Purchase fodder		• Same strategies
	Increased disease	Practice traditional medicine		Vaccinate animals – cattle/buffalo		Overall limited strategies for poultry disease		• Training in livestock care • No strategy (poultry)
Infrastructure/erosion damage	Damage to roads, impeded transport (F)	Limit non-essential travel		Increase boat travel		Community repair of roads		• Seek government support
	Damage to banks/dams & other infrastructure (F)	Community repair of damage		Plant vegetation for erosion control		Seek government support		• Seek increased government support
	Sedimentation damage of farmland (F)	Abandon land		Remove sand		No additional strategy		• Same strategies
Resources/environmental impacts	Reduced fish catch/ availability (F,D)	Re-stock fish (community pond) (F,D)		Build/ Improve community pond (F, D)		No effective strategy drought loss from wetland		• Further improve/ community pond infrastructure
	Lack of water/drying of water source (D)	Find alternative water point (D)		Expand or deepen well/pond (D)		Harvest rain water		• Same strategies
	Poor water quality (F,D)	Treat water (F,D)		Buy drinking water (F,D)		Repair damaged infrastructure (F)		• Same strategies
	Expansion of *Mimosa pigra* (in rice fields) (D)	Controlling *Mimosa* plants		Use *Mimosa* as goat fodder		No additional strategy		• Same strategies
	Expansion of Golden apple snail (F)	Collect snails for consumption		Kill snails by feeding rice husks		No additional strategy		• Same strategies

While most strategies scored overall average success, the strategies that were identified as above average success or below average success, with respect to how they benefit livelihoods, are summarized below in Table 9, coupled with the reasoning for success (positives) or non-success (negatives), from a livelihood perspective.

Considerations of these strategies, with respect to their effects on *wetlands and sustainability*, adaptation and future management will be addressed in Section 7.

Table 9. *Livelihood implications of successful and unsuccessful strategies*

Successful strategy	**Livelihood positives**	**Livelihood negatives**
Undertaking irrigated dry season rice cultivation	Guaranteed crop success, controlled water application, higher yield	Labour investment, cost of fuel; high water use
Growing alternative/ secondary crops	Alternative income; Can grow crops/varieties to suit climate conditions	Income maybe less than lost crop; Need experience & market for new crop
Livestock Vaccination	Reduced livestock loss	Only effective if done regularly; Veterinary costs
Control of golden apple snail with rice husks	Success by 1 village; Potential benefit for small scale control	Not large scale option (technique testing needed)
Unsuccessful strategy	**Livelihood positives**	**Livelihood negatives**
Find new/alternative water point		Difficult to locate new nearby source or involves significant labour
Re-stock community fish ponds	Good extra source of livelihood	Extra labour; Expensive and economic loss to replace lost fish
Control *Mimosa pigra in rice paddies*	Must control to plant rice; Control effective if vigilant	Species continues to expand
Control of golden apple snails by collecting for consumption	Provides some food source	Not preferred food source and snails continue to expand
Abandoning land, damaged by sedimentation		Major loss of livelihood; Difficult and expensive to find new land
Few overall strategies for dealing with poultry disease		Poultry disease kills quickly and no vaccination available

Key findings: Overall livelihood and community vulnerabilities

Considering several factors, including the major climatic impacts identified, effects on wetland ecology observed by communities and success and sustainability of strategies, the main livelihood vulnerabilities identified for Xe Champhone communities include:

- For all village: loss of traditional rice cultivation, restricted livestock production, declining fisheries security, and invasive species expansion.
- For selected villages: additional vulnerabilities include erosion and sedimentation damage, water shortages and reliance on vulnerable resource areas.

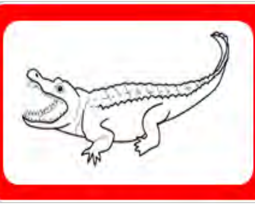
Table 10 highlights major vulnerabilities and most vulnerable communities identified. Specific villages identified are those that reported an impact together with unsuccessful or limited coping strategies, and/or were identified based on village locations and habitat areas utilized.

Table 10. *Major vulnerabilities and most vulnerable communities*

Vulnerability	Communities affected/most vulnerable
Loss of traditional rice cultivation	All; but more impact for lower lying villages, Dondaeng, Sakunue-tai, Taleo-Phonkhor, Donyeng
Restricted livestock production	All
Declining fisheries security	All; but more impact for villages situated away from reservoirs
Water shortage	Nakhathang, Laonard, Ban Houamoung, Kaengkokdong
Invasive species expansion	All
Erosion and sedimentation damage	Dongmueang, Nakhathang, Laonard, Phonkhor-Taleo,
Reliance on vulnerable resources & resource areas	Nakhathang, Kaengkokdong, Kadan, Phonkhor-Taleo (i.e. villages more reliant on vulnerable, natural &/or seasonal habitats)

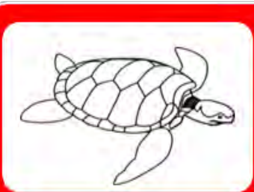
6.3 Summary: Species vulnerability

Several species and/or taxa groups were identified as vulnerable from the combined results of both the CAWA vulnerability assessment, previous vulnerability assessments, or as top priority resources from the livelihood assessment, and therefore at risk of over harvesting. Siamese crocodile and turtle species were identified to have highest vulnerability.



Siamese crocodile (*Crocodylus siamensis*)

Critically endangered, habitats at risk from water extraction and invasive species, vulnerable to temperature change/flooding effects on eggs and reproduction.



Turtles

Four species, including, elongated turtle (*I. elongata*), yellow headed temple turtle, *(H. annandalii), Mekong snail eating turtle (M. subtrijuga) and Asiatic soft shell turtle (A. carilaginea).* vulnerable to temperature and flood timing effects on reproduction/long incubation period & overharvesting.

Large migratory fish

Principally Pa khao, *Wallago attu*, Pakheung, *Hemibagrus Wyckioides* and Paphia, *Labio chrysophekadion*. Heavily reliant on Xe Champhone river, deep pool refuges and migration routes/cues and & at high risk from overharvesting.

Water birds

Principally duck species, such as spot-billed duck (*Anas poecilorhycha*), reliant on open wetland habitat at threat from increased closure/drying & most targeted species as a food resource.

Frogs

Particularly large, seasonal breeding and/or forest reliant species such as Kop na (*H. rugulosus)*, Eung Phao (*G. molossus*) and Kiat leuang (*R. lateralis)* assessed as moderate to highly vulnerable. As a top 3 priority resource, they are vulnerable as a heavily harvested resource group. Little is known about frog populations of the wetlands, with no baseline surveys, and reports of declines during recent droughts.

Snails

Several species, including *Pila scutata* (Hoi tadeng) and *Pila sp*. (Hoi peng), vulnerable to temperature changes and drought on reproduction and golden apple snail expansion. Heavily harvested and high priority taxa group as top 3 priority resource. Further species specific vulnerability research needed.

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 current 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.

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 as 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 addressed for baseline threat management and climate change adaptation

Rivers/streams and **open wetland** habitats are a priority for conservation and adaptation management, together with addressing individual threats for other habitat types:

- Clearing and conversion of habitat and increasing agricultural encroachment
- Erosion and sedimentation of Xe Champhone River and floodplain wetlands
- Invasive species expansion and increasing impacts
- Water extraction from important and vulnerable habitat areas

- ➢ All habitats are providing valuable ecosystem services that support important resource species but also reduce impacts on communities/livelihoods, such as from **erosion, flooding and sedimentation,** which are expected to be exacerbated under climate change. For example, flood forests provide buffering against sedimentation; terrestrial forests regulate water tables and reduce erosion and run-off, shallow open wetland edges are spawning grounds for economic fish species. *Management should focus on preventing further clearing and agricultural conversion of habitats including the encroachment of rice cultivation further into and around wetlands, and restoration of priority areas to improve ecosystem services, particularly flow, sedimentation and erosion control.*
- ➢ **Water extraction** is highlighted as a key impact on habitats during drought times, i.e. oxbows are reported to have almost dried due to pumping for irrigated rice cultivation during recent droughts. Pumping occurs from most habitats types including, oxbows, open wetlands, river/streams and reservoirs. Water extraction puts major pressure on habitats already at risk, reducing long-term resilience to climate change, and increasing susceptibility to invasive species. *Steps to assess current levels of water off-take and reduce water extraction from natural wetland areas needs to be addressed. This could include policy implementation by the*

Lao Government to ensure Environmental Impact Assessment are undertaken for any infrastructure project that would use water resources from the catchment.

- Three major **invasive species** are currently established at Xe Champhone wetlands. *Mimosa pigra* is currently having the greatest impact due to its growth form as a large woody shrub, difficulty of control on a large scale, and because it invades both agricultural areas and habitat areas. Water hyacinth, while also widespread and having a major impact, is generally easier to control as a floating aquatic species. Golden apple snail is yet to have as widespread impact as it is having in Beung Kiat Ngong, but it is expanding and further establishing.

  Control is needed for all invasive species but *Mimosa pigra* and golden apple snail are the two likely to have the greatest impacts and be the most difficult to implement effective control programs. While some control is currently being undertaken, innovative solutions and incentives for control are needed to gain widespread support from communities and increase control outside immediate areas of agriculture. The villages of Houamoung and Kadan have expressed their interest to participate in producing fertilizer out of water hyacinth, and Ban Laonard noted that they would like an updated management plan for Mimosa control in the area. *Golden apple is already established and eradication is no longer possible, but intensive programs to reduce abundance will limit impact and speed of expansion and potentially avoid the major impacts already being experienced at Beung Kiat Ngong. Support of research and testing of bio-controls and alternative techniques for all the invasive species currently in the area has potential to reduce impacts in the future.*

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 major considerations for species. Additional major consideration must be taken concerning hunting and overharvesting, and addressing specific climate change impacts on species.

