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Resilience on the Mekong:

A Vulnerability and Adaptation Assessment in North-East Cambodia

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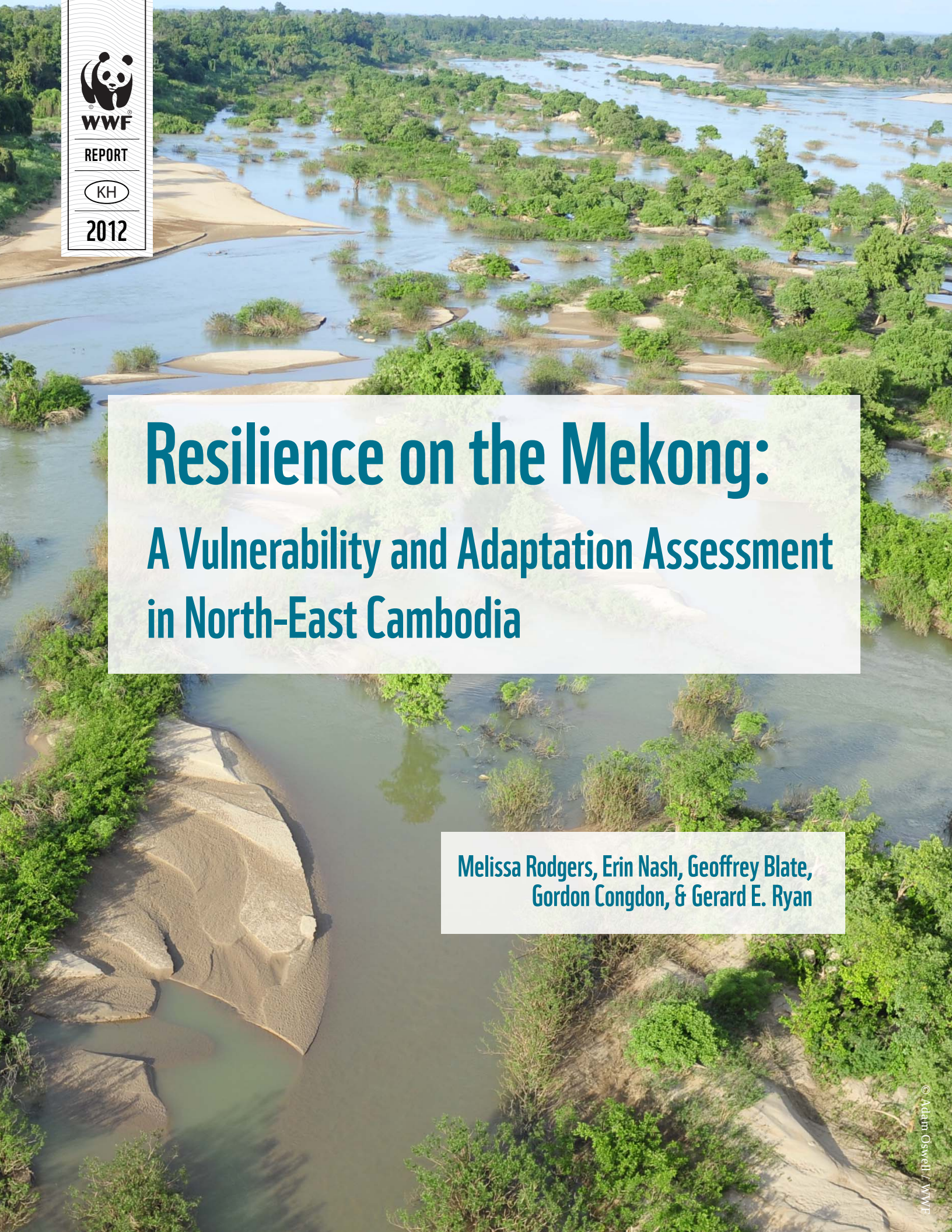

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Executive Summary

Climate change has wide-ranging and complex impacts on environmental systems and the communities that depend on them. Ecosystem-based adaptation is a means to help people adapt to climate change and other threats using ecosystems and biodiversity. Ecosystem-based adaptation is efficient at directly addressing some environmental consequences of climate change, it is cost-efficient compared with large infrastructure alternatives, and it maintains the provision of clean water, air, wild fisheries, and other ecosystem services on which we all depend. Here we report on a vulnerability and adaptation assessment focussed on a 56 linear-kilometre stretch of the Mekong River between Stung Treng and Kratie in North-East Cambodia - the "Mekong Flooded Forest".

This report summarizes an assessment of the combined impacts of climate change and non-climatic threats on communities and the ecosystem components on which they depend within the Mekong Flooded Forest. The assessment included a literature review, consultations with communities, and consultation with experts with deep experience in and knowledge of the Mekong Flooded Forest.

The communities in the Mekong Flooded Forest heavily depend on the local environment for subsistence and their livelihoods. WWF believes that measures to respond to climate change should not only increase a community's ability to adapt to changes in the climate but also maintain and, ideally, enhance ecosystem resilience. To develop such measures, it is important to understand the full range of threats facing the system – not only those posed by climate change – but also the various ways communities depend on the natural ecosystems in which they live. During consultations, communities were asked to rank the environmental assets on which they depend, so that we could understand the importance of these assets.

Villagers tended to nominate a similar pool of key environmental assets - forest, river, NTFPs, fish and farm land - which reflect the primarily subsistence lifestyles of these communities. Communities were also asked to detail the key threats they are facing. These included proposed construction of hydropower dams, economic land concessions, illegal deforestation, illegal fishing, over-exploitation of mineral resources and exploitation of wildlife.

Communities were also asked about their knowledge and experience of extreme weather events, as these are expected to be exacerbated under climate change scenarios. **All communities surveyed have experienced extreme drought and flood events**. Other weather-related anomalies experienced by communities were: extended dry season, increased temperatures, increased storm activity, extended wet season, unpredictable weather, and increased lightning. Villagers were asked about trends in the frequency and impact of extreme events, such as drought and flooding. However, there was **no coherent trend in the frequency or impact of extreme events reported over the past 20 years**.

To reflect the communities' reliance on different parts of the environment, the study site was broken down into ecosystem components to assess the vulnerability of each ecosystem to a range of climate change and other threats. **These ecosystem components - flooded forest, riparian forest, terrestrial forest, deep pools, river channels, rapids and rocky outcrops, and sand formations - were assessed individually**, and used as the basis for understanding vulnerability of the landscape and the communities dependent on it.

All ecosystem components were ranked as vulnerable overall, except for riparian and terrestrial forests which were both ranked as highly vulnerable. All of these ecosystem components were considered to be extremely vulnerable to the proposed Sambor Dam and the majority of ecosystem components were considered highly vulnerable to other proposed hydropower development upstream from the Mekong Flooded Forest. If the Sambor Dam is built, almost all of the study area would be inundated and the environmental and socio-economic values of these natural ecosystems would be greatly reduced or completely lost.

A majority of threats common to ecosystem components across the Mekong Flooded Forest are related to land and natural resource management issues – clearing, logging, burning, unsustainable fishing and hunting, and mining. Climate change is expected to exacerbate these threats – namely that the impacts of droughts, floods and changes in rainfall and temperature patterns will reduce groundwater retention and the absence of physical ecological barriers will exacerbate the impacts of extreme weather events.

As the population in the study area increases, the impacts of anthropogenic threats will continue to degrade the Mekong Flooded Forest unless effective management actions are taken. Furthermore, climate change projections point to an exacerbation of current non-climatic threats. Therefore, **we have developed a range of adaptation strategies to reduce vulnerability, by either reducing exposure or sensitivity to threats, by enhancing the adaptive capacity of the community or ecosystem, or by increasing the ability of communities to use the environment sustainably whilst maintaining or enhancing existing ecosystem structure**.

This assessment identified 4 key strategies:

- **Improve governance and natural resource management at the site,**
- **Improve land-use planning in and around the site,**
- **Raise the profile of the site and improve understanding of its value, and**
- **Address the threat from hydropower.**

Adaptation actions were coarsely prioritized according to cost and impact, such that high priorities had little cost and a broad impact, whereas lower priorities were more expensive and of localized or reduced impact. This rank will not perfectly reflect the priority of all actions relative to other conservation or development priorities.

Improvement of natural resource management in the area – and the many and varied actions that this implies – **is likely to be the most effective strategy to maintain communities and ecosystems in the future while reducing vulnerability to threats**. Additionally, strategic land-use planning, which balances conservation and development, will maintain the inherent adaptability of the ecosystem and reduce vulnerability. In particular, the riparian zones should be the focus for strategic protection in the Mekong Flooded Forest. The actions, priority levels, and means of reducing vulnerability though this strategy are detailed below in Table I, based on the more comprehensive Table 12, in the main text.

Table I. Adaptation options to improve governance and natural resource management at the site, ordered by priority level.

Action	Priority	How the action will reduce vulnerability
Enhance riparian buffers	High	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climate threats • Reduce erosion • Maintain fisheries
Develop payments for environmental services for biodiversity conservation schemes	High	• Provide financial incentive to maintain ecosystem services that maintain resilience • Improve ability of ecosystems to cope with climate and non-climate threats
Protect and restore forest	Medium	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climate threats • Reduce erosion • Increased forest cover may reduce the impact of rising temperatures • Stabilise landscape and retain topsoil • Provide sustainable resources (NTFPs, some timber)
Investigate alternative conservation and management initiatives	Medium	• Improve ability of ecosystems to cope with climate and non-climate threats
Improve community awareness of environmental protection	Medium	• Improved community and stakeholder understanding of climate change
Target enforcement	Medium	• Improved law enforcement • Community, government and stakeholder engagement in law enforcement • Improved sustainability of resource use
Improve fishery regulations	Medium	• Improve sustainability of fishery resources • Improve environments on which fisheries resources depend • Improved enforcement of regulations • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of fisheries to cope with climate and non-climate threats
Protect the river from mining	Medium	• Improved water quality • Decreased contaminant run-off • Decreased incidental degradation (burning, hunting, fishing, logging, clearing)
Promote fishery sustainability	Medium	• Improve sustainability of fishery resources • Improve environments on which fisheries resources depend • Improved enforcement of regulations • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of fisheries to cope with climate and non-climate threats

Strategic land use planning will also enhance the ability of planners and other stakeholder groups engaged in the planning process to plan and act under climate change as well as support the implementation of decisions that enhance communities and ecosystem. We describe these actions, priority levels, and means of reducing vulnerability here in Table II, based on the more detailed Table 13, found in the main text.

Table II. Adaptation options to improve land-use planning in and around the site, ordered by priority level.

Action	Priority	How the action will reduce vulnerability
Designate the Mekong Flooded Forest a 'special management site'	High	• Raise awareness of the importance of Mekong Flooded Forest and the biodiversity values and communities it supports • Improve management and sustainability of natural resource use • Retain ecosystem services at the site
Promote integrated planning	High	• Community, government and stakeholder engagement in land-use planning • Retain ecosystem services at the site
Apply appropriate zoning to balance conservation and development	High	• Protect essential habitat for many aquatic and terrestrial species • Improve ability of ecosystems and communities to cope with climate and non-climate threats • Community, government and stakeholder engagement in land-use planning • Retain ecosystem services
Develop appropriate road networks	High	• Retain riparian buffers • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climate threats • Reduce erosion
Protect riparian buffers	High	• Mitigate the impacts of changes in hydrology and increased river flow • Increased groundwater retention • Enhance physical buffers to extreme weather events • Reduced erosion
Restore degraded habitat	High	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climate threats • Reduce erosion • Increased forest cover may reduce the impact of rising temperatures
Integrate climate change into planning	High	• Improve ability of ecosystems and communities to cope with climate and non-climate threats • Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Reduce erosion

Action	Priority	How the action will reduce vulnerability
Offer incentives to complement planning	Medium	• Improve ability of ecosystems and communities to cope with climate and non-climate threats • Manage threat of increased population pressure on the environment • Generate sustainable income
Improve regulations	Medium	• Improve sustainability of resource management • Improved enforcement of regulations • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems and communities to cope with climate and non-climate threats • Manage threat of increased population pressure on the environment

Raising the profile of the Mekong Flooded Forest both nationally and locally is expected to provide impetus for improving the management of the area and significantly smooth the way for those actions that may appear to be in conflict with short-term economic benefit. **The Mekong Flooded Forest is important socio-economically for the value of the ecosystems to provide necessary services to communities, and because of its biodiversity significance; both of these should be considered in raising the profile of the area**. This strategy should raise the profile of the Mekong Flooded Forest nationally, whilst promoting the idea of improving the management locally. We describe this strategy in more Table III, below, and the more detailed Table 14 in the main text.

Table III. Adaptation options to raise the profile of the Mekong Flooded Forest, ordered by priority level.

Action	Priority	How the action will reduce vulnerability
Dialogue with government	High	• Improved management of natural resources at the site
Advocate against land concessions in the Mekong Flooded Forest	High	• Retain ecosystem services in the site • Retain sustainable natural resource uses
Dialogue with community	Medium	• Community engagement in future planning for the Mekong Flooded Forest • Grassroots impetus to retain the values of the site

The proposed Sambor Dam is considered a key threat, with all ecosystems considered highly or extremely vulnerable, by local communities and experts alike; the dam threatens all ecosystem services, livelihoods and biodiversity values of the site. The proposed dam would alter the site beyond recognition and reduce or obviate virtually all benefits the site now provides. Addressing the threat from hydropower, and in particular the Sambor Dam, is critical to reducing this looming threat to vulnerability. We describe the proposed actions for this strategy in Table IV, below, and later in Table 15.

These adaptation strategies will be shared with local government and communities in the site. We will aim **to identify and discuss gaps and barriers to implementation of these adaptation strategies, and work with local communities, and local and higher institutional governance structures to integrate these strategies into planning and management processes** - and seek to minimize vulnerability to climate change and other

threats, both in the site directly, and with luck, more broadly. These strategies will also inform WWF organizational strategic policy development.

Table IV. Adaptation actions that address the threat from hydropower development, ordered by priority level.

Action	Priority	How the action will reduce vulnerability
Develop advocacy strategy	High	• Influence decision making • Bring attention to the plight and vulnerability of local communities and ecosystems to policy and stakeholders • Retain the biodiversity and socio-economic values of the site
Investigate alternative energy sources	High	• Bring cost effective, ecosystem-harmonious alternatives to the discussion table • Reduce reliance on unsustainable natural resource use
Support a strategic approach to development	High	• Improve long-term sustainable management of ecosystems • Strengthen risk analysis and benefit sharing • Maintain ecosystem services at the basin level, while encouraging development opportunities with minimal degradation
Re-plant riparian buffers	Medium	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climatic threats • Reduce erosion

សេចក្តីសង្ខេប

ការប្រែប្រួលអាកាសធាតុគ្របដណ្តប់លើវិសាលភាពនៃទឹកន្លែងដ៏ធំទូលាយ និងបង្កផលប៉ះពាល់យ៉ាងស្មុគស្មាញទៅលើប្រព័ន្ធបរិស្ថាន និងសហគមន៍ដែលពឹងអាស្រ័យលើប្រពន្ធ័នេះ។ ដោយប្រើប្រាស់ប្រព័ន្ធអេកូឡូស៊ី និងជីវចម្រុះ ការបន្សាំដោយពឹងអាស្រ័យទៅលើប្រព័ន្ធអេកូឡូស៊ី គឺជាមធ្យោបាយមួយជួយដល់មនុស្សក្នុងការបន្សាំទៅនឹងការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងផ្សេងៗទៀត។ ការបន្សាំដោយពឹងអាស្រ័យទៅលើប្រព័ន្ធអេកូឡូស៊ីមានប្រសិទ្ធភាពដោយផ្នាល់ក្នុងការដោះស្រាយផលលំបាកមួយចំនួនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ។ វិធីនេះមានការសន្សំសំចៃខ្ពស់ធៀបទៅនឹងជម្រើសនៃការសាងសង់ហេដ្ឋារចនាសម្ព័ន្ធខ្នាតធំៗ ហើយរក្សាបាននូវការផ្តល់ទឹកស្អាត ខ្យល់បរិសុទ្ធ ធនធានជលផលនៅក្នុងធម្មជាតិ និងសេវាកម្មប្រព័ន្ធអេកូឡូស៊ីផ្សេងទៀតដែលយើងទាំងអស់គ្នាពឹងផ្អែកលើ។ របាយការណ៍នេះបង្ហាញពីការវាយតម្លៃលើភាពងាយរងគ្រោះ និងការបន្សាំទៅនឹងការប្រែប្រួលអាកាសធាតុដោយផ្តោតទៅលើតំបន់នៅតាមបណ្តោយទន្លេមេគង្គ ចន្លោះទីរួមខេត្តក្រចេះ និងខេត្តស្ទឹងត្រែង ដែលមានចម្ងាយ ៥៦គីឡូម៉ែត្រ នាប៉ែកខ្លាសាននៃប្រទេសកម្ពុជាដែលតំបន់នេះត្រូវបានឲ្យឈ្មោះថា "ព្រៃលិចទឹកទន្លេមេគង្គ"។

របាយការណ៍នេះ សង្ខេបពីការវាយតម្លៃរួមលើផលប៉ះពាល់បង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ ទៅលើសហគមន៍ និងបណ្តុំប្រព័ន្ធអេកូឡូស៊ីនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ ដែលសហគមន៍ពឹងអាស្រ័យលើ។ ការវាយតម្លៃនេះមានរាប់បញ្ចូលនូវ៖ ការពិនិត្យមើលឯកសារមូលដ្ឋានពាក់ពន្ធ ការពិគ្រោះយោបល់ជាមួយសហគមន៍ និងការពិគ្រោះយោបល់ជាមួយអ្នកជំនាញដែលមានបទពិសោធន៍ខ្ពស់ និងមានការយល់ដឹងច្រើនអំពីតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។

សហគមន៍នៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ ពឹងអាស្រ័យទាំងស្រុងទៅលើបរិស្ថានក្នុងតំបន់របស់ខ្លួនសម្រាប់ប្រកបរបរចិញ្ចឹមជីវិត។ អង្គការ WWF ជឿជាក់ថា វិធានការណ៍ឆ្លើយតបទៅនឹងការប្រែប្រួលអាកាសធាតុ មិនគួរផ្តោតតែទៅលើការបង្កើនសមត្ថភាពយល់ដឹងរបស់សហគមន៍អំពីការបន្សាំទៅនឹងការប្រែប្រួលអាកាសធាតុប៉ុណ្ណោះទេ ប៉ុន្តែចាំបាច់ត្រូវថែរក្សាប្រព័ន្ធអេកូឡូស៊ីឲ្យបានល្អ។ ដើម្បីបង្កើតវិធានការណ៍បែបនេះ ការស្វែងយល់ឲ្យបានស៊ីជម្រៅទៅលើការគំរាមកំហែងគ្រប់ប្រភេទដែលប្រពន្ធ័អេកូឡូស៊ីកំពុងប្រឈម គឺជាប្រការសំខាន់។ ការស្វែងយល់នេះមិនត្រូវផ្តោតតែទៅលើការកំហែង ដែលបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែង ដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុប៉ុណ្ណោះទេ ប៉ុន្តែត្រូវផ្តោតទៅលើប្រភេទមុខរបរចញ្ចឹមជីវិត ដែលសហគមន៍អាចបង្កើតបានដោយពឹងអាស្រ័យទៅលើប្រពន្ធ័អេកូឡូស៊ីធម្មជាតិដែលប្រជាជននៃសហគមន៍ទាំងនោះកំពុងរស់នៅជាមួយ។ ពេលពិគ្រោះ

យោបល់ សហគមន៍ត្រូវបានសុំឲ្យធ្វើការចាត់ថ្នាក់ធនធាន ដែលខ្លួនពឹងអាស្រ័យលើដើម្បីអាចឲ្យពួកគាត់យល់ដឹងអំពីសារៈសំខាន់នៃធនធានទាំងនេះ។

អ្នកភូមិមានបំណងចងក្រងធនធានបរិស្ថានសំខាន់ៗរបស់ខ្លួនជាក្រុម ដូចជា៖ ព្រៃ ទន្លេ អនុផលព្រៃឈើ ត្រី និងដីចំការ ដែលប្រភេទធនធានទាំងនេះបង្ហាញពីរបៀបរស់នៅមជីវិតដ៏សំខាន់របស់ពួកគាត់។ សហគមន៍ក៏ត្រូវបានសួរលម្អិតអំពីការគំរាមកំហែងចម្បងៗ ដែលពួកគាត់កំពុងតែប្រឈម។ កត្តាគំរាមកំហែងនោះមានរាប់បញ្ចូលនូវ៖ គម្រោងសាងសង់ទំនប់វារីអគ្គីសនី ដីសម្បទានសេដ្ឋកិច្ច ការកាប់ព្រៃឈើ និងការនេសាទខុសច្បាប់ អាជីវកម្មធនធានរ៉ែលើសចំណុះ និងអាជីវកម្មសត្វព្រៃជាដើម។

សហគមន៍ក៏ត្រូវបានសួរអំពីការយល់ដឹង និងបទពិសោធន៍ពាក់ព័ន្ធទៅនឹងព្រឹត្តិការណ៍អាកាសធាតុដ៏អាក្រក់ៗ ព្រោះគេរំពឹងថា ព្រឹត្តិការណ៍ទាំងនេះវិវឌ្ឍន៍កាន់តែអាក្រក់ៗ ក្រោមសេនារីយ៉ូនការប្រែប្រួលអាកាសធាតុ។ **សហគមន៍ទាំងអស់ ដែលបានសាកសួរធ្លាប់ជួបប្រទះទៅនឹងព្រឹត្តិការណ៍រាំងស្ងួត និងទឹកជំនន់។** ភាពមិនប្រក្រតីផ្សេងៗទៀតពាក់ព័ន្ធទៅនឹងអាកាសធាតុ ដែលសហគមន៍ធ្លាប់ជួបប្រទះ រួមមាន៖ ភាពអូសបន្លាយនៃរដូវប្រាំង ការកើនឡើងនៃសីតុណ្ហភាព ការកើនឡើងនូវសកម្មភាពព្យុះ ភាពអូសបន្លាយនៃរដូវភ្លៀង ការមិនអាចព្យាករណ៍បានលើអាកាសធាតុ និងការកើនឡើងនូវចំនួនរន្ទះបាញ់។ អ្នកភូមិត្រូវបានសួរអំពីទំនោរនៃការកើតឡើងជាញឹកញាប់ និងផលប៉ះពាល់នៃព្រឹត្តការណ៍ទាំងនោះ ដូចជា៖ ភាពរាំងស្ងួត និងទឹកជំនន់។ ផ្ទុយទៅវិញ ក្នុងរយៈពេលជាង ២០ ឆ្នាំកន្លងមកនេះ ទំនោរនៃការកើតឡើងជាញឹកញាប់ និងផលប៉ះពាល់នៃព្រឹត្តិការណ៍ខាងលើមិនដែលកើតមានឡើយ។

ដើម្បីបង្ហាញពីការពឹងអាស្រ័យរបស់សហគមន៍ទៅលើប្រភេទផ្សេងៗគ្នានៃធនធានបរិស្ថាន តំបន់សិក្សាស្រាវជ្រាវត្រូវបានបែងចែកទៅតាមបណ្តុំប្រព័ន្ធអេកូឡូស៊ី ក្នុងគោលបំណងវាយតម្លៃអំពីភាពងាយរងគ្រោះនៃប្រព័ន្ធអេកូឡូស៊ីនីមួយៗ ទៅតាមចំណាត់ថ្នាក់នៃការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងផ្សេងៗទៀត។ **បណ្តុំនៃប្រព័ន្ធអេកូឡូស៊ីទាំងនេះ ដែលមានរាប់បញ្ចូលនូវ៖ ព្រៃលិចទឹក ព្រៃតាមមាត់ទន្លេ ព្រៃដីគោក អន្លង់ទឹកជ្រៅៗ ចរន្តទឹកទន្លេ (ចរន្តទឹកមេ) ទឹកជូរ ថ្មប៉ប្រះទឹក និងស្រទាប់ដីខ្សាច់ ត្រូវបានវាយតម្លៃដាច់ដោយឡែកពីគ្នា** និងត្រូវបានប្រើជាមូលដ្ឋានសម្រាប់ស្វែងយល់ពីភាពងាយរងគ្រោះលើតំបន់ទេសភាព និងការពឹងផ្អែករបស់សហគមន៍ទៅលើបណ្តុំនៃប្រព័ន្ធអេកូឡូស៊ីទាំងនេះ។

គ្រប់បណ្តុំប្រព័ន្ធអេកូឡូស៊ីដែលបានលើកឡើង ត្រូវបានចាត់ថ្នាក់ជារួមក្នុងស្ថានភាពងាយរងគ្រោះលើកលែងតែព្រៃតាមមាត់ទន្លេ និងព្រៃដីគោក ដែលព្រៃទាំងពីរប្រភេទនេះត្រូវបានចាត់ថ្នាក់ជាប្រភេទងាយរងគ្រោះបំផុត។ ទំនប់វារីអគ្គីសនីនៅស្រុកសំបូរ ដែលបានដាក់ស្នើសុំសាងសង់នឹងធ្វើឲ្យបណ្តុំប្រព័ន្ធអេកូឡូស៊ី ដែលបានលើកឡើងខាងលើស្ថិតក្នុងស្ថានភាពងាយគ្រោះដ៏ធ្ងន់ធ្ងរ

ហើយគម្រោងអភិវឌ្ឍន៍ទំនប់វារីអគ្គីសនីផ្សេងៗទៀត ដែលបានស្នើសុំសាងសង់តាមបណ្តោយនៅខាងលើតំបន់ព្រៃលិចទឹកទឹកទន្លេមេគង្គ នឹងធ្វើឲ្យភាគច្រើននៃបណ្តុំប្រព័ន្ធអេកូឡូស៊ីស្ថិតនៅក្នុងស្ថានភាពងាយរងគ្រោះខ្ពស់បំផុត។ ប្រសិនបើទំនប់វារីអគ្គីសនីនៅស្រុកសំបូរត្រូវបានសាងសង់ ទីតាំងតំបន់សិក្សាស្រាវជ្រាវស្ទើរតែទាំងឯស់នឹងត្រូវលិចលង់ ហើយតម្លៃសេដ្ឋកិច្ចសង្គម និងបរិស្ថានរបស់ប្រព័ន្ធអេកូឡូស៊ីធម្មជាតិដែលបានលើកឡើង នឹងត្រូវបាត់បង់ដ៏ធំសម្បើម ឬក៏បាត់បង់ទាំងស្រុងតែម្តង។

ភាគច្រើននៃការគំរាមកំហែង កើតមានជាធម្មតាចំពោះបណ្តុំប្រព័ន្ធអេកូឡូស៊ីនៅតំបន់ព្រៃលិចទឹកទន្លេមេគង្គគឺពាក់ព័ន្ធទៅនឹងបញ្ហាគ្រប់គ្រងធនធាន និងដីធ្លី រួមមាន៖ ការកាប់ឆ្ការ ការកាប់ព្រៃ ការដុតភ្លើង ការនេសាទមិនមាននិរន្តរភាព ការបរបាញ់ និងការជីកយ៉ែ។ គេគិតថា ការប្រែប្រួលអាកាសធាតុកាន់តែធ្វើឲ្យការគំរាមកំហែងកាន់តែធ្ងន់ធ្ងរឡើង ព្រោះផលប៉ះពាល់នៃភាពរាំងស្ងួត ទឹកជំនន់ និងបម្រែបម្រួលរបបទឹកភ្លៀង និងសីតុណ្ហភាពតាមរដូវកាលនឹងកាត់បន្ថយការរក្សាទុកទឹកក្រោមដី ហើយការបាត់បង់នូវរបាំងអេកូឡូស៊ីនឹងធ្វើឲ្យព្រឹត្តិការប្រែប្រួលអាកាសធាតុដ៏អាក្រក់កាន់តែធ្ងន់ធ្ងរឡើង។

ប្រសិនសកម្មភាពគ្រប់គ្រងដ៏មានប្រសិទ្ធភាពមិនត្រូវបានបំពេញនោះទេ ផលប៉ះពាល់នៃការគំរាមកំហែងពីសកម្មភាពមនុស្ស នឹងបន្តបំផ្លិចបំផ្លាញតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ ព្រោះចំនួនប្រជាជននៅតំបន់សិក្សាស្រាវជ្រាវកាន់តែកើនឡើង។ ម្យ៉ាងវិញទៀត ការព្យាករណ៍ពីការប្រែប្រួលអាកាសធាតុ បង្ហាញពីការកើនឡើងនូវការគំរាមកំហែង ដែលមិនមែនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ។

ឆ្លើយតបទៅនឹងការគំរាមកំហែងនេះ យើងបានបង្កើតយុទ្ធសាស្ត្របន្សាំដើម្បីកាត់បន្ថយភាពងាយរងគ្រោះ ដោយកាត់បន្ថយទាំងការរាលដាល ឬក៏ការប៉ះពាល់ដោយផ្ទាល់ បង្កឡើងដោយការគំរាមកំហែង ដោយពង្រឹងសមត្ថភាពបន្សាំរបស់សហគមន៍ ឬក៏ពង្រឹងប្រព័ន្ធអេកូឡូស៊ី ឬក៏ដោយបង្កើនលទ្ធភាពរបស់សហគមន៍ក្នុងការប្រើប្រាស់បរិស្ថានប្រកបដោយនិរន្តរភាព ជាមួយគ្នានេះដែរត្រូវលើកកម្ពស់ ឬរក្សាឲ្យបាននូវរចនាសម្ព័ន្ធប្រព័ន្ធអេកូឡូស៊ីដែលមានស្រាប់។

ការវាយតម្លៃ កំណត់បានយុទ្ធសាស្ត្រសំខាន់ៗចំនួន ៤ដូចខាងក្រោម៖

- **ធ្វើឲ្យប្រសើរឡើងនូវអភិបាលកិច្ច និងការគ្រប់គ្រងធនធានធម្មជាតិនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ**
- **ធ្វើឲ្យប្រសើរឡើងនូវផែនការប្រើប្រាស់ដីខាងក្នុង និងនៅជុំវិញតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ**
- **ផ្សព្វផ្សាយកម្រងតម្លៃធនធាននៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ និងកែលម្អការយល់ដឹងពីតម្លៃធនធានទាំងនោះ**