Major threats on vulnerable species to be addressed

Threat	Description
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. Communities report an ongoing decline in fish populations, as well as the overall decline in many other fauna species.
Competition/displacement of native flora and fauna by invasive species	• Invasive plant species compete with and displace native flora. The level of impact of invasive animal species other than golden apple snail is not yet clear, including exotic fish species and potentially exotic turtle species, i.e. the red eared slider turtle (*Trachemys scripta elegans*) which was sighted recently in Hotay Pidok temple pond in Champhone, and is listed in the top worst invasive species (Chou, 2017).
Increased water extraction/diversion or altered hydrology potentially affecting refuge & breeding areas	• Species such as Siamese crocodile and turtles are threatened by water extraction in oxbow lakes and other deeper wetland areas, that may provide the only refuge habitat available during extended dry periods. Faster declines in water levels are also likely to affect water bird species that are reliant on maintenance of water levels around nests for breeding.
Species habitat loss	• Loss of habitat is threatening already vulnerable and reduced species populations, 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 are assessed in regards to their potential positive or negative effects on the wetlands.

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. The most frequently reported improvements that the villages would like to see is an increase in rice yield through better irrigation systems and flood tolerant seeds. A majority of comments from the validation workshop centred on water resources; improving community fish ponds such as Nong pandeang ponds, support in building better water infrastructure (i.e. wells), as well as improving water quality at Nong Pafa/Turtle lake.

7.3.1 Strategies that improve livelihood but potentially increase pressure on wetland

- Irrigated dry season rice cultivation involves pumping water from natural wetland areas, including from a number of habitats identified as most vulnerable to baseline risks and climate change. Pumping from reservoirs is also common, and for example, Laonard village indicated a decline in water level in Ang Makmee Reservoir was impacting irrigated rice farming in the dry season. This indicates significant concern such that if large reservoirs show decline, smaller water bodies such as oxbows are at significant risk from increased levels of irrigation.

- *Extending rice fields further into wetland during dry years*. This happens most often in open wetland habitat. Agricultural encroachment modifies wetland edge vegetation important for fauna that breed or spawn in shallow water habitat, such as *Wallago attu* and a number of frog species. Cultivating new areas also favours further invasion and establishment of *Mimosa pigra* as it prefers disturbed shallow water habitat.
- *Re-stocking of ponds with exotic fish species, following loss of fish to wetlands during floods.* Exotic species identified as used for re-stocking and lost to wetland include, Tilapia, grass carp, common carp etc. While exotic species have existed in Xe Champhone for many years (Claridge, 1996) specific impacts on the wetland and its biodiversity have not been assessed, and/or the size of exotic fish populations.
- *Harvesting fodder and more intensive pressure by livestock in habitat areas, such as forests and dry wetland beds, during drought.* Sustainable fodder sources are important to maintaining livestock production as a secure livelihood as well as preserving sensitive wetland vegetation. It should be further investigated for the villages of Kaengkokdong and Nakhathang that identified fodder shortage during drought, whether impacts are due to lack of available land or other issues involving land degradation or salinity.

7.3.2 Strategies that improve livelihood and potentially reduce impact on wetlands

- *Expanding/deepening community ponds/wells as water source.* Some impact is possible due to less water run-off to the wetland but due to high rates of evaporation from large open water bodies, smaller deep community ponds or wells result in less water loss within the whole system.
- *Harvesting rain water.* While any water capture method reduces run-off to the wetland as above, water tanks provide water capture at relatively low volumes and low evaporative rates. Harvesting rainwater reduces additional extraction of water from the wetland at most vulnerable dry times, and reduces the workload for villages to collect water from the wetland during the hottest time of year.
- *Building new or improving current community fish pond infrastructure* for expanded aquaculture, which reduces pressure on wetland resources.
- *Growing alternative or secondary crops*, including drought and/or flood tolerant rice varieties, and drought tolerant and wet season suitable vegetable crops.

- Planting vegetation for erosion control, to reduce flood damage to dykes/dams and limit run-off and sedimentation.

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

- *Further develop student research partnerships.* While some students from Savannakhet University, Department of Agriculture and Environment, have already been involved with undertaking small research projects for the CAWA project, greater involvement in research and management of the Ramsar site should be encouraged. There are numerous student-village collaborations that could be pursued in conjunction with several management recommendations outlined in Table 12, particularly those that need further research. Projects will need capacity, knowledge, and enthusiasm to achieve the desired result, all of which could be sourced from the students at Savannakhet University. This potential partnership would create many benefits such as giving students hands-on experience, solving important environmental issues, and improving livelihoods of local villagers, thereby extending the sense of community in the province.
- *Develop community involvement in activities.* Data collection/monitoring on a number of issues identified in the VA (erosion, invasive species, resource use, and 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 sharing and collaboration*. 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. 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. This has been started under the CAWA project with a GIS database established, but should be expanded to include data from all projects working in the area. This may be achieved by increased coordination and functionality of the recently established Lao Wetland Group initiated by the CAWA project.

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. Recommendations are presented in Table 11, 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 11. *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	Xe Champhone River + tributaries	Reduce erosion/ sedimentation & loss of deep pools	• Assess and identify key points of erosion along the XCP River • Identify riparian restoration priorities and options, and link with wider catchment restoration plan (below) • Support community protection of deep pool habitats & fish populations during dry periods through fish conservation zoning
	Open wetlands	Reduce impact of increased temperatures and drying by limiting encroachment and water extraction	• Assess extent and high risk areas for encroachment of rice fields further into open wetlands • Through community consultation, establish buffer zones from edge of water bodies to cultivation area &/or smaller priority exclusion areas to maintain proportion of natural wetland edge habitat • Assess current levels of water extraction from open wetland areas
	Oxbows	Reduce impacts of invasive species/closure, water extraction/encroachment	• Assess extent of encroachment/disturbance of oxbow edges • Conduct community consultation, with villages of Ban Kadan, Tansoum, Taleo-Phonkhor & Kaengkokdong, & identify potential to demarcate oxbow buffer zones • Assess current levels of water extraction from oxbows • Continue/ expand re-opening/invasive species control programs
	Reservoirs	Invasive species management to reduce closure/loss of open water areas	• Map and assess vegetation cover of reservoirs, Bak, Phai jiew, Talung • Consult with key villages surrounding reservoirs on major issues (some already consulted) • Plan (& continue) targeted invasive species removal programs, focussing on water hyacinth, Mimosa, and areas that are restricting flow and aquatic species movement. • Ensure sensitive threatened species habitats are maintained, i.e. particularly in Phai jiew, Talung, Ang Makmee

	Terrestrial Forest (Evergreen dry/deciduous forest)	Reduce rates of clearing/conversion	• Assess current terrestrial forest cover and high risk areas for future clearance • Consultation with villages associated with major forest areas, i.e. Laohuakham, Nakhathang • Propose an initial forest protection buffer zone of 2 km from Ramsar edge; • Identify priority restoration areas to improve catchment/hydrological management, i.e. to support groundwater and reduced run-off and sedimentation of Xe Champhone River.
		Reduce unsustainable timber use	• Assess timber use within the district, i.e. proportion for charcoal production, furniture making, construction etc. • Assess key users, both community and private, and undertake a consultation process to reduce timber use and extraction • Investigate alternatives to timber use, i.e. alternative energy sources other than charcoal for cooking, i.e. solar, briquettes from waste products/invasive species
	Flood forest	Reduce rates of clearing/conversion	• Assess high risk areas for flood forest clearing/conversion for cultivation • Undertake community consultation and plan for conservation measures, with key villages Ban Tansoum, Kadan, Taleo-Phonkhor, Dondaeng, Sakhounue-tai
	Grassland	Reduce rates of modification, conversion and over grazing	• Assess high risk grassland areas for modification/conversion to cultivation and/or over grazing, i.e. area near Kout Xelat Kadan • Undertake community consultation and plan for conservation measures with Ban Kadan village • Undertake study on current grazing and burning regimes and grassland fauna population
Species	All vulnerable/ threatened/ priority resource species	Limit loss of refuge and breeding habitat	• Implement protection and restoration measures of habitat, as above, for vulnerable species and priority resource species. • Identify and protect key spawning grounds (i.e. fish, frogs) nesting areas and refuge and roosting sites (i.e. birds, turtles, crocodiles) through conservation zoning where applicable, for all key fauna species/taxa groups identified as vulnerable.
	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 (all vertebrates and invertebrates, i.e. snails). • Establish and increase patrolling programs and enforcement of harvesting/ hunting regulations - focus on mammals, birds, reptiles (with fish enforcement well established). • Expand conservation zones to include seasonal resource collection (see above) of high risk seasonal species/climate risk species, i.e. seasonal frogs, i.e. Eung Phao, tadpole harvesting restrictions, and migratory birds, and increased restrictions under drought conditions.
	Turtles Siamese crocodile	Improve reproductive success of species affected by climate change and other baseline threats	• Assess options for community supported breeding programs for vulnerable turtle species, i.e. *A. cartilaginea,* in Dondaeng Turtle Lake. • Support re-activated WCS Siamese crocodile breeding program
	Declining fishing security	Increase aquaculture production & reduce pressure on wetland aquatic animal resources	• Establish new and/or increase existing community fish ponds in identified resource vulnerable villages, i.e. Nakhathang, Kaengkokdong, Kadan, Phonkhor-Taleo, Dondaeng • Develop pond design to reduce evaporation and increase depth & security of ponds. • Establish vegetation in and around ponds to support native fauna and reduce drought/heat effects • Stock ponds with native fish species, locally sourced, such as from Pakbor fishery facility • Support research and pilot trials for breeding a wider variety of important local species and different aquaculture methods.
	Water shortages/ Over extraction of water	Reduce water resource pressure and reduced extraction from wetland	• Initiate hydrological study to assess overall water extraction across the site • Identify best options for water interception and storage to reduce ecological impact on wetland and maximise storage • Increase water collection tanks and or support increased wells/dams for villages identified at high risk from water shortage & with few sustainable options, i.e. Nakhathang, Laonard, Ban Houamoung, Kaengkokdong. • Encourage pumping from constructed community ponds rather than wetland areas