- **បង្កើតដំណោះស្រាយចំពោះការគំរាមកំហែងបង្កឡើងដោយទំនប់វារីអគ្គីសនី**

អាទិភាពនៃសកម្មភាពបន្សាំ ត្រូវបានកំណត់ដោយយោងទៅលើតម្លៃ និងផលប៉ះពាល់។ រាល់អាទិភាពខ្ពស់នៃសកម្មភាពបន្សាំមានតម្លៃតិចតួច និងមានផលប៉ះពាល់ធំធេង ផ្ទុយទៅវិញអាទិភាពទាបមានតម្លៃធំធេង និងមានផលប៉ះពាល់តិចតួច។ ការធ្វើចំណាត់ថ្នាក់បែបនេះ នឹងមិនបង្ហាញឲ្យបានគ្រប់ជ្រុងជ្រោយពីអាទិភាពនៃគ្រប់សកម្មភាពពាក់ព័ន្ធទៅនឹងអាទិភាពអភិវឌ្ឍន៍ និងអភិរក្សដ៏ទៃទៀតនោះឡើយ

នៅពេលជាមួយគ្នានឹងការប្រឹងប្រែងកាត់បន្ថយភាពងាយរងគ្រោះ បង្កឡើងដោយការគំរាមកំហែង ការធ្វើឲ្យប្រសើរឡើងនូវការគ្រប់គ្រងធនធានធម្មជាតិក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ តាមរយៈសកម្មភាពផ្សេងៗជាច្រើន ដែលមានបញ្ជាក់ច្បាស់ពីខាងដើម**ទំនងជាយុទ្ធសាស្ត្រដ៏មានប្រសិទ្ធភាពបំផុតក្នុងការថែរក្សាសហគមន៍ និងប្រព័ន្ធអេកូឡូស៊ីសម្រាប់ពេលអនាគត។** ជាងនេះទៅទៀត ផែនការប្រើប្រាស់ដីធ្លី ជាយុទ្ធសាស្ត្រដែលធ្វើឲ្យការអភិវឌ្ឍន៍ និងការអភិរក្ស មានតុល្យភាព និងរក្សាបាននូវភាពបន្សាំរបស់ប្រព័ន្ធអេកូឡូស៊ី ហើយកាត់បន្ថយបាននូវភាពងាយរងគ្រោះ។ ពិសេសជាងនេះទៀត តំបន់ព្រៃតាមដងទន្លេគួរមានការផ្តោតយកចិត្តទុកដាក់លើកិច្ចការពារជាយុទ្ធសាស្ត្រសម្រាប់តំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។ សកម្មភាពកម្រិតអាទិភាព និងមធ្យោបាយផ្សេងៗសម្រាប់កាត់បន្ថយភាពងាយរងគ្រោះនៃយុទ្ធសាស្ត្រនេះមានចែងលំអិតនៅក្នុងតារាងទី១ ដោយយោងតាមការពន្យល់ក្បោះក្បាយនៅតារាងទី១៣។

តារាងទី ១. ជម្រើសនៃការបន្សាំដើម្បីកែលម្អអភិបាលកិច្ច និងការគ្រប់គ្រងធនធានធម្មជាតិនៅតំបន់លិចទឹក ទន្លេមេគង្គ ដែលបានចាត់ថ្នាក់តាមកម្រិតអាទិភាព

សកម្មភាព	ជំហានសំខាន់ៗ	អាទិភាព	តើសកម្មភាពនឹងរួមចំណែកកាត់បន្ថយភាពងាយរងគ្រោះដោយរបៀបណា?
ពង្រឹងកិច្ចការពារតំបន់ទ្រនាប់ព្រៃតាមដងទន្លេដើម្បីការពារតំបន់ស្នូល	• ការពារច្រាំងទន្លេពីការហូរច្រោះ និងពង្រឹងការអនុវត្តន៍ច្បាប់ដោយការពារតំបន់ទ្រនាប់ព្រៃតាមដងទន្លេដែលមានចំងាយ១៥០មព័ទ្ធជុំវិញដីសម្បទានសេដ្ឋកិច្ច • គ្រប់គ្រង និងលើកកំពស់តំបន់ទ្រនាប់ព្រៃតាមដងទន្លេឲ្យដូចទៅនឹងច្រករបៀងជីវចម្រុះ • ស្តារច្រាំងទន្លេដែលទទួលរងការខូច	ខ្ពស់	• ការរក្សាបាននូវបរិមាណទឹកក្រោមដី • ពង្រឹងតំបន់ទ្រនាប់ដើម្បីទប់ទល់នឹងព្រឹត្តិការណ៍អាកាសធាតុអាក្រក់ • កាត់បន្ថយផលប៉ះពាល់នៃបម្រែបម្រួលកម្រិតទឹក និងលំហូរទឹកដែលមានការកើនឡើង

	ខាតឡើងវិញ: បង្កើតកន្លែងបណ្តុះកូនឈើដើម្បីផ្គត់ផ្គង់ប្រភេទរុក្ខជាតិក្នុងស្រុក និងទាញការចូលរួមរបស់សហគមន៍ក្នុងសកម្មភាពស្តារឡើងវិញនូវច្រាំងទន្លេដែលទទួលរងការខូចខាត • សិក្សាវាយតម្លៃលើជ័យជំនះនៃការដុះឡើងវិញរបស់រុក្ខជាតិនៅក្នុងធម្មជាតិតាមរយៈការផ្តល់កូនឈើពីព្រៃការធ្វើកែលម្អរុក្ខជាតិនៅតាមច្រាំងគឺជាតម្រូវការសម្រាប់ស្តេរភាពច្រាំងទន្លេ • ការពារព្រៃតាមច្រាំងទន្លេដែលមិនទាន់ទទួលរងការខូចខាតនៅឡើយ និងស្តារឡើងវិញកន្លែងកំណត់ជាក់លាក់ដើម្បីរក្សាប្រពន្ធ័អេកូឡូស៊ី ការពារការហូរច្រោះច្រាំងទន្លេ និងផ្តល់ជាម្លប់ ជម្រក និងសោភណ្ឌភាព។		• កែលម្អលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីឲ្យអាចទប់ទល់នឹងគំរាមកំហែងផ្សេងៗ • កាត់បន្ថយការហូរច្រោះ • រក្សាបាននូវធនធានជលផល។
បង្កើតឲ្យមានការបង់ថ្លៃលើសេវាកម្មបរិស្ថានដើម្បីរួមចំណែកដល់កម្មវិធីអភិរក្សជីវចម្រុះ	• បង្កើតឲ្យមានការប្រម៉ាញ់/ការធ្វើពាណិជ្ជកម្មលើសត្វប្រកបដោយនិរន្តរភាពដោយអូសទាញអ្នកប្រមាញ់ទាំងនោះមកធ្វើជាសមាជិកក្រុមល្បាតតាមរយៈ ការអប់រំចំណេះដឹងនិងការផ្តល់ប្រាក់កម្រៃសម្រាប់ការចិញ្ចឹមជីវិត (ឧ. ការបង់កម្រៃលើការការពារសំបុកសត្វ) • ស្រាវជ្រាវលើសកម្មភាពកាប់បំផ្លាញព្រៃឈើ និងការធ្វើឲ្យព្រៃឈើបាត់បង់ដោយផ្តោតទៅលើ ព្រៃឡង់។	មធ្យម	• ផ្តល់ថវិកាលើកទឹកចិត្តសម្រាប់ការរក្សាសេវាកម្មប្រពន្ធ័អេកូឡូស៊ីដែលរក្សាបាននូវភាពបន្សុំ • កែលម្អលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងគំរាមកំហែងផ្សេងៗ។
ការពារ និងស្តារព្រៃឡើងវិញ	• ធានាឲ្យមានកិច្ចសម្របសម្រួលជាមួយរដ្ឋបាលព្រៃឈើដោយជួល RECOFTC ផ្តល់វគ្គបំពាក់បំប៉ន • ការពារព្រៃតាមច្រាំងទន្លេដែលមិនទាន់ទទួលរងការខូចខាតនៅឡើយ និងស្តារឡើងវិញកន្លែងកំណត់ជាក់លាក់ដើម្បីរក្សាប្រពន្ធ័អេកូឡូស៊ី	មធ្យម	• ការរក្សាបាននូវបរិមាណទឹកក្រោមដី • ពង្រឹងតំបន់ទ្រនាប់ដើម្បីទប់ទល់នឹងព្រឹត្តិការណ៍អាកាសធាតុអាក្រក់ • កាត់បន្ថយផលប៉ះពាល់នៃបម្រែបម្រួលកម្រិតទឹក

	ការពារការហូរច្រោះច្រាំងទន្លេ និងផ្តល់ជាម្លប់ ជម្រក និងសោភណ្ឌភាព • ផ្សព្វផ្សាយឲ្យយល់ដឹងពីអំពីសារៈសំខាន់របស់ព្រៃនៅតាមច្រាំងទន្លេ និងសេវាកម្មដែលព្រៃទាំងនេះផ្តល់ឲ្យ • បង្កើនការយកចិត្តទុកដាក់លើការការពារព្រៃនៅតាមដងទន្លេ (ពោលគឺត្រូវរក្សាបានព្រៃនៅតាមដងទន្លេដែលមានស្រាប់)		និងលំហូរទឹកដែលមានការកើនឡើង • កែលំអលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងគំរាមកំហែងផ្សេងៗ • កាត់បន្ថយការហូរច្រោះ • រក្សាបាននូវធនធានជលផល • គម្របព្រៃដែលមានការកើនឡើងអាចជួយកាត់បន្ថយផលប៉ះពាល់នៃការកើឡើងនូវសីតុណ្ហភាព • ធ្វើឲ្យតំបន់ទេសភាពមានស្ថេរភាព និងរក្សាឲ្យបាននូវស្រទាប់ដីខាងលើ • ផ្តល់ប្រភពធនធានប្រកបដោយនិរន្តរភាព(អនុផលព្រៃឈើ និងឈើធំៗ)។
ស្រាវជ្រាវរកឲ្យឃើញពីគំនិតផ្តួចផ្តើមលើការគ្រប់គ្រង និងជម្រើសនៃការអភិរក្ស	សហការជាមួយសកលវិទ្យាល័យភ្នំពេញ បំពេញការសិក្សា ការអនុវត្តសកម្មភាព /ការស្រាវជ្រាវដោយដាក់បញ្ចូល LEK និងគូបផ្សំជាមួយនឹងការអប់រំឲ្យយល់ដឹងអំពីអនុផលព្រៃឈើ។	មធ្យម	• កែលម្អលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងការគំរាមកំហែងបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ។
កែលម្អការយល់ដឹងរបស់សហគមន៍លើកិច្ចការពារបរិស្ថាន	• សហការជាមួយអង្គការព្រះពុទ្ធសាសនាដើម្បីបរិស្ថាន និងអង្គការផ្សេងៗដើម្បីបង្កើនការវាយតម្លៃខ្ពស់លើតម្លៃសត្វព្រៃ និងជម្រុញឲ្យមានសិទ្ធកាន់កាប់របស់សហគមន៍លើធនធានធម្មជាតិ។	មធ្យម	• កែលម្អការយល់ដឹងរបស់សហគមន៍ និងស្ថាប័នផ្សេងៗទៀតអំពីការ ប្រែប្រួលអាកាសធាតុ។
កំណត់គោលដៅលើការពង្រឹងអនុវត្ត	• ធ្វើការជាមួយសហគមន៍ រដ្ឋាភិបាល និងស្ថាប័នពាក់ពន្ធ័ផ្សេងៗដើម្បីសម្រេចឲ្យបាននូវកិច្ចព្រមព្រៀងលើ	មធ្យម	• ការអនុវត្តន៍ច្បាប់ត្រូវកែលម្អ • ការចូលរួមរបស់

ច្បាប់	ការចូលរួមក្នុងការអនុវត្តន៍ច្បាប់ (ជលផល ព្រៃឈើ ការប្រមាញ់សត្វព្រៃ អាជីវកម្ម និងអុស)		សហគមន៍ រដ្ឋាភិបាល និង អ្នកពាក់ព័ន្ធ ក្នុងសកម្មភាពអនុវត្តច្បាប់ • និរន្តរភាពនៃការប្រើប្រាស់ប្រភពធនធានត្រូវកែលម្អ។
កែលម្អបទបញ្ជាផ្ទៃក្នុងរបស់សហគមន៍នេសាទ	• រកឲ្យឃើញនូវចន្លោះខ្វះខាតរបស់បទបញ្ជាផ្ទៃក្នុងរបស់សហគមន៍នេសាទ និងការអនុវត្តច្បាប់ ហើយស្វែងរកការកែលម្អការប្រតិបត្តិច្បាប់ ការពង្រឹងអនុវត្តច្បាប់ និងពិនិត្យឡើងវិញលើបទបញ្ជាផ្ទៃក្នុងរបស់សហគមន៍ ដោយសហការជាមួយសហគមន៍មូលដ្ឋាន រដ្ឋបាលជលផល និងស្ថាប័នពាក់ព័ន្ធ ផ្សេងៗ • កែលម្អការគ្រប់គ្រងវិស័យជលផល និងជម្រកត្រីនៅក្នុងតំបន់ព្រៃលិចទឹក ទន្លេមេគង្គ។	មធ្យម	• កែលម្អនិរន្តរភាពនៃធនធាជលផល • កែលម្អបរិស្ថានដែលធនធានជលផលពឹងអាស្រ័យលើ • កែលម្អការអនុវត្តន៍បទបញ្ជាផ្ទៃក្នុងរបស់សហគមន៍នេសាទ • កាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលរបបទឹក និងលំហូរទឹកទន្លេដែលមានការកើនឡើង • កែលម្អលទ្ធភាពនៃធនធានជលផលឲ្យអាចទប់ទល់នឹងការគំរាមកំហែង ផ្សេងៗ។
ការពារទន្លេកុំឲ្យមានសកម្មភាពរុករករ៉ែ	• ពង្រឹងការអនុវត្តច្បាប់ដែលមានស្រាប់លើការរុករករ៉ែ និងកំណត់ពីចំនុចខ្វះខាតនៃច្បាប់ដើម្បីការពារតំបន់ដែលសម្បូរណ៍ដោយតម្លៃជីវចម្រុះខ្ពស់ពីការបំផ្លាញយ៉ាងឆាប់រហ័ស អាស្រ័យដោយការកើនឡើងនៃសកម្មភាពរុករករ៉ែនៅរដូវប្រាំង • កាត់បន្ថយផលប៉ះពាល់ដោយសកម្មភាពរករ៉ែលើប្រភពធនធានវារីសត្វ និងជលផលឲ្យបានក្នុងកម្រិតទាបតាមរយៈការពង្រឹងអនុវត្តច្បាប់ស្តីពីការរុករករ៉ែរបស់កម្មវិធីអង្គការសហប្រជាជាតិដែលនឹងចូលជា	មធ្យម	• គុណភាពទឹកត្រូវកែលម្អ • ការបង្ហូរជាតិពុលក្នុងបរិស្ថានត្រូវកាត់បន្ថយ • សកម្មភាពបំផ្លាញផ្សេងៗត្រូវកាត់បន្ថយ(ការដុតព្រៃ ការប្រមាញ់សត្វ ការនេសាទខុសច្បាប់ ការកាប់ឈើខុសច្បាប់ និងវានដីព្រៃ) • ការរំខាននៅតាមច្រាំងទន្លេត្រូវកាត់បន្ថយ។