		• Consider Government policy to address infrastructure activities within the catchment, and Environmental Impact Assessment process.
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 • Research alternative climate tolerant crops with focus on new vegetable varieties and tropical tree crops (link with restoration plan) and 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. • Research and discuss options for further collaboration with Savannakhet University's Department of Agriculture and Environment for student project work on these issues
Invasive species, *Mimosa*, Golden apple snail, water hyacinth.	Reduce impact of Invasive species *Invasive plants - Mimosa pigra/water hyacinth/other species*	• Update mapping of *Mimosa pigra* distribution • Identify areas of XCP where Mimosa is yet to occur or is in low abundance • Practice exclusion management from these areas to prevent invasion/establishment • Continue to support management of MP and WH in high priority habitat areas and/or agricultural areas • Ascertain options of introducing biological control agents for Mimosa and water hyacinth • Investigate alternative uses/processing options for invasive species (see below under alternative income sources). • Identify species and extent of 'invasive sedge' impact identified by Laohuakham village • Develop student studies to support different areas of research
	Invasive animals - Golden apple snail/other species	• Conduct rapid assessment of snail distribution within the Xe Champhone Ramsar site • Conduct community consultation highlighting potential future impacts • 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). • Investigate extent and potential impact of other exotic species including, exotic fish species and, red eared slider turtle, (*Trachemys scripta elegans*)
Restricted livestock production	Reduce incidence of livestock loss and villager labour	• Implement training program on improved husbandry and livestock care • Investigate alternatives to improve small livestock (poultry) disease prevention/management • Further testing and introduction of flood tolerant fodder varieties • Investigate increasing native fodder options, including shrub/tree forage species (link with restoration/erosion strategy).
Erosion and sedimentation damage	Interventions to reduce erosion of river banks/dams/dykes and sedimentation of farmland	• Site visits to assess locations of erosion and sedimentation damage, in villages of Nakhathang, Laonard, Dongmeuang (including Dong Ling boundary) and Taleo-Phonkhor • Investigate and support options for infrastructure/ vegetation restoration mitigation
Reduce dependence on wetland resources/ increase value of invasive species	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. • Assess feasibility to establish frog farming pilot site facility, using species *Hoplobatrachus rugulosus*, a previously successful farmed and local species • Research, training and increased support in the use and processing of invasive species, i.e. water hyacinth - fertiliser, baskets/bags, furniture; Golden apple snail drying, smoking, fish meal; *Mimosa pigra* – fuel/processing into briquettes. • Assess feasibility to establish small village handicraft co-op and marketing plan, (link with ecotourism strategy) – i.e. expanded weaving products, bamboo craft, local fabric souvenirs, that can be transported and sold easily to visiting tourists or in Savannakhet.

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 ongoing 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.

Demarcation of the Ramsar site and increased awareness of the main boundary and core zone boundaries is important for effective implementation of regulations and community perceptions. Update of these boundaries also needs to be reconsidered in line with recommendations of additional priority habitat areas for inclusion (Timmins, 2014), along with designation of buffer zones. Buffer zones should be considered as a priority to ensure integrity of the site is maintained in an already modified landscape by preserving important habitat components critical for supporting important ecosystem services. This is particularly important in light of a number of current potential concerns; several new irrigation development projects around the wetlands; ambitious provincial targets for increasing agricultural production; and forest clearance within private concessions that is occurring on the boundary edge, all of which could influence the future values and status of the Ramsar Site.

7.5 Conclusions

In planning for adaptation, it's important to carefully consider 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 habitats and species is critical for environmental and community sustainability.

The recommendations made have attempted to provide this balance but with a priority focus on long-term sustainability of resources and the habitats that support them. Any potential livelihood impact on resources has been addressed with recommendations of alternative strategies, or mitigation options. However, support for key livelihoods of communities surrounding the wetland, principally agricultural production, is paramount and recommendations to improve effectiveness and reduce loss of agricultural production to climate change is 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

	Algae	Bamboo shoots	Birds	Boiling salt	Crabs	Crickets	Eels	Firewood	Fish	Frogs	Grass	Local potatoes	Lotus	Mushrooms	Rats	Red ant eggs	Sedges	Shrimp	Snails	Snakes	Tadpoles	Turtles	Water	Wild vegetables
Dondaeng																								
Men		2					5		1	6					10		9	8	3	7				4
Women		3	9		8	5	2		1	7				6	10				4					
Dongmeuang																								
Men		8	9				4		1	5							7	3	2			10		6
Women		3					6	8	1	2				7		10	9		5					4
Donyeng																								
Men		6					4		1	3			10		7		9	5	8					2
Women		4				7			1	6			10	8			9	3	2					5
Hoaumoung																								
Men		7	9				3		1	10			5					6	4			8	2	
Women		3	10				9		1	7			5					6	4			8	2	
Kadan																								
Men		10			8	2	5		1	3				7				9	4					6
Women		1			2	9			2	4		7		8		6			5		10			3
Kengkokdong																								
Men	10	3					5		1	4				7				6	2					9
Women		2			9	8	4		1	7				5				6	3	10				2
Laohuakham																								
Men		3					6		1	5	10			9			4	7	2					8
Women		2	10			9	7		1	6				4			8		3					5
Laonad																								
Men		4					8		1	5		9				10	3	6	2					7
Women		4	10				3		1	7				8			9	6	2					5
Nakathang																								
Men		3					5		1	4				7				6	2			10		9
Women		5			9	10	7		1	2				8				4	3					6
Nonsithan																								
Men					7		6		1	5			10				9	8	2				3	4
Women	9	3				7			1	5				8			10	6	2					4
Phaleng																								
Men							10		1	5	7	8	6			9		3	2					4
Women		3					6	8	1	5				11	7	12	9	4	2					10
Phonkhor-Taleo																								
Men		4		10		6	2		1	3				8		7			5					9
Women		2		10		9	5		1	4						8		6	7					3
Sakhounue-tai																								
Men		6					4		1	3			10		7		9	5	8					2
Women	6	5			7	9			1				10				8	3	2					4
Tansoum																								
Men		2				6	3		1	4				10	9			7	8					5
Women	10	5				9	4		1			7				6		3	2					8

APPENDIX II: SAMPLE HABITAT AND SPECIES ASSESSMENTS

Habitat: Flood forest

a) Baseline conservation status

Habitat Baseline Conservation Status assessment				
Habitat name	**Flooded forest**			
Wetland name and location	**Xe Champhone**			
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 · The habitat covers small proportion of the wetland area	Flooded forest covers a medium proportion of the XCP wetland area particularly in the southern section and cores areas
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	Habitat is decreasing principally due to clearing for agricultural conversion and timber/bamboo collection, and/or for charcoal production
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	Flooded forest distribution is moderate within the LMB region found in several areas but not on a large scale
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	Flooded forest considered to be decreasing in LMB due to similar reasons as for XCP, i.e. converison for agricultural land, some timber/bamboo removal
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	Medium species diversity (ICEM 2012); Ground layer below trees generally sparse (Meyell et al 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	Regular seasonal flooding is important process in flood forest habitat; flooding important for regeneraton and to maintain habitat
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 is not needed to maintain habitat, but its unclear if 'fire is not tolerated', i.e. if trees are killed by fire or they can regnerate.
8. What is the degree of disturbance needed to maintain this habitat?	**3**	**1** **2** **3**	· High disturbance is needed · Modified · Undisturbed is needed	No non-natural disturbances are required to maintan this habitat.
9. Are there flagship species in this habitat?	**2**	**1** **2** **3**	· No · A few · Many	Siamese crocodile and several threatened turtle species utilise XCP flood forest areas (ICEM, 2012).
10. Are there keystone species needed to maintain this habitat?	**2**	**1** **2** **3**	· No · A few · Many	Flooded forest tree species including *Barringtonia acutangula;* Bamboo (*Bambusa bambos*)
11. Are there important economic species in this wetland?	**2**	**1** **2** **3**	· No · A few · Many	A few: Several economic fish spp., i.e. snake head, *Channa spp* .,. and catfsh, *Clarias spp* ;, plus snails, frogs, bamboo etc
12. Are exotic species a problem in this habitat?	**2**	**1** **2** **3**	· No · A little · Very serious problem	Some Mimosa pigra in disturbed areas of flooded forest, but generally low in intact forest
13. Are there threats to conversion of this habitat?	**3**	**1** **2** **3**	· No · Maybe · Yes	Principally conversion for agricultural land, also timber/ bamboo removal.
14. How does the habitat recover from recent extreme weather events?	**1**	**1** **2** **3**	· recovers fast · recovers slowly · does not recover	Considered to recover relatively fast as tolerant of flooding and tree/shrub species tolerant of moderate drought.
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	It is officially protected as Ramsar site, though protection of species/ habitats not currently fully enforced
Total score	**2.2**			
Moderate vulnerability	**2.2**			

Habitat: Flood forest

B) Climate change vulnerability

Habitat climate change vulnerability analysis				
Habitat name	**Flooded forest**			
Wetland name and location	**Xe Champhone**			
Variable	**Score**		**Definitions**	**Field Notes**
Threats: Climate and non-climate				
1. Is temperature change considered to be an issue	2	1 2 3	· Temperature change is not an issue. · Temperature change is a moderate · Temperature change is a serious issue	Moderate temperature exposure expected for flood forest habitat, some bufferng from vegtation cover. 'Trees are able to survive periods of increased temperatures...though increased temperatures in the wet season may have inhibitory effects on flowering, fruiting and seed setting... (Meynell 2014)'.
2. Is exposure to drought an issue?	2	1 2 3	· Precipitation changes is not an issue. · Moderate exposure to drought · major drought issues	Moderate drought exposure expected for flood forest 'Trees are able to survive periods of drought...(Meynell et al 2014'), but prolonged and more frequent droughts could alter habitat/species composition.
3. Is exposure to flood an issue?	1	1 2 3	· Flooding is not an issue. · Moderate exposure to flood · Major flood issues	Flood exposure is not considered a significant issue for flood forest, and habitat is naturally seasonally flooded
4. Is exposure to hydrological change an issue?	2	1 2 3	· Hydrological change is not an issue · Moderate hydrological exposure · Major hydrological exposure	Moderate exposure to increased evapotranspiraton - vegetaion cover and shading expected to provide buffering
5. extreme weather events - typhoons and high winds?	2	1 2 3	· Extreme weather is not an issue · Moderate exposure to extreme events · major exposure to extreme events	Moderate exposure to increased extreme drought & storms/high winds - increased loss of trees; Moderate increase in extreme drought events and storms expected.
Exposure				
7. How much of this habitat type will be exposed to **changing hydrology** and hydraulics (i.e. flows)?	2	1 2 3	· <25% · >25% and <75% · >75%	Moderate-high exposure to changing hydrology/flows as flood forest inundates principally via overflow from river but not as direct exposure as river/stream channel.
8. How much of this habitat type will be exposed to changes in extent, depth and duration of **inundation** from rainfall?	1	1 2 3	· <25% · >25% and <75% · >75%	Low to moderate exposure to change in rainfall as flood forest mainly influenced by river bank flooding/upstream catchment flows rather than direct inundation from rainfall
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	· <25% · >25% and <75% · >75%	Moderate increases in exposure to sediment expected as flood forest receives flood waters from XCP River/tributories carrying high sediment loads, but not as direct exposure as river channel habitat.
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	Increased timber clearance and conversion for dry season rice cultivation expected to increase baseline stress
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	Canopy of flooded forest expected to moderate temperature increase
14. Is the habitat generally tolerant to flooding?	2	1 2 3	· The habitat has tolerance to flooding · Intermediate · The habitat has narrow tolerance to flooding	The flood forest habitat has tolerance to flooding, with trees species *Barringtonia* '...well adapted to living in areas that have prolonged inundation and is especially resilient to increased flooding'...(Meynell et al 2014)'. However longer, and higher inundation levels may have negative impacts on regeneration of other vegetation, such as Bamboo common in XCP flooded forests, and may inhibit development of new shoots of young bamboo; Increased flood intensity may also increase sediment deposition in XCP flood forest habitat filling in deeper pools reducing refuge areas during dry season.
15. Is the habitat generally tolerant to drought?	2	1 2 3	· The habitat has tolerance to drought · Intermediate · The habitat has narrow tolerance to drought	The flood forest habitat has intermediate tolerance to drought - tree species tolerant of moderate drying (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	Flagship species not tolerant of climate change: Siamese crocodile & turtle spp, i.e. increased temperature and flood effects on successful breeding, and influence of increased drought on habitat loss.
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	Bamboo regeneration could be affected by deeper flood levels/Barringtonia is resilient to prolonged flooding and able to withstand periods of drought, but higher temperatures may alter flowering and fruiting patterns (Meynell et al 2015)
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, considered relatvely tolerant of effects of climate change
19. Is the habitat generally tolerant to sediment increase?	2	1 2 3	· The habitat has tolerance to a broad sediment range · Intermediate · The habitat has narrow sediment range	Moderate tolerance to sedimentation, dense vegetation reduces sedimentation risk but some filling of depressions occurs with higher sediment loads, reducing water retention into dry season.
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	Flooded forest is more a site of deposition than erosion
Adaptive capacity				
22. 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 viable for many years · long-lived trees and shrubs with slow germination and slow generation time	XCP flood forest composed of bamboo, shrub and tree species, with mixed germination and generation times, i.e. bamboo faster growing
22. Are invasive species likely to increase with climate change?	1	1 2 3	· pretty sure they will not · 50/50 chance · pretty sure they will	Invasive species are not expected to be an increasing issue under climate change, as invasive species don't tend to occur or have significant impact in intact flood forest habitat.
23. Does the habitat have traits that will allow it to bounce back from the new extremes/maxima/minima due to climate exposure?	2	1 2 3	· pretty sure it can · 50/50 chance · pretty sure it cannot	Flooded forest habitat (& its plant species) has some traits that indicate its resilience to climatic changes expected, but long-term affects are unclear
24. Is there adequate space for change. i.e. is there suitable adjacent water, terrain and soils to allow expansion or "movement" of the habitat?	2	1 2 3	· There are large areas of suitable land or water adjacent to the wetland · 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.	Potential for habitat to expand to some extent with flood level
25. Are there physical barriers (natural or man-made) that might prevent expansion or "movement" of the habitat?	1	1 2 3	· There are no barriers. · There are some barriers · There are major barriers	No specific physical barriers as such are known
26. 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	Dense vegetation and moisture retention of soils may provide refuge for a number of fauna species during dry periods.
28. Are biological thresholds exceeded for this habitat, e.g. for keystone species ?			**No** **Don't know** **Yes = Very Vulnerable**	
Total score	**1.9**			
Moderate vulnerability	**1.9**			

Species: Siamese Crocodile (*Crocodylus siamensis*)

a) Baseline status assessment

Species Baseline Conservation Status assessment						
Species name	***Siamese Crocodile***					
Wetland name and location	**Xe Champhone Wetlands**					
Variable	**Adult Score**	**Juvenile Score**	**Egg/Seed Score**		**Characteristics of the Species**	**Comments**
1. What is the **population** size within the LMB?	3	na	na	1 2 3	· With in LMB the species is common · Intermediate between Large and · With in the LMB the species is rare	Species is rare with LMB - *'...now rare or locally extinct in many sites (Bezuijen et al. 2006)'* - listed as *critically endangered.*
2. What is the **populations trend** in the LMB in the last 50 years?	3	na	na	1 2 3	· The population is increasing · The population is staying the same · The population is decreasing	Population has decreased in the last 50 years - *'...available data indcate a severe national decline in abundance (Bezuijen et al. 2006)'.*
3. What is the **geographic range** size in the LMB ?	2	na	na	1 2 3	· The species is widespread in the basin · Intermediate between Large and · The species is within a small/restricted range	Species has an intermediate geographic range in LMB occurring within several river systems of Southern Lao PDR and Cambodia.
4. What is the **range size trend** in the LMB in the last 50 years?	3	na	na	1 2 3	· The range is increasing · The range is the same · The range is decreasing.	The range has decreased - 'Surveys in 2005 suggest a severe range decline has occurred...of 24 surveyed wetlands where crocodiles were reported to have occurred...crocodiles now only occurred in 15 sites (Bezuijen et al. 2006)'.
5. Can the species **reproduce** fast?	3	na	na	1 2 3	· Many offspring, many times a year · Many offspring, once a year · few offspring once a year.	Indications are that successful breeding in Lao PDR is not frequent...i.e. 'Successful breeding in 2005 was confirmed in only two of six sites...reports of nests in some years but eggs not hatching or hatclings seen (Bezuijen et al. 2006)'; Reports of some nests (potentially old females) containing mostly infertile eggs, i.e. from WCS egg collection at Kout Xe Lat Kadan (ox-bow) and Berng hor sites (Pers. com. O.Thongsavath).
6. Is the species a generalist or specialist?	2	2	na	1 2 3	· Generalist · Intermediate · Specialist	Considered intermediate: Appears to have more specific habitat & nesting site requirements, i.e. dense vegetation/floating mats (especially at XCP wetlands); but diet more generalist i.e. fish, and snakes most frequently recorded but also birds, mammals, invertebrates (Bezuijen et al. 2006), snails,crabs (O. Thongsavath pers. com.) . - 'Similar to many other crocodilians, C. siamensis feeds on a wide variety of prey such as invertebrates, frogs, reptiles, birds and mammals, including carrion (Daltry et al. 2003;
7. Does the species need a lot of habitat?	3	3	na	1 2 3	· Requires a small habitat · Requires a moderate habitat · Requires a large habitat	Homerange: Inhabits restricted habitat area during dry season, with high site fidelity, but larger area during wet season on migraton routes.
8. Is the species able to disperse?	1	2	na	1 2 3	· Can move long distances easily · Can move short distances easily · Can not move very far.	During the wet season, individuals disperse across flooded landscapes (eg radio-tracked individuals have moved up to 25 km before returning to dry season sites; Simpson et al. 2006b' - Simpson & Bezuijen 2010.
9. How does the species survive current floods?	1	1	2	1 2 3	· Recovers fast · Recovers medium · Recovers slow	Adults and juveniles considered tolerant of ***current*** floods; Eggs are destroyed by extended high water levels, i.e. 'if the eggs are submerged for more than 2 or 3 hours (depending on the stage of incubation) the embryos will likely die (S. Platt pers. com.)', but moderately tolerant of ***normal*** flood levels.
10. How does the species survive current droughts?	2	2	2	1 2 3	· Recovers fast · Recovers medium · Recovers slow	Medium recovery rates from current droughts expected due to effects on water levels and/or food sources, particularly at smaller wetland areas - Issue with drought would be if wetlands actually dry out and crocodiles and turtles must leave and travel to wetlands containing water or become more vulnerable to humans catching them. Crococdiles in large wetlands less at risk, but higher risk for small wetland areas, particularly with increased water extraction levels (S. Platt pers. com).
11. Are there threats to survival from humans use?	2	2	2	1 2 3	· The species has low value · The species has medium value · The species has high value	Human use of species has decreased with increased conservation/ awareness but some poaching and inadvertant capture of juvenile in nets/hooks and collection of eggs is expected to still occur. - 'Threats include accidental capture and drowning in fishing gear, poaching...(Han et al 2015: Cambodia)'; 'Ongoing regional demand for live crocodiles may encourage capture/sale of crocodiles in Lao PDR (Bezuijen et al. 2006)'.
12. Are there threats to survival from non-humans interactions?	3	3	2	1 2 3	· Is not affected · Is slightly affected · Is highly affected	Water Hyacinth (& Mimosa pigra) invading habitat areas and inhibiting adult wet season migrations/ movements; Burning of vegetation around habitat areas also reported; Juveniles populations suffer high rates of predation and some level of disease (observed mostly in captivity); Predation of eggs, i.e. by rodents, monitor lizards, birds, snakes etc.
13. Does the wetland have effective management?	3	3	3	1 2 3	· Highly effective · Moderately effective · Not very effective	Not very effective: Ramsar site, but regulationsnot well enforced; Does not yet have a METT score.
14. Does the species have a national conservation status?	3	3	3	1 2 3	· Not priority · Priority · High priority	Yes nationally listed as an 'At Risk'/Category I species
15. Does the species have a IUCN Redlist status	5	5	5	NA NA 1 2 3 4 5	· Not evaluated · Data deficient · Least Concerned · Near Threatened · Vulnerable · Endangered · Critically endangered	Critically endangered
Average score	**2.6**	**2.7**	**2.7**			
Very high baseline status			**2.7**			