	ធរមានក្នុងពេលដ៏ខ្លីខាងមុខ។		
• **លើកកម្ពស់** និរន្តរភាព **វិស័យជលផល**	• អប់រំ និងផ្សព្វផ្សាយចំណេះដឹងអំពីការប្រើប្រាស់ធនធានជលផលប្រកបដោយនិរន្តរភាព • រៀបចំការវិភាគផលចាប់ត្រីនៅក្នុងតំបន់សិក្សាស្រាវជ្រាវតាមរយៈការសិក្សាធ្វើឡើងដោយសហគមន៍ខ្លួនឯងដើម្បីរៀបចំបង្កើតព័ត៌មានគោល។	• មធ្យម	• កែលម្អនិរន្តរភាពនៃធនធាជលផល • កែលម្អបរិស្ថានដែលធនធានជលផលពឹងអាស្រ័យលើ • កែលម្អការពង្រឹងអនុវត្តច្បាប់ • កាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលរបបទឹក និងលំហូរទឹកទន្លេដែលមានការកើនឡើង • កែលម្អលទ្ធភាពនៃធនធានជលផលឲ្យអាចទប់ទល់នឹងការគំរាមកំហែងផ្សេងៗ។

ផែនការប្រើប្រាស់ដីជាយុទ្ធសាស្ត្រកក៏នឹងពង្រឹងលទ្ធភាពរបស់អ្នកធ្វើផែនការ និងក្រុមអ្នកពាក់ព័ន្ធផ្សេងៗទៀតដែលចូលរួមក្នុងដំណើរការរៀបចំផែនការ ហើយបំពេញសកម្មភាពឆ្លើយតបទៅនឹងការប្រែប្រួលអាកាសធាតុ ហើយជួយដល់ការសម្រេចចិត្តដែលជួយដល់សហគមន៍ និងប្រព័ន្ធអេកូឡូស៊ី។ តារាងទី២ នេះមានរៀបរាប់អំពីសកម្មភាព និងកម្រិតអាទិភាព និងមធ្យោបាយកាត់បន្ថយភាពងាយរងគ្រោះ ដោយផ្អែកលើតារាងទី១៤។

តារាងទី ២. ជម្រើសនៃការបន្សាំដើម្បីកែលម្អផែនការប្រើប្រាស់ដីធ្លីនៅក្នុង និងជុំវិញតំបន់ព្រៃលិចទឹកទន្លេ មេគង្គដែលបានចាត់ថ្នាក់តាមកម្រិតអាទិភាព

សកម្មភាព	ជំហានសំខាន់ៗ	អាទិភាព	តើសកម្មភាពនឹងរួមចំណែកកាត់បន្ថយភាពងាយរងគ្រោះដោយរបៀបណា?
រៀបចំបង្កើតតំបន់ព្រៃលិចទឹកទន្លេមេគង្គជា "តំបន់គ្រប់គ្រងពិសេស"	• រៀបចំបង្កើតតំបន់ព្រៃលិចទឹកទន្លេមេគង្គជា "តំបន់គ្រប់គ្រងពិសេស" • ធានាឲ្យបានថាបទបញ្ជាសមស្របអមជាមួយនឹងការរៀបចំតំបន់	ខ្ពស់	• ផ្សព្វផ្សាយចំណេះដឹងអំពីសារៈប្រយោជន៍នៃតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ និងតម្លៃនៃ

	• ពង្រឹងសមត្ថភាពអនុវត្តច្បាប់ • ផ្តល់ប្រាក់ឧបត្ថមដល់សហគមន៍ដើម្បីលើកទឹកចិត្តពួកគាត់ឲ្យជួយការងារកំណត់តំបន់ • ធានាឲ្យបានថា ការកំណត់តំបន់រក្សាបាននូវវត្តមានព្រៃលិចទឹក • អនុម័ត្តផែនការគ្រប់គ្រង និងផែនការបែងចែកតំបន់នៅតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។		ជីវចម្រុះនិងការចូលរួមរបស់សហគមន៍ • កែលម្អការគ្រប់គ្រង និងនិរន្តរភាពនៃការប្រើប្រាស់ប្រភពធនធាន • រក្សាសេវាកម្មប្រពន្ធ័អេកូឡូស៊ីនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។
លើកកម្ពស់ការរៀបចំផែនការតាមបែបសមាហរណកម្ម	• ជម្រុញការធ្វើសមាហរណកម្មក្នុងការរៀបចំផែនការពីថ្នាក់សហគមន៍ដល់ថ្នាក់ជាតិ ដោយរាប់បញ្ចូលទាំងកិច្ចសម្របសម្រួលអន្តរស្ថាប័នក្នុងការរៀបចំផែនការប្រើប្រាស់ដីធ្លី។ ការងារនេះគួរបញ្ចូលទៅក្នុងផែនការអភិវឌ្ឍឃុំ ហើយគួរឲ្យមានការសម្របសម្រួលជាមួយនាយកដ្ឋានផែនការថ្នាក់ខេត្ត។	ខ្ពស់	• ការចូលរួមរបស់សហគមន៍ ស្ថាបន័រដ្ឋាភិបាល និងអ្នកពាក់ពន័ធ្ធផ្សេងៗក្នុងការធ្វើផែនការប្រើប្រាស់ដី • រក្សាសេវាកម្មប្រព័ន្ធអេកូឡូស៊ីនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។
ធ្វើការបែងចែកតំបន់ឲ្យបានសមស្រប ដើម្បីធ្វើឲ្យមានតុល្យភាពរវាងការអភិវឌ្ឍន៍ និងការអភិរក្ស	• រៀបចំបង្កើតតំបន់ដែនជំរក/តំបន់ការងារ/តំបន់ព្រៃផលិតកម្មរបស់សហគមន៍នៅក្នុងផែនការប្រើប្រាស់ដីធ្លី • រៀបចំបង្កើតតំបន់សមស្រប និងមិនសមស្របសម្រាប់សកម្មភាពរុករករ៉ែ និងឃ្លងថ្ម • រៀបចំបង្កើត និងការពារតំបន់ព្រៃនៅលើកោះ និងទីទួល • កំណត់តំបន់អាទិភាពនៃព្រៃលិចទឹក និងរៀបចំបង្កើតតំបន់ទាំងនេះជាតំបន់អភិរក្សត្រីសហគមន៍ដែលសហគមន៍ជាអ្នកបង្កើត គ្រប់គ្រង និងត្រួតពិនិត្យ • កំណត់អន្លង់ជ្រៅៗដែលចាំបាច់សម្រាប់កិច្ចការពារ និងផ្តល់កិច្ច	ខ្ពស់	• ការពារជម្រកសំខាន់សម្រាប់ប្រភេទវារីសត្វ និងប្រភេទសត្វព្រៃ • កែលម្អលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងគំរាមកំហែងបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែ ប្រួលអាកាសធាតុ • ការចូលរួមរបស់សហគមន៍ រដ្ឋាភិបាល និងស្ថាប័នពាក់ព័ន្ធក្នុងការរៀបចំផែនការប្រើប្រាស់ដីធ្លី

	ការពារបន្ថែមលើអន្លង់ជ្រៅៗទាំងនេះ។		• រក្សាសេវាកម្មប្រព័ន្ធអេកូឡូស៊ី។
អភិវឌ្ឍបណ្តាញផ្លូវថ្នល់សមស្រប	• ជម្រុញការសង់ផ្លូវថ្នល់វាង ជាជាងការសាងសង់ផ្លូវថ្នលរត់ស្របនឹងដងទន្លេ និងធានាឲ្យបានថាបណ្តាញផ្លូវថ្នល់មានដាក់បញ្ចូលទៅក្នុងការរៀបចំផែនការប្រើប្រាស់ដីធ្លី • គ្រប់គ្រងការកើនឡើងនៃការធ្វើចំណាកស្រុកចូលទៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ ប្រសិនផ្លូវត្រូវបានសាងសង់។	ខ្ពស់	• រក្សាឲ្យបាននូវតំបន់ព្រៃតាមដងទន្លេ • កាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលរបបទឹក និងលំហូរដែលមានការកើនឡើង • កែលម្អលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងគំរាមកំហែងបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ • កាត់បន្ថយនូវការហូរច្រោះ។
ការពារតំបន់ទ្រនាប់ព្រៃតាមដងទន្លេដើម្បីការពារតំបន់ស្នូល	• បង្កើតទឹកន្លែងនៅតាមព្រៃតាមដងទន្លេសម្រាប់ជាកន្លែងកំសាន្តក្នុងគោលបំណងធានាឲ្យបានថា វានឹងមិនមានហេដ្ឋារចនាសម្ព័ន្ធអចិន្ត្រៃយ៍ណាមួយត្រូវបានបង្កើតនៅតាមតំបន់ព្រៃតាមដងទន្លេ	ខ្ពស់	• កាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលរបបទឹក និងលំហូរដែលមានការកើនឡើង • បង្កើនការរក្សាទឹកទុកក្រោមដី • លើកកម្ពស់ភាពបន្សាំរបស់សត្វ និងរុក្ខជាតិនៅតំបន់ទ្រនាប់ព្រៃតាមដងទន្លេឲ្យបន្សាំទៅនឹងព្រឹត្តិការណ៍អាកាសធាតុដ៏អាក្រក់ • កាត់បន្ថយនូវការហូរច្រោះ។
ស្តារទីជម្រកដែលខូចខាតឡើងវិញ	• កំណត់តំបន់ព្រៃសំខាន់ៗដែលបានកាប់បំផ្លាញ និងរៀបចំតំបន់ទាំងនោះជាតំបន់អាទិភាពដើម្បីស្តារ	ខ្ពស់	• បង្កើនការរក្សាទឹកទុកក្រោមដី • លើកកម្ពស់ភាពបន្សាំ

	ឡើងវិញ		របស់សត្វ និងរុក្ខជាតិនៅតំបន់ទ្រនាប់ព្រៃតាមដងទន្លេឲ្យបន្សាំទៅនឹងព្រឹត្តិការណ៍អាកាសធាតុដ៏អាក្រក់ • កាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលរបបទឹក និងលំហូរដែលមានការកើនឡើង • កែលម្អរលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងគំរាមកំហែងបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ • កាត់បន្ថយការហូរច្រោះ • បង្កើនគម្របព្រៃដែលអាចនឹងកាត់បន្ថយផលប៉ះពាល់ដោយការកើនឡើងសីតុណ្ហភាព។
ធ្វើសមាហរណកម្មការប្រែប្រួលអាកាសធាតុទៅក្នុងការរៀបចំផែនការ	• ធានាឲ្យបានថា ផែនការប្រើប្រាស់ដីធ្លីត្រូវគិតឲ្យបានល្អិតល្អន់ទៅលើផលប៉ះពាល់នៃការប្រែប្រួលអាកាសធាតុដែលអាចកើតមាន (និងការប្រែប្រួលផ្សេងៗទៀត) ទៅលើ ៖ o ទឹកក្រោមដី និងរួមទាំងការផ្តល់ឲ្យមានទ្រនាប់ទឹកក្រោមដីដែលអាចជួយកាត់បន្ថយការកើនឡើងនូវការប្រែប្រួលអាកាសធាតុតាមរយៈការរក្សារចនាសម្ព័ន្ធរុក្ខជាតិនៅក្នុងតំបន់អាទិភាព o បង្កើត និងរក្សាឲ្យមានជានិរន្ត	ខ្ពស់	• កែលម្អរលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងគំរាមកំហែងបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ • បង្កើនលំនឹងទឹកក្រោមដី • លើកកម្ពស់ភាពបន្សាំរបស់សត្វនិងរុក្ខជាតិនៅតំបន់ទ្រនាប់ព្រៃតាមដងទន្លេឲ្យបន្សាំទៅនឹងព្រឹត្តិការណ៍អាកាសធាតុ

	នូវកាំងខ្សាច់ និងការកកើតនូវបណ្តុំខ្សាច់ផ្សេងៗទៀតដើម្បីថែរក្សាសមាសភាព និងរចនាសម្ព័ន្ធរុក្ខជាតិដើម្បីបង្កើនការធនទៅនឹងការហូរច្រោះ។		ដ៏អាក្រក់ • កាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលរបបទឹក និងលំហូរដែលមានការកើនឡើង • កាត់បន្ថយនូវការហូរច្រោះ។
ផ្តល់ប្រាក់ឧបត្ថបលើកទឹកចិត្តដើម្បីជួយបន្ថែមដល់ការរៀបចំផែនការ	• បង្កើត/ផ្តល់ប្រាក់ឧបត្ថមលើកទឹកចិត្តដើម្បីថែរក្សាទេសភាពតំបន់ដ៏ស្រស់ស្អាតនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ៖ o ពិនិត្យលើសកម្មភាពកាប់បំផ្លាញព្រៃឈើ និងការធ្វើឲ្យព្រៃឈើបាត់បង់+ការស្រាវជ្រាវដោយផ្តោតទៅលើព្រៃឡង់ និង/រឺសហគមន៍ព្រៃឈើ/ដែនជម្រក o ផ្តល់ការលើកទឹកចិត្តចំពោះការមិនអភិវឌ្ឍន៍សហគមន៍នៅក្នុងតំបន់ព្រៃលិចទឹក មេគង្គទេ និងបង្ការការតាំងទីលំនៅមិនផ្លូវការ។	មធ្យម	• កែលម្អលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បីទប់ទល់នឹងគំរាមកំហែងបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ • គ្រប់គ្រងការគំរាមកំហែងលើបរិស្ថានដែលបង្កឡើងដោយចំនួនប្រជាជនដែលមានការកើនឡើង • បង្កើតឲ្យមានប្រាក់ចំណូលប្រកបដោយនិរន្តភាព។
កែលំអបទបញ្ជា (និយតកម្ម)	• កែលម្អ និងពន្លឿនដំណើរការបង្កើតសហគមន៍ព្រៃឈើ • ជួយសហគមន៍នៅក្នុងតំបន់សិក្សាក្នុងការចុះបញ្ជីដីស្របច្បាប់ដើម្បីការពារការចាប់យកដី និងជាវិធីកាត់បន្ថយការបន្តតាំងទីលំនៅថ្មី។	មធ្យម	• កែលំអនិរន្តរភាពនៃការគ្រប់គ្រងប្រភពធនធាន • កែលម្អការពង្រឹងអនុវត្តន៍ច្បាប់ពាក់ព័ន្ធ • កាត់បន្ថយផលប៉ះពាល់នៃការប្រែប្រួលរបបទឹក និងលំហូរដែលមានការកើនឡើង • កែលម្អលទ្ធភាពនៃប្រពន្ធ័អេកូឡូស៊ីដើម្បី

			ទប់ទល់នឹងគំរាមកំហែង បង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងដែលមិនបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ • គ្រប់គ្រងការគំរាមកំហែងលើបរិស្ថានដែលបង្កឡើងដោយចំនួនប្រជាជនដែលមានការកើនឡើង។

ការផ្សព្វផ្សាយឲ្យដឹងពីកម្រងធនធាននៅតំបន់ព្រៃលិចទឹកមេគង្គនៅថ្នាក់មូលដ្ឋាន និងថ្នាក់ជាតិគឺជាក្តីសង្ឃឹមក្នុងការផ្តល់កម្លាំងជម្រុញឲ្យមានកែលម្អលើការគ្រប់គ្រងតំបន់ និងធ្វើឲ្យមធ្យោបាយគ្រប់គ្រងមានការវិវត្តន៍ទៅមុខដោយគ្មានឧបសគ្គ ដែលទង្វើរបៀបនេះ ទំនងអាចជាទំនាស់អត្ថប្រយោជន៍សេដ្ឋកិច្ចក្នុងរយៈពេលខ្លី។ **តំបន់ព្រៃលិចទឹកទន្លេមេគង្គមានសារសំខាន់ដល់សេដ្ឋកិច្ចសង្គមលើតំលៃប្រព័ន្ធអេកូឡូស៊ី ដែលផ្តល់សេវាកម្មយ៉ាងចាំបាច់ដល់សហគមន៍ ហើយដោយសារតែតំបន់នេះពោរពេញដោយជីវចំរុះសំខាន់ៗ ហេតុផលទាំងពីរយ៉ាងនេះ គួរគិតឲ្យបានដិតដល់ពីការផ្សព្វផ្សាយឲ្យបានទូលំទូលាយអំពីកម្រងធនធាននៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ** ។ យុទ្ធសាស្ត្រសំខាន់ៗគួរផ្សព្វផ្សាយ អំពីកម្រងធនធាននៃតំបន់ព្រៃលិចទឹកទន្លេមេគង្គដល់ថ្នាក់ជាតិ ជាមួយគ្នានេះដែរក៏ត្រូវជម្រុញការកែលម្អរលើការគ្រប់គ្រងនៅតាមមូលដ្ឋាន។ យុទ្ធសាស្ត្រនេះមានពិពណ៌នាលំអិតនៅក្នុងតារាងទី៣ខាងក្រោម និងតារាងទី១៥នៃរបាយការណ៍នេះ។

តារាងទី ៣. ជម្រើសនៃការបន្សាំនៃប្រភេទធនធាននៅតំបន់ព្រៃលិចទឹកទន្លេមេគង្គដែលបានចាត់ថ្នាក់តាម កម្រិតអាទិភាព

សកម្មភាព	ជំហានសំខាន់ៗ	អាទិភាព	តើសកម្មភាពនឹងរួមចំណែកកាត់បន្ថយភាពងាយរងគ្រោះដោយរបៀបណា?
ប្រឹក្សាយោបល់ជាមួយរដ្ឋាភិបាល	• កំណត់ស្ថាបន័រដ្ឋាភិបាលសំខាន់ៗ ប្រើវិធីសាស្ត្រប្រយោល និងផ្ទាល់តាមរយៈដំណើរការសម្របសម្រួល និងការប្រឹក្សាយោបល់នៅថ្នាក់ខេត្ត និងពិភាក្សាជាមួយដៃគូរដ្ឋាភិបាល និងស្ថាប័នពាក់ពន្ធ័ផ្សេងៗព្រមទាំងការផ្សព្វផ្សាយតាមរូបភាពផ្សេងៗទៀត ដូចជា៖ ការផ្សព្វផ្សាយតាមសារព័ត៌មាន និងការបង្កើតទំនាក់ទំនងនានា។	ខ្ពស់	• ការគ្រប់គ្រងប្រភពធនធានធម្មជាតិនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គត្រូវកែលម្អរ • ជម្រុញដើម្បីរក្សាឲ្យបានសមត្ថភាពបន្សាំតាមរយៈសេវាកម្មប្រព័ន្ធអេកូឡូស៊ី
តស៊ូមតិនឹងសម្បទានដីសេដ្ឋកិច្ចនៅតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ	• បង្កើតឲ្យមានការបង្ហាញពីផលប៉ះពាល់នៃការផ្តល់ដីសម្បទានសេដ្ឋកិច្ចដល់រដ្ឋាភិបាល និងបញ្ចុះបញ្ចូលរដ្ឋាភិបាលកុំឲ្យផ្តល់ដីសម្បទានសេដ្ឋកិច្ចនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គទៅឲ្យក្រុមហ៊ុន	ខ្ពស់	• រក្សាឲ្យបាននូវសេវាកម្មប្រពន្ធ័អេកូឡូស៊ីនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ • រក្សាឲ្យនូវការប្រើប្រាស់ប្រភពធនធានធម្មជាតិប្រកបដោយនិរន្តរភាព។
ប្រឹក្សាយោបល់ជាមួយសហគមន៍	• ប្រឹក្សាយោបល់ជាមួយអ្នកពាក់ព័ន្ធ និងបង្កើនការផ្សព្វផ្សាយដូចជាតាមរយៈ ប្រព័ន្ធផ្សព្វផ្សាយ ការបង្កើតទំនាក់ទំនង និងឪកាសផ្សេងៗទៀត ។ល។	មធ្យម	• ការចូលរួមរបស់សហគមន៍ក្នុងការរៀបចំផែនការពេលអនាគតសម្រាប់គ្រប់គ្រងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ • បង្កើតឲ្យមានកម្លាំងជម្រុញនៅថ្នាក់មូលដ្ឋានដើម្បីរក្សាឲ្យបាននូវធនធានដ៏មានតម្លៃនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។

គេគិតថា គម្រោងសាងសង់ទំនប់វារីអគ្គិសនីនៅស្រុកសំបូរ គឺជាការគំរាមកំហែងដ៏គ្រោះថ្នាក់បំផុតចំពោះគ្រប់ប្រព័ន្ធអេកូឡូស៊ីហើយប្រជាជននៅសហគមន៍ និងគ្រប់អ្នកជំនាញទាំងអស់គិតថាប្រព័ន្ធអេកូឡូស៊ីនោះងាយនឹងរងគ្រោះបំផុត។ ទំនប់វារីអគ្គីសនីគំរាមកំហែងដល់សេវាកម្មប្រព័ន្ធអេកូឡូស៊ី ការចញ្ចឹមជីវិតរបស់ប្រជាជនមូលដ្ឋាន និងជីវចម្រុះនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។ គម្រោងសាងសង់វារីអគ្គិសនីនេះ នឹងប្រែក្លាយតំបន់ព្រៃលិចទឹកទន្លេមេគង្គឲ្យទៅជាតំបន់ដែលពុំមានការទទួលអំពីតម្លៃនៃជីវចម្រុះ ហើយធ្វើឲ្យបាត់បង់អត្ថប្រយោជន៍ដែលតំបន់នេះផ្តល់ឲ្យសហគមន៍។ ការបង្កើតឲ្យមានដំណោះស្រាយចំពោះការគំរាមកំហែងបង្កឡើងដោយទំនប់វារីអគ្គីសនី ពិសេសទំនប់វារីអគ្គីសនីនៅសំបូរ គឺជាជាំហានដ៏សំខាន់មួយដើម្បីកាត់បន្ថយការគំរាមកំហែងបង្កឲ្យមានភាពងាយរងគ្រោះ។ សកម្មភាពនៃយុទ្ធសាស្ត្រមានពិពណ៌នានៅក្នុងតារាងទី៥ ។

យុទ្ធសាស្ត្របន្សាំទាំងនេះ នឹងមានការចែករំលែកដល់សហគមន៍នៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ និងអាជ្ញាធរមូលដ្ឋាន។ **យើងមានគោលបំណងរកឲ្យឃើញ និងពិភាក្សាពីចំណុចខ្វះខាត និងឧប-សគ្គនានាចំពោះការបំពេញយុទ្ធសាស្ត្របន្សាំទាំងនេះ ហើយធ្វើការជាមួយសហគមន៍ និងរចនាសម្ព័ន្ធអភិបាលកិច្ចថ្នាក់មូលដ្ឋាន និងបណ្តាស្ថាប័នថ្នាក់ខ្ពស់ដើម្បីសមាហរណកម្មយុទ្ធសាស្ត្រនេះទៅក្នុងការរៀបចំផែនការ និងដំណើរការគ្រប់គ្រងដើម្បីកម្រិតឲ្យបានជាអប្បបរិមានៃ**ភាពងាយរងគ្រោះបង្កឡើងដោយការប្រែប្រួលអាកាសធាតុ និងការគំរាមកំហែងផ្សេងៗទៀត ទាំងដោយផ្ទាល់និងដោយសំណាងនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ។ យុទ្ធសាស្ត្រទាំងនេះជួយដល់ការបង្កើតគោលនយោបាយយុទ្ធសាស្ត្ររបស់អង្គការ WWF។

តារាងទី៤. សកម្មភាពបន្សាំ ដែលឆ្លើយតបទៅនឹងការគំរាមកំហែងបង្កឡើងដោយសារការសាងសង់ទំនប់វារីអគ្គិសនីដែលបានចាត់ថ្នាក់តាមកម្រិតអាទិភាព

សកម្មភាព	ជំហានសំខាន់ៗ	អាទិភាព	តើសកម្មភាពនឹងរួម ចំណែកកាត់បន្ថយ ភាពងាយរងគ្រោះដោយរបៀបណា?
រៀបចំយុទ្ធសាស្ត្រតស៊ូមតិ	• សម្របសម្រួលរវាងក្រុមសង្គមស៊ីវិល សហគមន៍ និងអ្នកពាក់ព័ន្ធផ្សេងៗរៀបចំបង្កើតការតស៊ូមតិរួមនិងជំហរគោលនយោបាយពាក់ព័ន្ធទៅនឹងការអភិវឌ្ឍន៍ទំនប់វារីអគ្គីសនីនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ និងជុំវិញតំបន់ • ជំរុញឲ្យមានការស្រាវជ្រាវរកមើលជម្រើសផ្សេងក្រៅពីសំណង់ទំនប់ទ្រង់ទ្រាយធំដែលបង្កការខូតខាតខ្ពស់ (ឧ. Thakho ឬសំណង់ទំនប់ខ្នាតតូចនៅសំបូរ)។	ខ្ពស់	• ការធ្វើឲ្យមានឥទ្ធិពលលើការសម្រេចចិត្ត • ធ្វើឲ្យមានចំណាប់អារម្មណ៍ពីអ្នកពាក់ព័ន្ធ និងគោលនយោបាយលើភាពរងគ្រោះនិងការប៉ះពាល់ដល់ប្រជាពលរដ្ឋនៅក្នុងសហគមន៍និងប្រព័ន្ធអេកូឡូស៊ី • រក្សាបាននូវធនធានដ៏មានតម្លៃនៅក្នុងតំបន់ព្រៃលិចទឹកទន្លេមេគង្គ
ស្វែងរកជម្រើសប្រភពថាមពលផ្សេង	• ស្វែងរកជម្រើសប្រភពថាមពល • សិក្សាស្រាវជ្រាវពីតម្រូវការ និងផលប្រយោជន៍សេដ្ឋកិច្ចដែលទទួលបានពីការលក់ថាមពលអគ្គិសនី។	ខ្ពស់	• លើកយកការប្រើប្រាស់ថវិកាប្រកបដោយប្រសិទ្ធភាព និងជម្រើសប្រព័ន្ធអេកូឡូស៊ីសមស្របត្រូវបានយកទៅជជែកពិភាក្សា • កាត់បន្ថយការពឹងអាស្រ័យលើការប្រើប្រាស់ធនធានធម្មជាតិតាមបែបមិនមាននិរន្តភាព។
គាំទ្រគោលការណ៍ជាយុទ្ធសាស្ត្រចំពោះការអភិវឌ្ឍន៍	• លើកទឹកចិត្ត គាំទ្រ និងសម្របសម្រួលឲ្យមានគោលការណ៍ជាយុទ្ធសាស្ត្រចំពោះការអភិវឌ្ឍន៍ទំនប់វារីអគ្គិសនី ដូចជាការគិតគូរអំពីបញ្ហាលម្អិតនៃទំនប់វារីអគ្គិសនីនិងប្រភពថាមពលអគ្គិសនីផ្សេង	ខ្ពស់	• កែលម្អការគ្រប់គ្រងប្រព័ន្ធអេកូឡូស៊ីប្រកបដោយនិរន្តភាពសម្រាប់រយៈពេលវែង • ពង្រឹងការវិភាគលើហានិភ័យ និងការចែក រំលែក

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Contents

Definitions

Many of the following definitions are based on those detailed by Livina and Tirpak (2006)

Adaptation – adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Adaptive capacity – refers to the natural ability of the system to adjust to change (e.g. for an ecosystem to retreat inland over time in response to rising sea levels) or to human resource availability and capacity to manage the system to adjust to change (e.g. human, technological and financial capital). In this study, adaptive capacity was considered only to be the inherent capacity of ecosystem components to adapt to change (from climate change threats or non-climate threats).

Climate – refers to the weather conditions that characteristically prevail within a particular region, and/or time period (usually a long period such as 30 years). It includes meteorological conditions such as temperature, wind, humidity, and precipitation.

Climate change – refers to a biophysically meaningful variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural processes or external forcing, or due to persistent anthropogenic changes in the composition of the atmosphere or in land-use.

Exposure – relates to the extent of the impact (geographical, temporal, intensity) on any system component. Here this generally refers to ecosystem components.

Potential impact – is a function of exposure and sensitivity; by relating exposure and sensitivity to each other, the degree that a threat may affect an ecosystem component is understood.

Resilience – refers to the amount of change a system can undergo without changing state. Resilience can also refer to the ability of a system to recover from the effect of an extreme load that may have caused harm. Therefore, resilience encompasses the ability of a system to tolerate disturbance without changing state, and also its ability to recover from an affect.

Sensitivity – relates to the degree to which a system/species is affected, either adversely or beneficially.

Vulnerability – is defined by the Intergovernmental Panel on Climate Change (IPCC) as the degree to which an entity is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity (Gitay et al, 2002 in Bezuijen et al. 2011). This study also considered the vulnerability of ecological components to the adverse effects of non-climate threats.

Acronyms

ABE	Association of Buddhists for the Environment
CED	Community Economic Development
CRDT	Cambodian Rural Development Team
FA	Forestry Administration
FAO	Food and Agriculture Organization of the United Nations
FiA	Fisheries Administration
GMS	Greater-Mekong Subregion (incl. Cambodia, Lao PDR, Myanmar, Thailand, Vietnam and Yunnan Province, China)
ICEM	International Centre for Environmental Management
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
Lao PDR	Lao People's Democratic Republic
LEK	Local Ecological Knowledge
MoE	Ministry of Environment (Cambodia)
MRC	Mekong River Commission
NTFP	Non-Timber Forest Product
RECOFTC	The Centre for People and Forests
REDD+	Reducing Emissions from Deforestation and Forest Degradation
VAA	Vulnerability and Adaptation Assessment
UNEP	United Nations Environment Program
UNDP	United Nations Development Program
WWF	The World Wide Fund for Nature

Introduction

Climate change is a global threat to all humans and the ecosystems that support them. Climate change has diverse and complex impacts, many of which impact the Mekong region – a region characterized by poverty and subsistence intertwined with rapid socio-economic and environmental change. A region that is also heavily reliant on wild-caught fish and rain-fed rice fields. Projected changes in the region include increases in the intensity, frequency and duration of flooding, increases in annual temperature, decreased dry season precipitation, and increased river flow year round (Eastham et al, 2008, MRC 2011). The implications of such projections threaten the aquatic and terrestrial ecosystems of the Mekong River, and the communities who live in and depend upon them. Severe socio-economic consequences are expected in the region (e.g. Warner *et al*. 2009). Presently, in addition to climate change, the Greater-Mekong Subregion (GMS) is experiencing high levels of population and economic growth and spiralling environmental degradation that will exacerbate the impacts of climate change. To reduce the worst impacts of climate change on the peoples of the GMS, urgent attention must be paid to reducing sources of vulnerability and improving their resilience to climate change.