Species: Siamese Crocodile (*Crocodylus siamensis*)

a) Climate change vulnerability assessment

Species climate change vulnerability analysis					
Species name	***Siamese Crocodile***				
Wetland name and location	**Xe Champhone Wetlands**				
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	3	1 · Temperature change is not an issue. 2 · **Temperature change is moderate** 3 · Temperature change is a serious issue	Temperature increases could influence hatchling gender, and in the longer term skew population gender ratios. Eggs are deposited during warmest time of year when largest temperature increases are forecast -"...most clutches are deposited during the late dry season (March–April)...and hatchlings emerge at the beginning of the wet season (June–July) (Platt et al 2006)'; Potential for moderate heat effects on juveniles and Adults during hottest periods, i.e. Apr-June - 'Lethal thermal temperatures for most lowland tropical herpetofauna are approximately 38–42 C... (Brattstrom 1968; Snyder and Weathers 1975). However, most ectotherms do not perform optimally at the high end of their thermal tolerance...(Bickford et al 2010)'
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**	Moderate reduction in dry season rainfall expected and an increase in frequency of drought events: Major issues for adults and juveniles expected with drought impacting habitat i.e. particularly loss of connectivity for migrating adults, habitat closure/ increase in invasive species, decreased food supply etc; Because eggs are naturally deposited at end of dry season it is expected that drought is not a major issue for eggs - moderate threat applied
3. Is increased flooding likely to be an issue?	1	2	3	1 · Flooding is not an issue. 2 **. Moderate threat of flood** 3 **. Major flood issues**	High inundation levels can flood nests and destroy eggs if submerged for too long, plus potential increased fungal growth/ disease, i.e. '...mortality of reptiles...that lay their eggs on land may increase due to nest flooding and increased fungal growth on eggs (Kraemer and Bell 1980; Houghton et al. 2007) - (Bickford et al 2010)'; Potential moderate effects on juveniles that could be displaced by flood waters but adults considered generally tolerant to floods.
4. Is exposure to hydrological change an issue?	2	2	3	1 · Hydrological change is not an issue 2 · **Moderate hydrological changes**	Increased evaporation rates that effect depth of habitat areas and increase closure is an issue for adults and juveniles; and increased flooding/ inundation levels that result in extended submergence of eggs and loss of viability
5. Extreme weather events - typhoons and high winds?	3	2	2	1 · Extreme weather is not an issue 2 · **Moderate risk of extreme events**	Increase in frequency and severity of extreme drought events, i.e. extreme El ninos expected to effect all stages but especially adults limiting seasonal movements due to habitat disconnectivity/closure and drying of habitat
Exposure to climate change					
7. Are microhabitats or refugia available to reduce exposure to temperature change	2	2	3	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 eggs deposited in terrestrial nests increasing protection is limited other than protection already provided by soil and vegetation cover and density of plants/small trees For adults & juveniles vegetated permanent water habitats, for example deeper oxbows and Pai jiew reservoir, provide some refugia to reduce exposure to increased temperature.
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**	Main oxbow areas & Pai jiew habitats incorporate some vegetated deep water areas to provide moderate buffering of drought effects; As eggs are buried temperature is considered more an issue for eggs than reduction in rainfall
9. Are microhabitats or refugia available to reduce exposure to flood?	1	1	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**	Increased exposure to flood not considered major concern for adults or juveniles as primary habitat areas arent flowing so change is a higher or more frequent rise in inundation level, may even benefit by increasing habitat connectivity across wetland area; Eggs can be destroyed if inundated for too long so increased flooding is major issue for eggs with no option of 'refugia'.
10. Are microhabitats and refugia available to reduce exposure to hydrological	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**	Biggest concern for adults & juveniles is increased evaporation rates reducing water levels and reducing connectivity of habitats, though refugia is available in main home range zone, i.e. Phai jiew reservoir; Limited refugia is availble to reduce eggs exposure to higher flood levels (projected earlier commencement of wet season/ flooding).
11. Are microhabitats or refugia available to reduce exposure to extreme weather events?	2	2	2	1 · Extreme weather is not an issue 2 · **Refugia are available** to buffer impacts 3 · there is **little option for the species to**	Increase in frequency and severity of extreme drought events, i.e. extreme El ninos - At XCP main Pai chaio reservoir incorporate some vegetated deep water areas to provide moderate buffering of drought effects, oxbows may dry out; eggs are buried and temperature is considered more an issue for eggs than reduction in rainfall - confirm? - other extreme weather events not considered an issue.
Sensitivity to climate change					
13. Does the species have a wide **heat** tolerance ?	1	1	3	1 · Tolerant to a broad range 2 · Tolerant to an intermediate range 3 · Tolerant to a narrow range	Adults and juveniles considered to have wide wide heat tolerance as reptiles; Eggs however due to effect of temperature on determining sex of hatchlings are considered to have narrow heat tolerance.
14. Does the species have a wide **precipitation** tolerance?	1	1	2	1 · Tolerant to a broad range 2 · Tolerant to an intermediate range 3 · Tolerant to a narrow range	Due to large natural seasonal differences between wet and dry seasons adults and juveniles are considered to have a wide precipitaion tolerance, and eggs to have moderate tolerance due to sensitivity to inundation
15. Does the species have a wide **hydrological** tolerance?	2	2	3	1 · Tolerant to a broad range 2 · Tolerant to an intermediate range 3 · Tolerant to a narrow range	Adults and juveniles as individuals considered to have moderately wide hydrological tolerance in that can tolerate floods and lowering water levels to a degree but as aquatic animals require a certain level of aquatic habitat; Eggs considered to have less hydrological tolerance due to sensitivity to inundation
16. Is the species sensitive to **associated risks** from other species?	2	2	2	1 · Tolerant to a broad range 2 · Tolerant to an intermediate range 3 · Tolerant to a narrow range	Eggs (and juveiles) suffer a level of predation due to long incubation period; and juveniles and adults impacted by invasive plant species , i.e. water hyacinth invading habitat.
Adaptive Capacity					
17. Does this specie have **reproductive traits** that will allow it to bounce back from the new climate exposure	3			1 · pretty sure it can 2 · 50/50 chance 3 · pretty sure it cannot	Eggs exposed to moderate-long incubation period, i.e.'Hatchlings emerge in the wet season after 70-80 days incubation (in Simpson & Bezuijen 2010)' - Chance of increased climate exposure with projected increase in early wet season rains/ flooding); Indications are that successful breeding in Lao PDR is not frequent...i.e. 'Successful breeding in 2005 was confirmed in only two of six sites...reports of nests in some years but eggs not hatching nor hatchlings seen (Bezuijen et al. 2006)'; Females do provide parental care and protect nests (Whittaker 2007) i.e., ' female crocodiles will sleep on the nest during the incubation period during (OT pers.com) but otherfactors may deem reproductive traits a limiting factor.
18. Does this species have **habitat traits** that will allow it to bounce back from the	2			1 · pretty sure it can 2 · 50/50 chance 3 · pretty sure it cannot	Considered moderate: Has more specific habitat & nesting site requirements, i.e. dense vegetation, floating mats; but diet considered generalist - 'Similar to many other crocodilians, *C. siamensis* feeds on a wide variety of prey such as invertebrates, frogs, reptiles, birds and mammals, including carrion (Daltry et al. 2003; Bezuijen, in press in Simpson & Bezuijen 2010)'.
19. Is the population big enough and with enough **genetic diversity** to withstand	3			1 · pretty sure it can 2 · 50/50 chance 3 · pretty sure it cannot	Small population size: Species is rare with LMB - '...now rare or locally extinct in many sites (Bezuijen et al. 2006)' - listed as critically endangered.
20. Does the species have **behavior** that will allow it to adapt to the new climate?	3			1 · can acclimatize to the new climate 2 · intermediate between High and Low 3 · has little ability or opportunity to	Species has high site fidelity. This is expected to be a limiting behaviour in adpating to changing climate and habitat decline if species doesn't readily disperse to new habitat areas.
21. Is there sufficient **habitat connectivity** to allow organisms to reach	3			0 · pretty sure it can 1 · 50/50 chance 3 · pretty sure it cannot	Habitat connectivity is a major issue especially during dry periods at XCP when key oxbow habitat areas may become disconnected
22. Is there **adequate time** to allow an individual to develop adaptive changes?	3			0 · pretty sure it can 1 · 50/50 chance 3 · pretty sure it cannot	Difficult to confirm the timeframe before major climate change impacts are felt for *C. siamensis,* though impacts are apparent during extreme dry periods. Significant adaptive changes, for example, to behaviour, reproduction, habitat use etc, are considered less likely for a reptile species to achieve than a higher order vertebrate, i.e. mammal.
23. Will baseline stress be increased by the new climate in the LMB?	3			1 · pretty sure they will not 2 · 50/50 chance 3 · pretty sure they will	Invasive species, i.e. water hyacinth and mimosa pigra, and closure/disconnectivity of habitat expected to be exacerbated under climate change
26. Are biological thresholds exceeded for this species ?				**No** **Don't know** **Yes = Very Vulnerable**	
Total score	**2.1**	**2.3**	**2.7**	**Average Confidence**	
Very Vulnerable	**2.7**				