This report provides a vulnerability and adaptation assessment focussed on the Mekong Flooded Forest, a 56 linear-kilometre stretch of the Mekong River between Stung Treng and Kratie in North-East Cambodia. This site is a complex mosaic landscape of islands among braided river channels, wetlands, and forests with high levels of biodiversity, and small villages and scattered settlements throughout (Figure 1).

Poverty is endemic in the area and communities subsist on small-scale agriculture and the exploitation of natural resources, especially fisheries. The heterogeneous riverine environment provides habitats and nursery grounds for many aquatic species, upon which local communities rely heavily for protein and a small income. The area is also used seasonally by fishers and loggers based outside the area, and rapidly increasing numbers of artisanal gold miners. Logging, settlement and forest conversion, egg collection, wildlife hunting and trading, and invasive species are all known local threats to communities and the ecosystems on which they depend. Clearing of forest for settlement often occurs on river banks and the growing and spreading human population is of particular concern. Bezuijen *et al.* (2008) provide an excellent, detailed overview of the area.

Much of this site would be inundated by the reservoir of the proposed Sambor dam, sited merely 20 kilometres downstream of the southern end of the Mekong Flooded Forest. Connectivity loss and hydrological changes from the upstream Lower Sesan II dam under construction and the proposed Stung Treng dam also threaten the area (ICEM 2009). These anthropogenic threats to the area are expected to exacerbate the future impacts of climate change. As the population in the study area increases, the impacts of these threats will rapidly degrade the Mekong Flooded Forest, reducing ecosystem services and productivity, and thus harming local communities.

Conversely, climate change impacts are also expected to exacerbate non-climatic threats. The Mekong is already considered among those river basins that will be most severely impacted by the

effects of climate change (UNEP 2009). Climate change will alter the water cycle, shifting the timing, duration, and intensity of rainfall patterns and seasons, changing basin hydrology, and altering the quantity, quality, availability, and distribution of water (ICEM 2010, TKK and SEA START RC 2009, Bate et al. 2008, Eastham et al. 2008). These changes will impact agriculture, food production (Fraiture et al. 2007), and, ultimately, human health and well-being (TKK and SEA START RC 2009, MoE and UNDP 2011).

Here we investigate ecosystem-based adaptation as a means to help people adapt to climate change and other threats. This focuses on ecosystem services to provide resilience against climate change to the local communities and their environment. Ecosystem-based adaptation is efficient at directly addressing some environmental consequences of climate change. It is cost-efficient, generally significantly less expensive than potential alternatives such as large hard-infrastructure projects, and it maintains the provision of those ecosystem services on which all human life depends. Although hard-engineering approaches may be appropriate in some cases, ecosystem-based approaches are preferable as they provide sustainable and adaptable resilience, rather than artificial solutions which are costly to enact and may result in mal-adaptation or may be difficult to adjust to changing threats. Further, ecosystem services such as water flow, timber provision, carbon storage, or clean air, fundamentally underpin economic and social stability.

The aim of this assessment is to identify strategies to reduce vulnerability of the people and ecosystems of the Mekong Flooded Forest to climate change, through addressing both climate change and non-climatic threats. Using a modified version of an ecosystem-based adaptation method focussed on water resources (Flowing Forward; LeQuesne et al. 2010), this report evaluates the combined impacts of climate change and non-climate threats on ecosystem components (and therefore communities) in the Mekong Flooded Forest. This methodology assesses the exposure, sensitivity, and adaptive capacity of ecosystem components to a range of climate change related and non-climate threats. Given the high reliance of the local human community on natural resources, we use this lens to assess their vulnerability too. Using expert elicitation, based on a wide range of data, including community level vulnerability assessment, we generate a range of adaptation strategies to reduce vulnerability in the area. Their feasibility and priority is discussed. Following this we aim to use these strategies to support local governance structures and civil society organizations to plan for resilience in their community, and to inform strategic directions for broader management in the Mekong Flooded Forest.

Methods

Our target site is a braided channel complex on the upper Mekong in Cambodia known as the Mekong Flooded Forest (see *Study area* below). The Flowing Forward methodology (LeQuesne et al, 2010) outlines an approach to the assessment of freshwater ecosystem vulnerability and risk to climate change using a top-down analysis of future scenarios and a bottom-up analysis of exposure, sensitivity and adaptive capacity to existing threats. Considering the projections of Estham et al. (2008) and the Mekong River Commission (2011), we modified the Flowing Forward methods to assess the vulnerability of ecosystem components in this area to climatic and non-climatic threats by:

- vulnerability assessment and consultation with local communities in six target villages,
- an expert elicitation workshop, and
- review and analysis of these and other data available about the site.

We then generated strategies to reduce vulnerability in the target site, focussing on ecosystem components as the best means to maintain resilience and maximise the social and environmental stability of the site. We provide details of these processes below.

Study Area

The Mekong Flooded Forest is a 56 linear-kilometre stretch of the Mekong River mid-way between Kratie and Stung Treng in North-East Cambodia (Figure 1). A unique site, with high levels of biodiversity, the site is considered regionally important for conservation. The area encompasses the mainstream of the Mekong River, and a biodiverse complex of braided channels, deep-water pools, flooded forest wetlands, sandbars, and islands covered in dry and semi-evergreen forest. The target section of the river extends from 49 km north of Kratie Town to 14 km north of the Kratie-Stung Treng provincial border, and is part of a larger distinct and unique hydrological sub-unit comprised of a wide series of braided channels that extend from above Kratie town, to the Siphandone region in Southern Lao PDR. This area corresponds to the 'Central Section' of Bezuijen et al. (2008), who conducted biological surveys of the area between Kratie and Stung Treng towns, and provide an excellent and detailed overview of the site.

The study area experiences a pronounced tropical cycle, with heavy rain from May-October, and a dry season from approximately November to May. Wet season flow accounts for 80-90% of river flow (MRC 2010), with pronounced differences in monthly rainfall (Table 1).

Table 1: Annual rainfall metrics. [A]1994-2000; [B]1997-2000. Data: Try & Chambers 2006 and Kratie meteorological station unpublished data 2007, both in Bezuijen et al. (2008)

	Mean annual rainfall	**Mean monthly rainfall**	
	1994-2000	**January**	**September**
Stung Treng	1966 mm (1441- 2600 mm)[A]	0.9mm	333.4 mm
Kratie	2050mm (1743-2549 mm)[B]	0 mm	469 mm

Some of the most biologically significant habitats along the Mekong River are found in the site. The heterogeneous landscape supports a great mix of flora and fauna, and relatively little human disturbance has occurred there. For channel-associated biota the site is of a very high conservation value. The integrity of habitats in this river section appears to have resulted from a combination of low regional population densities, limited and difficult access, and recent historic political instability, which restricted most local settlement until the last decade.

The channels vary from large, wide, and slow flowing sections to narrow rapids through flooded forest that become impassable or cease to flow in the dry season. Islands are likewise varied from the 49 km long Koh Rohngeav Island, to very small, seasonally emergent, shifting sandbars. The islands are generally surrounded by evergreen riparian gallery forest, and covered variably by dry deciduous forest or mixed semi-evergreen forest, with small areas converted to agriculture. Seasonal variation in water height is up to 10 m, and the river's main channel consists of pools over 40 m deep (Poulsen et al. 2002a).

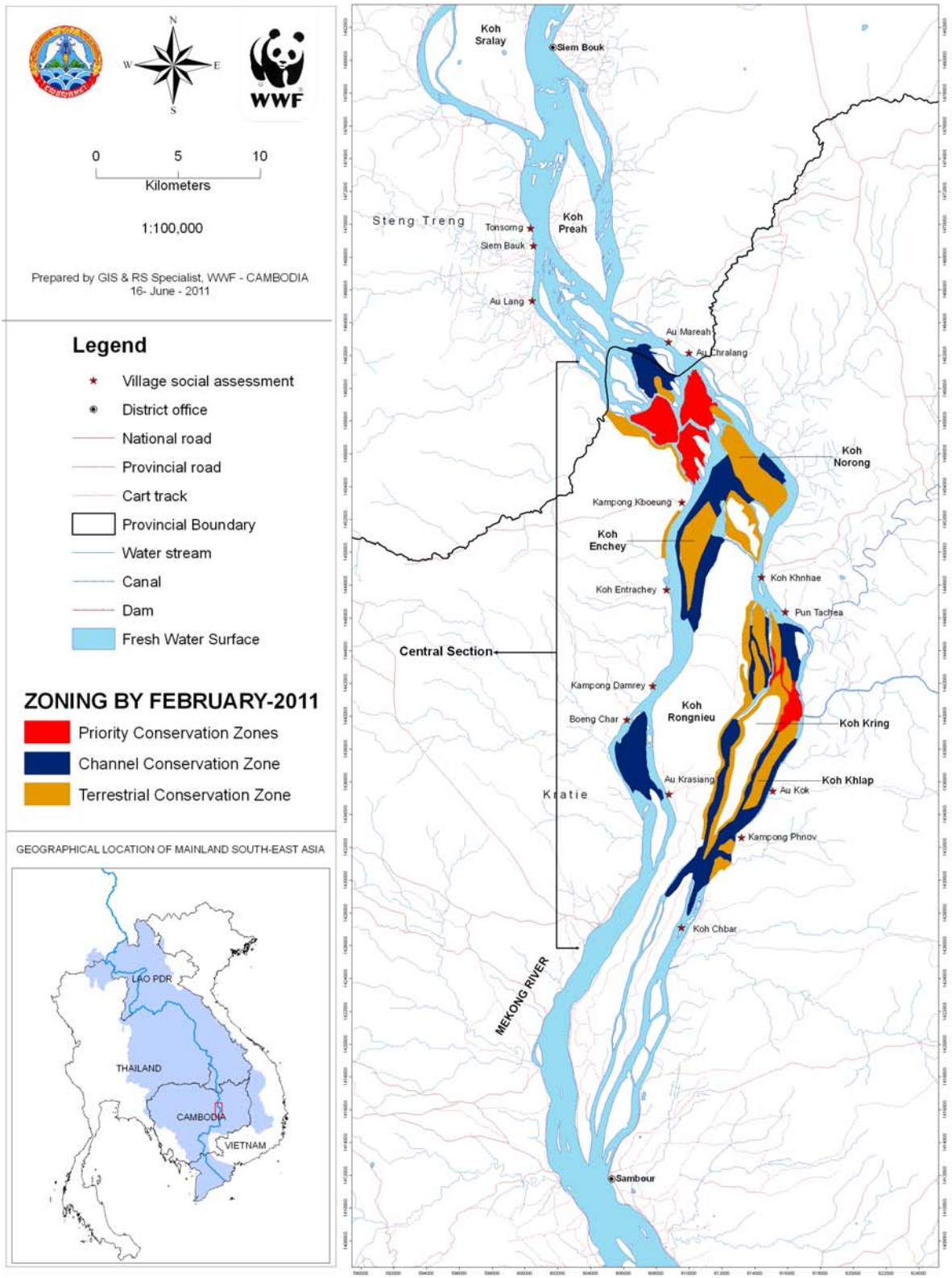

Figure 1: The study area on the Mekong River in North-East Cambodia, including target villages from community workshops and priority conservation zones. *Inset*, the lower Mekong basin shaded in blue, showing the target area and mainland South-East Asia. Map courtesy of Huy Keavuth, WWF-Cambodia.

Flora & Fauna

The vegetation in the study area form a series of distinct zones from aquatic and emergent vegetation close to water level, through to seasonally flooded and riparian forest, to terrestrial forests above the flood zone (Maxwell 2001, Bezuijen *et al.* 2008; Figure 2). The lower zones may be submerged for more than three months of the year, including the 'flooded forest', with some trees emerging from several metres of water. Terrestrial forests are a mixture of deciduous dipterocarp forests to mixed semi-evergreen patches, with small areas of bamboos and grasslands. Low-intensity agriculture, including active and fallow rice fields, is scattered throughout the site, with small areas of fruit and vegetable cultivation around settlements. A total of 690 plant species are recorded in the target site, including one species known from nowhere else, and many species suspected to be endemic to the basin (Maxwell 2009).

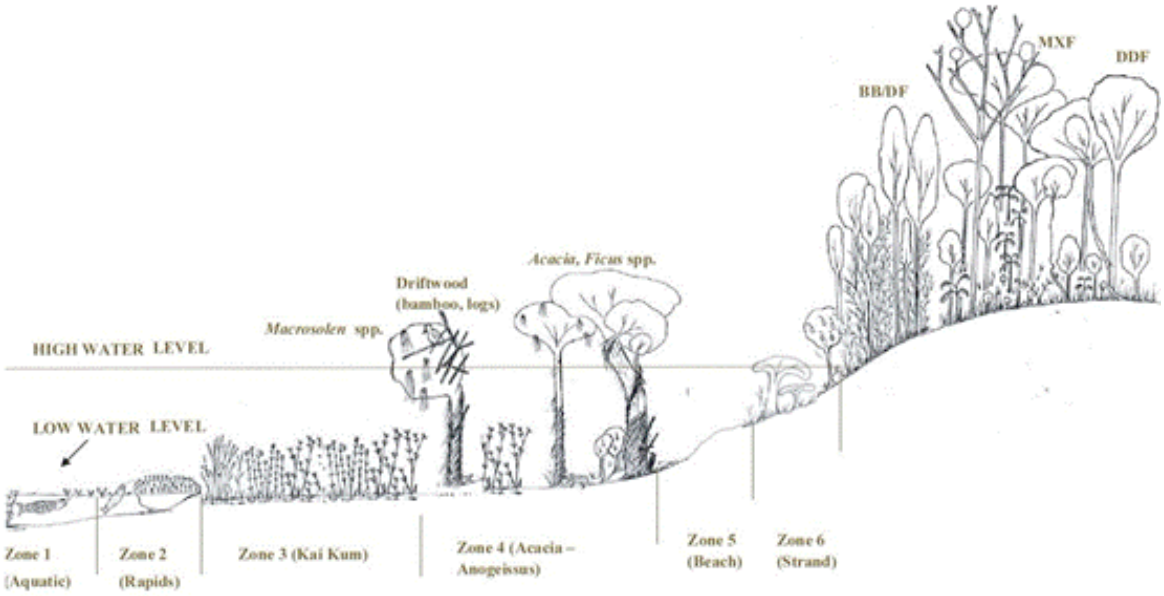

Figure 2: Riverine and terrestrial vegetation zones within the study area, from Bezuijen et al.(2008), p. 45, drawing by P. Palee.