APPENDIX III: COPING STRATEGIES

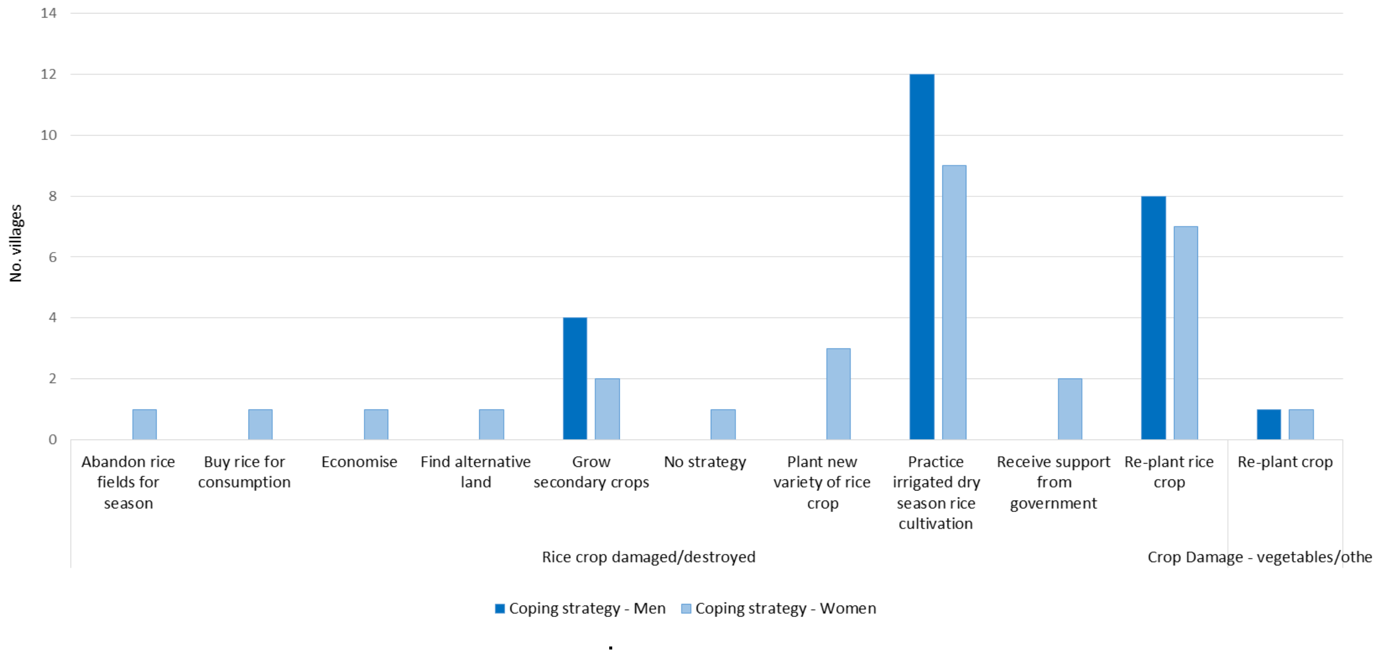


Figure a. *Current coping strategies for flood impacts associated with cropping (men & women)*

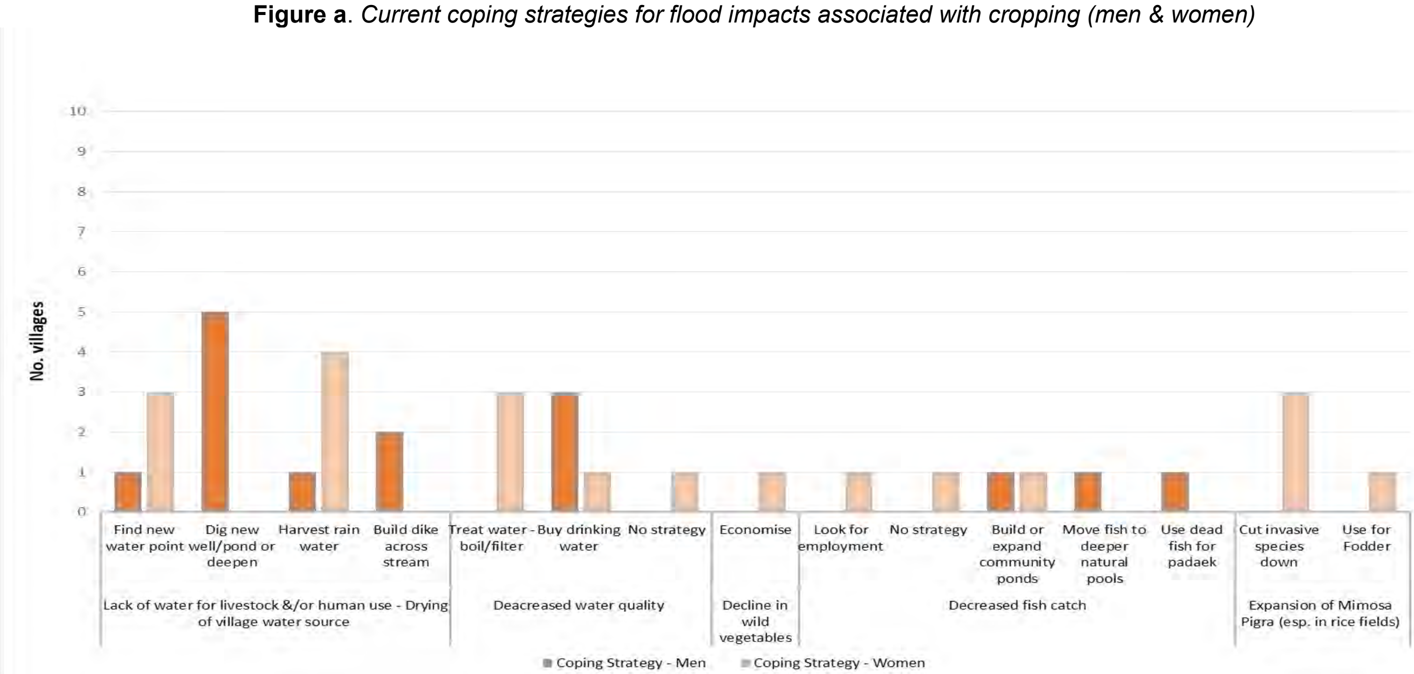


Figure b. *Current coping strategies for drought impacts associated with cropping (men & women)*

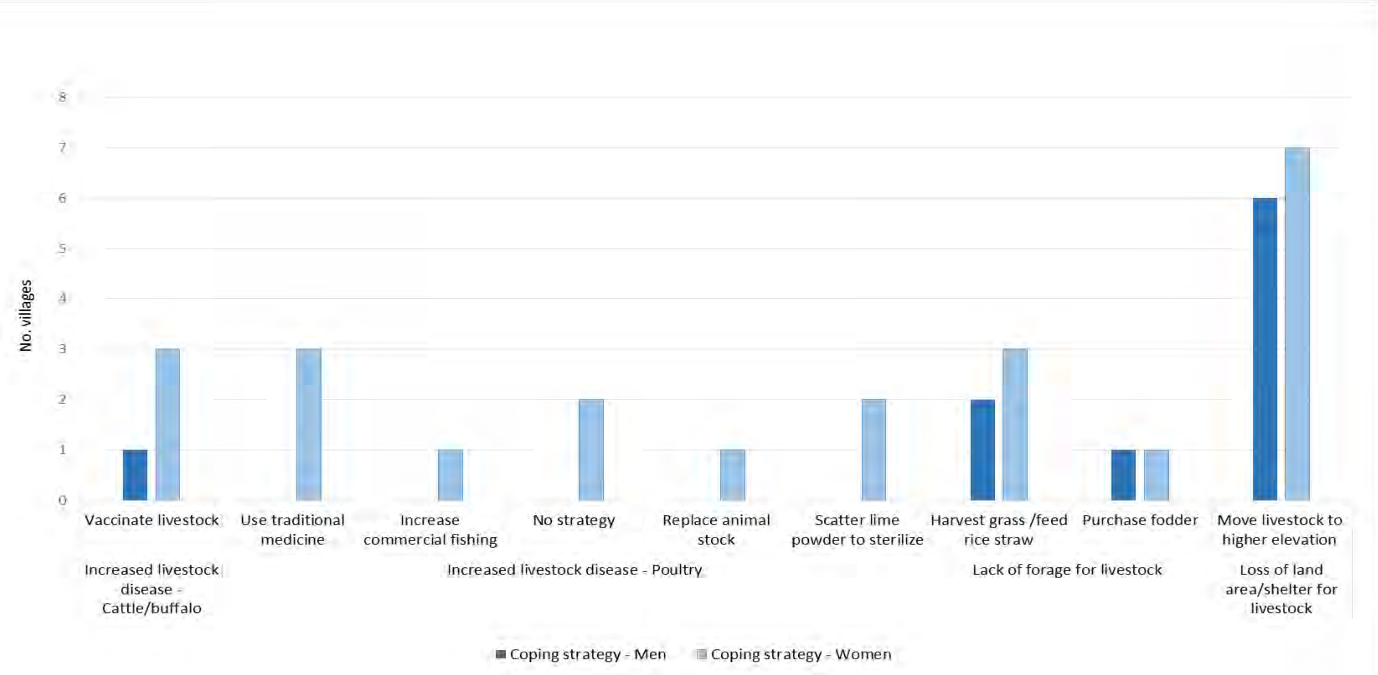


Figure c. *Current coping strategies for flood impacts associated with livestock (men & women)*

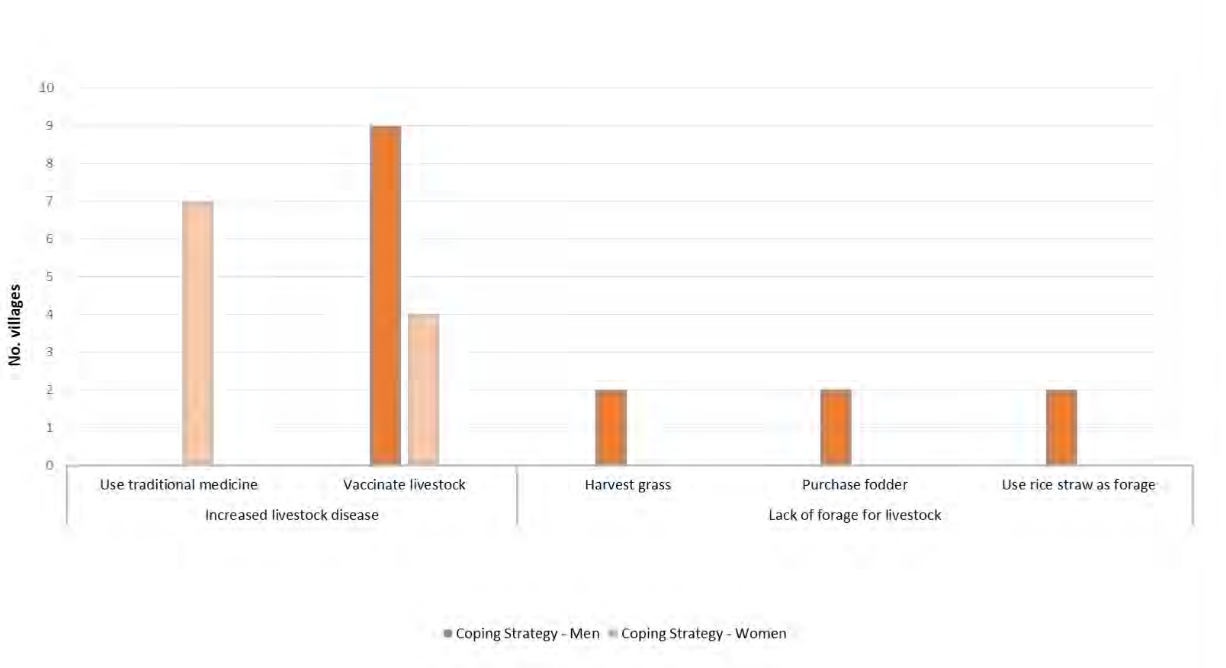


Figure d. *Current coping strategies for flood impacts associated with livestock (men & women)*

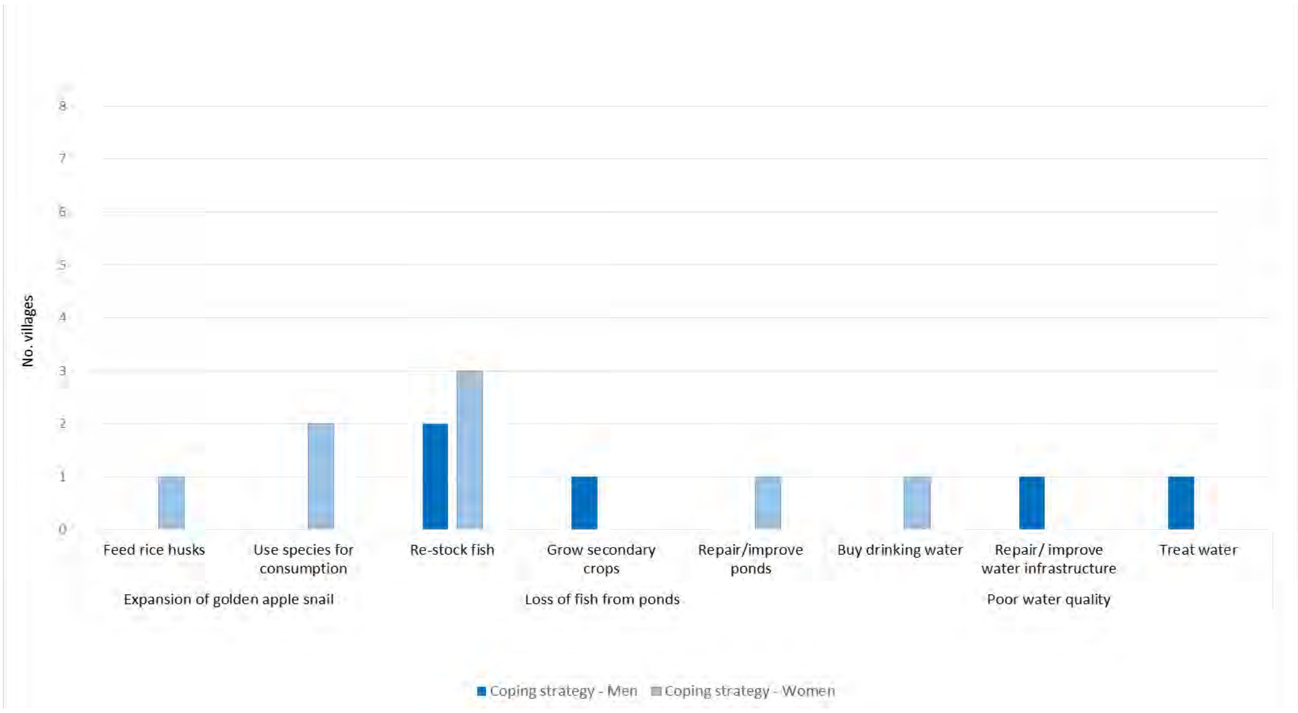


Figure e. *Current coping strategies for flood impacts associated with resources & invasive species (men & women)*

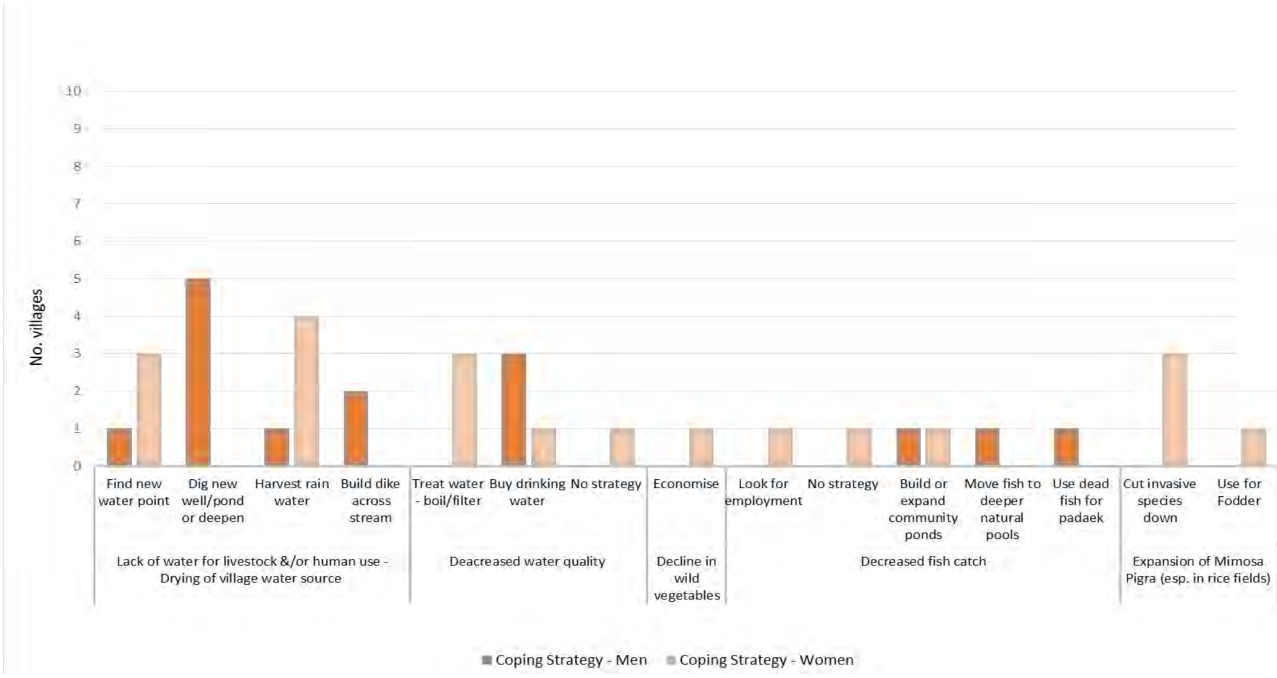


Figure f. *Current coping strategies for drought impacts associated with resources & invasive species (men & women)*