The river channel habitats of the study area are of great regional significance for fauna. There are globally significant populations present of White-shouldered Ibis (*Pseudibis davisoni)*, Mekong Wagtail (*Motacilla samveasnae)*, Asian Giant Softshell Turtle (*Pelochelys cantorii)*, and Indochinese silvered leaf monkey (*Trachypithecus germaini)*, among others. The site is of very high conservation value, especially for aquatic and channel associated species, with many wetland birds known and over 200 species of fish (Bezuijen et al. 2008). Hunting is prevalent, in particular for smaller ungulates, turtles, and monitor lizards and collection of bird and turtle eggs is widespread. Some illegal and commercial fishing also occurs. Conversion of land for agriculture and settlement threatens all biodiversity in the site.

For the purposes of this assessment, we chose to focus on separate 'ecosystem components' and evaluate these individually. This approach was intended to allow for a clearer and more direct assessment of vulnerability than the general landscape alone. We separate:

- River channels, rapids and rocky outcrops,
- Deep pools,
- Sand formations,
- Flooded forest,
- Riparian/gallery forest, and
- Terrestrial forest.
-

River Channels and Rapids and Rocky Outcrops were initially considered and assessed separately, however as the latter occur strictly within the former and delineation is ultimately arbitrary, we here consider them together for the purposes of the assessment. We describe and define these components in detail in Table 2, below.

Table 2: Ecosystem components within the Mekong Flooded Forest.

Ecosystem Component	**Definition**
River channels, rapids and rocky outcrops RC, RRO	Permanently flooded areas are critical stable aquatic habitats and serve as a corridor for the migration of over 100 species of fish in the dry season (Warren et al. 1998). Channels also provide water for local communities as well as avenues for transportation and sites for recreation. The bottom substrates include alluvial deposits, varying from fine mud to larger pebbles and stones. Bedrock occurs in some areas of swiftly flowing current. The depth of the river varies from very shallow to over 18 m during the wet season. The flow of water along steep and narrow channels creates accelerated and turbulent flows resulting in rapids over rocky outcrops. The rapids provide critical migration cues and passages for fish in the basin, particularly during the dry season (Roberts 1993; Baird et al. 2004). These areas are also important for fish catch and tourism (IUCN 2008b).
Deep pools DP	Pockets of deep water within the Mekong riverbed provide important habitat and refugia for many species in the basin, including Irrawaddy Dolphins and a variety of migratory fish including the Mekong Giant Catfish. Estimates suggest that roughly 75% of fish caught downstream in the highly productive Tonle Sap fishery depend on migration to deep pools for dry season refuge, including those in the case study area (Poulson et al. 2002).
Sand formations SF	Sandbars, sandy beaches, and sandy islands shift according to seasons and flood patterns in the basin. They provide important habitat for a variety of species, including nesting habitat for some rare birds (Bezuijen et al. 2008). In the dry season, some sandbars are also used by local communities for vegetable cultivation (IUCN 2008a).
Flooded forest FF	Seasonally flooded forests comprise various forest types, with vegetation ranging from shrubs to trees over 15 m tall. These forests serve as important habitat and refugia, supporting a wide range of animal species (Baird 2007, Mollot 2005). Flooded forests are important fish habitat, and therefore fisheries productivity; thus food security depends on the integrity of the flooded forests. The area is also important for channel stability.
Riparian/gallery forest RF	Riparian/gallery forests are evergreen forests located directly above the riverbank, permanently out of the water. It may be flooded episodically during extreme floods. Riparian forest has a significant role in holding the river banks together and preventing erosion.

Ecosystem Component	Definition
Terrestrial forest TF	Forests found above the high-water mark in the case study area comprise a mixture of mixed evergreen, seasonally deciduous, hardwood, and bamboo forest. These provide critical habitat for many species, as well as timber and NTFPs for local communities.

Demographics & Livelihoods

Poverty is endemic throughout Cambodia, ranking just 139 from 177 countries in the UNDP Human Development Index (UNDP 2011). Kratie and Stung Treng provinces support some of the lowest human population densities in the Lower Mekong Basin, with 20-70 and 0-20 persons/km^2 respectively (Hook et al. 2003). Their populations were estimated in 2005 at 290,695 and 96,015 people respectively (Seila Programme 2005).

The villages in the eastern channels of the Mekong in the study area - Kampong Pnov, Ou Kok, Punthachea, Koh Khnhae, Ksach Liev, Koh Dambong, Kampong Roteh and Domrae – support fairly low and diffuse populations. In 2007, the total population of these villages was at least 5,553 people, though this estimate does not include new settlements (which are increasing rapidly) or seasonal visitation by non-residents. The number of people using natural resources in the area is therefore certainly higher. The majority of residents report their primary occupation as farming, supplemented by fishing, logging and hunting. Although most settlements belong to a village's administrative or traditional area, and most families have the permission of a relevant village chief to live there, there is no effective control or monitoring of in-migration and land clearing, both of which are ongoing. The *status quo* is unsustainable and the rapid degradation of riparian vegetation caused by preferential settlement and clearing on and near river banks is especially concerning. This uncontrolled settlement is a major threat to the important and unique features of the site, and the ecosystem services it provides.

Governance

In Cambodia, the state administration is structured around a hierarchy of national (Cheat), provincial (Khet), district (Srok), commune (Khum), village (Phum), and group (Krom) organizations. Laws and policies are set at the national level by the Royal Government of Cambodia and disseminated and implemented at the provincial, district, and commune levels.

Land use planning is initiated by communities and commune councils and is approved by the Provincial State Land Management Committee and relevant departments, such as the Department of Land Management Urban Planning and Cadastre, the Department of Agriculture Fishery and Forestry, and the Department of Environment. Land development planning follows these levels of approach:

- Provincial Development Plan (PDP) is a sector and local development plan, through coordination with provincial and district department lines and local planning units which are formulated by the Department of Planning, reporting to the Ministry of Interior.

- District Development Plan (DDP) reports to the provincial investment division (Provincial Office), every 3 months. DDP is either a sector plan or plan that is based upon the results of the commune development plan, which provides the framework for guiding investment decisions and represents a strategic policy document that describes the problems in a district to reconcile and integrate national development guidelines with local needs and requirements.
- Commune Administrative Management Law: the objectives of this Law are to establish administrative management of all communes in Cambodia through a policy of decentralization. The commune manages local affairs of its territory in accordance with the constitution, laws, royal decrees, sub-decrees, proclamations, and legal instruments concerned and thus the system of local governance shall be implemented at the commune level.
- Commune Development Plan (CDP) is a five year plan containing a three year rolling plan – roads, schools and culverts are currently the dominant topics in these plans. CDP reports to District Investment Office every 3 months. The annual Commune Investment Plan nested within this process.

In this assessment we later develop some broad policy directions and a series of more direct actions to reduce vulnerability at the site. We will focus on the commune level planning as a means to integrate priority recommendations directly at the scale of the site, and at a governance level close to and visible to the community.

Assessment methodology

Previous WWF work in the Mekong Flooded Forest

Prior to this VAA, social assessment and consultation was undertaken in 15 villages within the Mekong Flooded Forest, as part of the scoping for a Critical Ecosystem Partnership Fund project by WWF, the Cambodian Rural Development Team and Community Economic Development, to improve management of natural resources and protection of biodiversity within the area. The assessment and consultation process included recording of demographic and livelihood information, consultations on proposed project activities including discussion of the role of development organizations, and local preferences for project activities. An Indigenous People's Plan was also developed following the WorldBank guidelines to mitigate negative impacts of the project on customary rights of indigenous peoples. This scoping was used to inform the development of this assessment.

Village consultations

A vulnerability assessment was carried out through a series of consultations in six target villages in the Mekong Flooded Forest – Ou Kok, Puntachea, Koh Khnhae, Ou Krasang, Koh Entrachey, and Kampong Kboeung (all of these villages were previously surveyed during the social assessment). Villages were selected within two communes in close proximity to proposed core conservation zones. All villagers were invited to participate in the consultations, which were held over a single morning in each village. The assessment used consultation activities to gain an understanding of the perspectives and concerns of villagers on:

- the critical ecosystem goods and services in each community and the environmental assets that these depend on; and
- the impacts of extreme weather, weather-related anomalies and non-climatic threats on the community and environmental assets.

These consultations enabled an understanding of threats faced by communities in the study area; an understanding of how communities currently deal with these threats and how they plan to adapt to threats in the future. The consultations also formed the basis of determining key threats to ecosystems components, which were then assessed in the experts consultation.

Experts consultation

Using a modified version of 'Flowing Forward' (Le Quesne et al. 2010, Matthews and Wickel 2010), 16 national and regional experts evaluated the combined impacts of climate change projections and non-climatic threats in the site on ecosystem components (the attendance list can be found at Appendix 1: Experts Consultation Attendees).

Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, the system's sensitivity, and the system's adaptive capacity. The IPCC defines

three variables necessary to assess vulnerability: the climate hazard (exposure), sensitivity to the hazard, and the capacity to adapt or cope with the potential impacts.

Expert Consultation participants completed the following step-by-step analysis to assess vulnerability:

- Assess current ecological health and general trends of each ecosystem component across the study area. Participants were asked to give their professional opinions of the current ecological health and general trends for each ecosystem component based on their experience and site knowledge.
- Assess the potential impact of each climate and non-climate threat on each ecosystem component. This was done by rating the exposure and sensitivity of each ecosystem component to each threat (Figure 3). Potential impact is a function of exposure and sensitivity. Exposure relates to the extent of the impact (geographically and/or temporally) intensity) on the ecological component/landscape, whereas sensitivity relates to the degree to which a system/species is affected, either adversely or beneficially. When exposure is related to sensitivity, the degree of potential impact is understood.
- Rate the adaptive capacity of each ecosystem component to climate and non-climatic threats, to understand vulnerability. Adaptive capacity refers to the ability of the system to change in a way that makes it better equipped to manage its exposure and/or sensitivity to a threat. Figure 4 outlines the relationship between adaptive capacity and potential impact, used to score a vulnerability ranking.

Adaptation strategies were then developed to maintain or increase the resilience of the environment and local community. Adaptation strategies were developed for those threats that contributed most to the vulnerability of ecosystem components, i.e. those ranked as vulnerable, highly vulnerable or extremely vulnerable.

Adaptation actions were prioritized according to cost and impact. The potential cost of each action was coarsely estimated to be: none-to-low, within the bounds of typical project expenses, or exceptionally expensive. The impact of the project on the area of the site was estimated to be: very localised, part of the site, most or all of the site 0r all of a significant component (i.e. all of the river or all of the forests), or all of the site and beyond. Figure 5 shows the matrix used for prioritising adaptation options.

Potential Impact Matrix					
Exposure	**Very High**	Moderate	High	Very High	Extremely High
	High	Moderate	Moderate	High	Very High
	Moderate	Low	Moderate	Moderate	High
	Low	Very low	Low	Moderate	Moderate
		Not Sensitive (robust)	**Slightly sensitive**	**Sensitive**	**Highly Sensitive**
		Sensitivity			

Figure 3: Potential impact matrix: the relationship between exposure and sensitivity in determining the degree of potential impact from a threat (adapted from Hills and Bennett, 2010)

Vulnerability Matrix					
Potential impact	**Extremely High**	Vulnerable	Highly Vulnerable	Highly Vulnerable	Extremely Vulnerable
	Very High	Moderately vulnerable	Vulnerable	Highly Vulnerable	Highly Vulnerable
	High	Slightly vulnerable	Moderately Vulnerable	Vulnerable	Highly Vulnerable
	Moderate	Limited vulnerability	Slightly vulnerable	Moderately Vulnerable	Vulnerable
		Substantial	**Moderate**	**Minor to Some**	**Very little to none**
		Adaptive capacity			

Figure 4: Vulnerability matrix: the relationship between potential impact and adaptive capacity in determining the degree of vulnerability to a threat (adapted from Hills and Bennett, 2010)

Impact		**Very localised**	**Part of site**	**Most or all of site**	**All of site and beyond**
Cost	None to low	Medium	Medium	High	High
	Typical project costs	Low	Low	Medium	High
	Exceptionally expensive	Low	Low	Low	Medium

Figure 5: Criteria used to rank priority of adaptation options

Vulnerability Assessment

This section outlines the results of the vulnerability assessment process, including the existing data on threats and their impacts, and the results of the village and expert-level consultations. We outline the situation through the village level assessment. Then we outline those non-climatic and climate change induced threats identified in the workshop from local knowledge, in the literature, and through climate modelling.

Next, we outline the vulnerability of ecosystem components based on the assessment during expert consultation and describe in detail the major vulnerabilities associated with each component. We also introduce actions to reduce vulnerability associated with threats to ecosystem components. These actions are detailed further in the *Key Adaptation Strategies* section, following.

Situational Assessment

Village vulnerability assessment

The key environmental assets identified by villagers reflect their primarily subsistence lifestyles. Villagers were asked to list key ecosystem goods and services on which they depend, and the environmental assets that support these were then identified. With few economic opportunities the communities depend heavily on the natural environment to sustain themselves, with hunting and logging also widespread in the site; this is reflected in the river and forest consistently being ranked as most the important assets (Figure 6).

Villages tended to nominate a similar pool of key environmental assets (Figure 6), however there were deviations in their order of rankings. River and forest assets received highest rankings because participants tended to separate these into several components that for the purposes of presentation we have grouped similar assets; e.g. community forest, spirit forest, and other forest were all grouped together under “forest”, likewise streams, pools and river were all grouped together as “river”. The nominated assets were to be used during expert consultation to assess the specific vulnerability of each asset to climate change. However, due to the range of assets listed by communities this was not possible. Instead, the information on key environmental assets has been used in the vulnerability assessment to understand community dependence on particular ecosystem goods and services, and inform the development of actions.

In Boeng Char Commune, the significance of the river and forest was considered primary, whilst villages in Ou Krieng Commune were more focussed on those assets aligned with to economic benefits such as rice fields and timber resources. This may stem from the slightly greater connection of Ou Krieng to markets based on the east bank of the Mekong River, and the higher population density in the area. Communities in Boeng Char tend to be more isolated and less developed, depending more heavily on shifting traditional land uses and subsistence hunting.

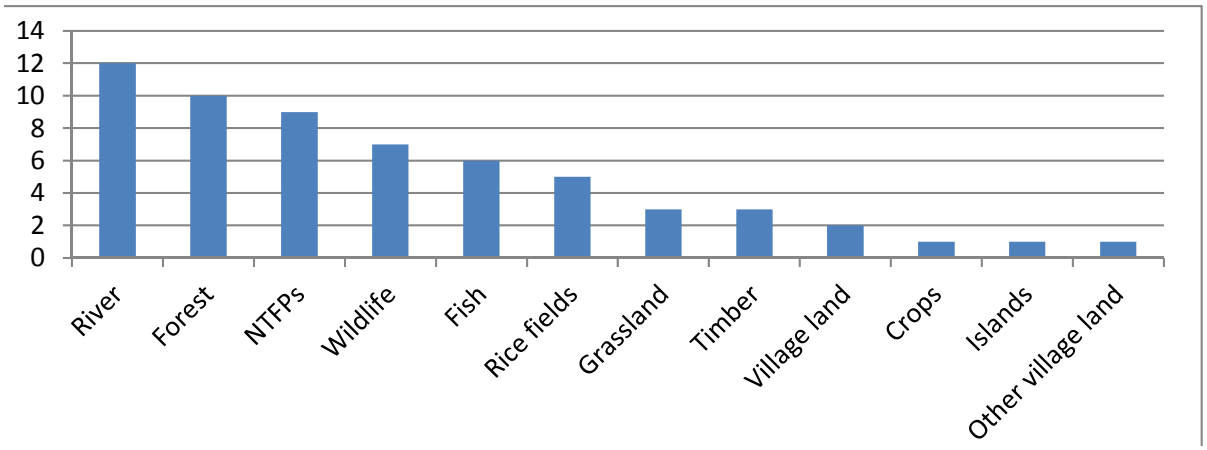

Figure 6: Frequency that environmental assets were ranked in the top 10 environmental assets across all villages.