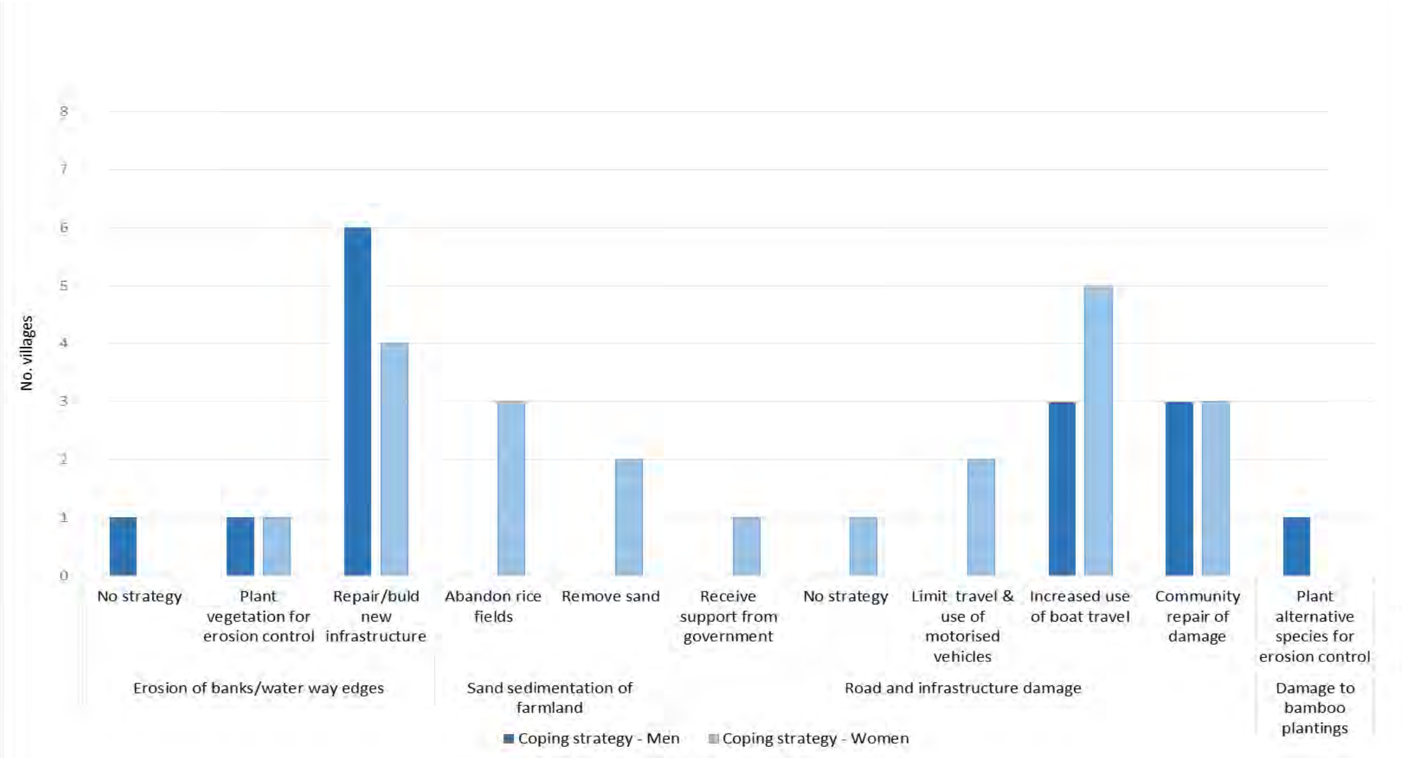


Figure g. *Current coping strategies for flood impacts associated with erosion/sedimentation or infrastructure (men & women)*

APPENDIX IV: CURRENT WETLAND MANAGEMENT AND FUTURE RECOMMENDATIONS FOR COMMUNITY MANAGEMENT

Village	Resource / Issue	Current management	Future recommendations
Ban Houamoung	Fish Water/ Erosion control	• Fish conservation zone (FCZ) in Bak Reservoir • Village Authority monitor water levels and report high levels at causeway/weir to DAFO Irrigation Unit to open water gate to XCP • After flooding villagers/fish conservation team monitor the dyke for erosion and repair	• Restrict fishing in conservation zones during drought.
Dondaeng	Fish Wildlife Forest resources	• Use of guns prohibited (wildlife hunting) • Other villages prohibited from collecting wild products in Dondaeng's bamboo forest. • One section of Talung Reservoir is under private concession to remove floating vegetation mats and fishing rights. Villagers are not allowed to fish here.	• Establish a fish conservation zone at Fai Talung reservoir (reported there was a previous FCZ).
Dong meuang	Fish Forest resources	• FCZ established in Ang Soui Reservoir, by several surrounding villages, but Dongmeaung not involved in management. • Dong Ling (Sacred monkey forest) – prohibited hunting and collection of other forest resources (mushrooms, vegetables permitted)	• Improved regulations for protection of fish when spawning, old regulations are insufficient and need updating.
Donyeng	Fish	• Three villages, Ban Donyeng, Phonthong and Sakhounue manage FCZ in Ang Soui, and together monitor (night/day) for illegal fishing and report to village police/guard to enforce fines.	• Restrict fishing in FCZ during drought. • Expand FCZ & continue monitoring/ enforcement to ensure regulations are widely known by outside fishermen.
Kadan	Crocodile	• Crocodile conservation zone and regulation, set up among communities. • Monitoring both night and day time in Kout Xe Lat Kadan oxbow lake. • FCZ in Xe Champhone for deep pool protection recently established under CAWA project	• Expand Crocodile conservation zone, Improve signage, and update regulation on water use • Restrict access/water extraction during drought period
Kaengkok Dong	Fish Forest trees & forest products	• Fish/aquatic animals protected in 4 wetlands of the village; Nongdern open-wetland, designated as FCZ in 2017; Nongkan wetland is a crocodile conservation area; Nongmaehang (oxbow) and Nong Puta (oxbow) are sacred wetlands where harvesting of animals is prohibited. • Cutting trees or damaging forest prohibited around conservation zones.	• Continue using same regulations, considered effective. • Harvest of bamboo shoots, mushroom, crickets etc. should not be restricted as only seasonally harvested for consumption and/or small income.
Laohuakham	Fish Bamboo shoots Flood control	• An FCZ is located in Vang-peauy (open wetland) located adjacent to Pha jiew Reservoir, established in 2016 with regulations for enforcement. The FCZ is monitored by village militia around 2-3 times a week. No fishing by hooks or net is permitted in FCZ, or only during every 2 year harvest. • No over harvesting of bamboo shoots	• Regulations on fishing during fish breeding/spawning period. Otherwise villagers would like to continue use old regulations as believe effective for their village.

Laonard		• Initial FCZ was established in Ang Makmee in 2013-14, and an additional 6 Ha zone established in 2017 by LNMC (sign board not yet posted but regulations available). Fishing is prohibited in the FCZs, 2 yearly harvest permitted. • Regulations exist against cutting trees in nearby forest conservation areas.	• Villagers would like to maintain the same regulations in the future • New dyke or spillway at Kout-Peng to reduce runoff to rice field and Ang Makmee Reservoir.
Nakhathang	Wildlife Forest resources Fish	• Village spiritual forest – prohibited hunting & restricted collection of resources such bamboo shoots • Nonglom oxbow has a FCZ and regulations established in 2014 by CCAI project. • Outside these areas there is no specific management for frogs, snails, bamboo, eels, mushrooms, crabs, crickets, although some restriction on tadpole harvesting in drought.	• Continue using same regulations
Nonsithan	Fish	• Ban Nonsithan and Phaleng, recently became involved in management of Bak Reservoir FCZ, previously only Ban Hoamoung. • Nongmaleng Lake managed between Nonsithan and Ban Kengpoun with alternate fishing years and restricted to use of local fishing gear.	• Prohibition of fishing in conservation zone during drought.
Phaleng	Fish	• Establishment of FCZ in Bak Reservoir discussed in 2017, it's now under the process of finalization. • Besides fish, other species listed are not protected by means of legislation, rather they are just harvested seasonally.	• Continue using same regulations
Sakhounue-tai	Fish	• FCZ in Soui is managed, between three villages, Ban Donyeng, Phonthong and Sakhounue. Monitoring undertaken and illegal fishing reported to village police/guard to enforce.	• Revise and update old regulations • Improve FCZ signage/ boundary posts. • Increase restrictions during drought • Expand FCZ and continue monitoring/ enforcement to ensure regulations are widely known by outside fishermen.
Taleo-Phonkhor	Crocodile Fish	• Crocodile Conservation Zone (CCZ) and village conservation team is established. Regulations were agreed among local communities and equipment provided in both villages. • Sign boards with information/mapping are installed onsite. • FCZ in Kout khan oxbow recently established under CAWA project	• Continue to enforce CCZ regulations and monitoring at Kout Khan during drought and Flooding. • Maintain sign boards twice a year.
Tansoum	Crocodile Fish	• 2 CCZs established in Kout Makpheo/ Pheenoi oxbows. Regulation agree among community and approved by Champhone district governor. • Information signage is in place and village conservation team monitors habitat change, species etc. • Two FCZs in Phai Jiew Reservoir, managed by village authority & monitors water level/erosion reporting to DAFO.	• Restrict fishing in FCZ during drought. • Expand FCZ and continue monitoring/enforcement to ensure regulations are widely known by outside fishermen.

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