In Ou Krieng Commune environmental assets in each village were similar, but rankings of these assets were dissimilar. The most important assets in Koh Khnhae Village were pools, rice fields, village land, community forest and wood. In Ou Kok Village the most important assets were village land, rice fields, community forest and bamboo. The most important assets in Puntachea Village were luxury wood, other wood, bamboo, fish and deer. Other environmental assets identified include grass land, pools, streams and wildlife (e.g. White-shouldered Ibis).

In Boeng Char Commune, the river and forest were considered the most important environmental assets. In Ou Krasang and Kampong Kboeung Villages the river was ranked most important, followed by the forest. In Koh Entrachey Village, the forest was ranked primary. Other common environmental assets in this commune include rice fields, pools, fish, wildlife (including dolphins and birds), bamboo, islands, lakes, and streams.

The key non-climate threats identified by villagers in the target area include proposed construction of hydropower dams, economic land concessions (and the resulting loss of village land), illegal deforestation, illegal fishing, and over-exploitation of mineral resources and wildlife.

Non-Climatic Threats

Threats to the study area include both current and emerging or potential threats. Current threats observed in the Mekong Flooded Forest are symptomatic of the human activities that have led to the decline or extirpation of many taxa and natural habitats elsewhere in the region.

Three principle causal factors are responsible for most threats to biodiversity in the study area:

- Increasing population growth and settlement,
- Unsustainable natural resource exploitation by residents and visitors, and
- Incursion of impacts from wider provincial development.

Through effective planning these causal factors could be reduced, therefore planning – or a lack thereof – is a key issue in the area.

Emerging threats to biodiversity in the study area mainly arise from development projects, especially hydropower, conversion to industrial agriculture in areas of economic land concession, and roads that are proposed or under construction along the Mekong River and tributaries in North-East Cambodia, and nearby Lao PDR and Viet Nam. Without careful oversight and mitigation measures, these developments may cause severe and cumulative impacts to biodiversity when added to existing threats.

Hydropower is of particular concern. Within the Mekong Basin there has been burgeoning hydropower development, especially in the last decade. There are currently 12 proposals for mainstream projects in the Mekong Basin, one of which, the Sambor Dam, is just below the project site, and a second, Stung Treng, not far above the site.

The Sambor proposal is currently understood to be a 56 m high, 18 km wide structure generating 2,600 MW. Located across the Mekong River at Sambor Town, the reservoir would extend nearly to Stung Treng Town, inundating more than 62,000 ha, including 13,000 ha of forest and necessitating the resettlement of more than 19,000 people. It would have extensive impacts on the environment at the study site (ICEM 2009).

There is limited public information available on the Sambor proposal however according to the MRC's Strategic Environmental Assessment for hydropower in the Lower Mekong Basin any single or multiple developments are likely to have the following impacts:

1. A net loss of fisheries and decline in fisheries based enterprises. Also a loss in productivity of the Mekong Delta fishery.
2. A net loss of riparian agriculture and forestry, and a decline in nutrient levels (via sediment transport) to farm lands. Some areas however may benefit from irrigation opportunities.
3. A net loss of commercially valuable aquatic plant species.
4. A downturn in the booming tourism sector caused by the impacts on popular fauna, such as the Irrawaddy Dolphin.
5. Loss of key wetland areas, and their environmental services.

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The impact on food security and economic costs associated with increased malnutrition amongst vulnerable populations are likely to be high. The poor would be disproportionally negatively impacted by mainstream hydropower development.

The proposed Stung Treng dam on the Mekong just above Stung Treng town, and the Lower Sesan II dam, under construction on the Sesan River are also expected to have similar negative impacts, with the exception that they would be less pronounced, and the vast majority of the site would not be flooded in consequence.

Table 3: Non-climatic threats, their impacts, and associated factors contributing to the threat and the impacts. Two-letter codes below each impact indicate which threats are associated with the ecosystem components identified in Table 2. (This table has been adapted from Bezuijen *et al*. 2008, Page 136.)

	Threat	Impact	Factors driving each threat
Current threats	Clearance for new settlement	- Most new settlement is restricted to riverbanks alongside the mainstream and islands due to the proximity to boat transport, with interior patches on some larger islands converted to rice cultivation - Clearing results in rapid fragmentation and loss of riverbank vegetation - Loss of riverbank forest results in loss of critical nesting and/or foraging habitat for 7+ threatened bird species and 2+ mammal species - Loss of riverbank forest increases exposure of riparian vegetation nearest high-water mark and terrestrial forests to edge effects (altered microclimate, increased vulnerability to fire). The net area of impacted habitat is much greater than the area cleared RC SF FF RF TF	- Residents of established villages are moving due to land shortages and colonizing new sections of riverbank - Arrival of new migrants - Seasonal migrants clear land for a home and crops during their stay - Expansion of existing cultivation areas - Slash-and-burn shifting cultivation practices
	Unregulated timber extraction	- Loss of forest along riverbanks and island interiors - Loss and damage of riparian vegetation through logging, branch removal, and seasonal firewood collection - Increased fuel-loads from discarded wood causes increased risk of dry season fires - Loss of specific high value species RF TF	- Subsistence timber use - Commercial timber demands outside study area
	Burning	- Loss of forest along riverbanks and island interiors - Deliberate or accidental (e.g. campfires) burning of riparian vegetation - Fire in channel woodlands, bushlands, and accumulations of flotsam - Frequent burning suppresses seasonal recruitment of non-fire-tolerant flora and increases likelihood of invasive species colonizing and/or loss of native species FF RF TF	- Subsistence land use - New settlement - Large seasonal influx of highly flammable flotsam - Cattle grazing - Flush wildlife from cover
	Smallholder Cultivation Expansion	- Loss of forest for crop conversion, especially along riverbanks (usually after logging, burning, construction of seasonal camps, or permanent settlements) - Loss of terrestrial forest to commercial crops and monoculture plantations (e.g. cassava) - Smallholder cultivation on sandbars, particularly for watermelon. SF FF RF TF	- Increasing food needs of human population - Increased economic opportunities in communities
	Economic Land Concession	- Large and expanding sugar cane plantation in the south of the site is clearing large areas of forest, and will cause local communities to use other forest areas more intensively. - Expansion of site and construction of refinery plant will cause increasing clearance, and increasing intensity of use at the site, which will degrade the surrounding areas - Other concessions have been granted around the site RF TF	- Economic development - Non-transparent allocation of land concessions - Minimal or incomplete environmental and social assessment processes
	Fishing	- Population declines of commercially valued species - Fishing methods (e.g. intensive gillnet fishing, poison, explosives) target all size classes and impact breeding females	- Subsistence fish use - Commercial fish demand in Kratie, Stung Treng, and elsewhere

	Threat	Impact	Factors driving each threat
		- Most fisherman conduct opportunistic hunting of other fauna, including large mammals (especially Long-Tailed Macaque), birds, turtles, and collection of eggs of birds and Cantor's Giant Softshell Turtle - Accidental entanglement of Irrawaddy Dolphins in gillnets (Gilbert and Beasley 2006) - Loss and damage of riverbank forest and other riparian vegetation due to associated activities – camp construction, camp fires, firewood collection - Seasonal fishing camps develop into permanent settlements RC RRO DP FF	
	Wildlife hunting and trade	- High risk of local extirpation for most remaining large mammal species, especially Long-Tailed Macaque and Hog Deer - Population declines of 23+ bird species, 6 turtle species, large lizards, and snakes due to commercial and subsistence hunting of adults and/or egg collection - Population decline of Cantor's Giant Softshell Turtle due to egg collection (subsistence use) and incidental capture of breeding adults - Collection of parakeet eggs RC RRO DP SF FF RF TF	- National and international commercial demand for wildlife consumption and/or medicinal use - Subsistence hunting - Exotic pet trade - Poor regulation of wildlife farms
	Weed invasion	- *Mimosa pigra*, an invasive species from South America, is spreading along the Mekong and will increase as more sections of riverbank forest are cleared - May outcompete native flora - Difficult to remove once established - Other invasive species are establishing in the region SF TF	- Infestation will increase as natural vegetation is cleared
	Algal bloom	- Algal blooms in the dry season in some slow flowing areas can impact other aquatic vegetation and may impact the habitats of some aquatic fauna RC	- Changes in nutrient levels, water flow, and temperature
	Pollution – via irrigation, industrial use, sewage, and dams	- Decline in water quality would negatively impact upon fish and other aquatic fauna RC RRO DP	- Economic development - Changing agricultural practices - Higher population densities - Poverty and poor sanitation
	Motorboat traffic	- Disruption of wildlife as traffic increases - Stressor for dolphins RC RRO DP	- Higher population densities - Tourism
	Mining and quarrying	- Mining of minerals, especially gold, quarrying for rock, and extraction of peat - Heavy metal contamination of waterways and the land from mining tailings has serious negative health implications for flora and fauna, as well as humans - Contamination from artisanal mercury use in riverside gold extraction	- Economic development - High price of gold

	Threat	Impact	Factors driving each threat
		- Direct removal and disturbance of habitat through excavation - Noise pollution - In-migration of small- to mid-scale gold miners into site increases peripheral impacts (land clearing, burning, fishing, hunting, logging) - Additional people inhabiting riparian areas – leads to more fishing, hunting, burning, wood collection. RC RRO DP SF FF RF TF	
Emerging threats	Hydro-power development (1): Proposed Sambor Dam in Study Area	- The reservoir would inundate almost all of the riverine habitats in project site, and cause the loss of most species and habitats - Many potentially irreversible impacts, particularly to water quality, migratory fish, and Irrawaddy Dolphin. Sambor rapids and associated deep pools "*are important fish habitats, particularly for spawning and refuge purposes*"; 75% of total catch in Dai fisheries in Tonle Sap Lake depend on availability of deep pool habitats in North-East Cambodia, including Mekong mainstream from Kratie – Khone falls (Poulsen et al. 2002b) - Dam construction could cut or impede fish migration corridors between floodplain habitats in the south and refuge habitats in the north, and interfere with fish larval drift systems (Poulsen et al. 2002b) - Probable extirpation of the entire Mekong River population (Cambodia, Lao PDR) of the Irrawaddy Dolphin, due to isolation of dolphin groups above and below dam, and loss or alteration of critical deep pool habitats (4 of 9 deep pools utilized by dolphins are within 15 km of the proposed dam site; 6 are within the reservoir zone, and 1 immediately downstream of the wall) (Ryan and Goichot 2011) - Loss of most flooded forest habitat within the area - Resettlement of almost all villages in the project site – resulting in further land clearing elsewhere RC RRO DP SF FF RF TF	- Regional and national economic development - Regional and national electricity demands
	Hydro-power development (2): proposed or under construction nearby the study area	- Extensive dams exist on many tributaries, including the nearby 3S Rivers (Sesan, Srepok and Sekong) and on the mainstream in China. All have variable and cumulative impacts on downstream hydrology. Dams along the 3S Rivers could significantly impact mainstream hydrology because most are annual storage schemes with large reservoirs. - The close upstream proximity to the study area of the impending Lower Sesan II and proposed Stung Treng dams and/or cumulative impacts of these dams would potentially cause a wide range of biological impacts. In particular, a dampened annual flow regime, with higher dry seasons and lower wet seasons, will drastically alter the vegetation zonation. Sediment deposition would also be decreased, which could alter the extent of sandbar habitats. Water releases from these dams would also have impacts on the vegetation structure and could cause irreversible erosion of banks and sandbars - Nearby dams could result in severe impacts to fish migration (Baran & Ratner 2007), including the study area, and decline or local extinction of Irrawaddy Dolphin in the Mekong River Basin (Ryan and Goichot 2011) RC RRO DP SF FF RF TF	- Regional economic development in Cambodia, Lao PDR and Viet Nam - Regional and national electricity demands
	Expanding road network	- Improved transport routes for transfer of wildlife, fish, and other natural resources from study area to urban centres - Further roads will be built as land concessions are developed and communities expand RC RRO DP SF FF RF TF (All indirect impacts)	- Provincial economic development

Villagers' perceptions on threats from changes in weather patterns

All communities surveyed have experienced extreme drought and flood events. In five of the six villages, drought was ranked as having the greatest impact on the community and livelihoods, followed by flooding. In Koh Entrachey Village, flood was ranked as having the greatest impact, followed by storms and drought. The strong reliance on good annual rice harvests among most of the communities may be the source of general concern over drought. In the case of Koh Entrachey however, this island community may be at greater risk of the river flooding rice fields, rather than insufficient water.

Other weather-related anomalies perceived by communities were an extended dry season, increased temperatures, increased storm activity, extended wet season, increasingly unpredictable weather, and increased lightning. Extended wet or dry seasons may be of especial concern to communities as it affects the timing and quality of annual harvests. Lightning and storms are violent weather events that may damage property and crops, and harm people. Unpredictable weather was defined as unexpected shifts between hot and cold weather and may be of concern because subsistence lifestyles may rely on the predictability of weather to determine when to plant rice and other crops.

Villagers were asked about trends in the frequency and impact of extreme events, such as drought and flooding. However, there was no coherent trend in the perceived frequency or impact of such events over the past 20 years.

Projected climatic threats

In global assessments, the Mekong basin has been projected to be severely impacted by the effects of climate change (UNEP 2009). Climate change will alter the water cycle, shifting the timing, duration, and intensity of rainfall patterns and seasons, changing the hydrology of rivers and groundwater flows, and altering the quantity, quality, availability, and distribution of water (ICEM 2010, TKK and SEA START RC 2009, Bate et al. 2008, Eastham et al. 2008). These changes will impact food production (Fraiture et al. 2007) and ultimately human nutrition and livelihoods (TKK and SEA START RC 2009, MoE and UNDP 2011).

The following table (Table 5) presents the projected ecosystem-related impacts of climate change on various environmental attributes at the project site. Projected impacts have generally been taken from two studies:

1. Eastham et al. (2008) - an analysis undertaken by the Australian Commonwealth Scientific and Industrial Research Organisation, using the A1B scenario from the IPCC 4th Assessment Report. The A1B scenario was chosen as it as it represents a midrange scenario in terms of development impacts on greenhouse gas emissions. The assessment is to the year 2030 and projections are for Kratie Province.
2. MRC (2011) - an analysis undertaken by the Mekong River Commission (MRC), which uses climate change data based on daily climate projections of two emissions scenarios

(A2 and B2) from the IPCC. The assessment is to the year 2050, and projections are made at the regional (Mekong Basin) level.

The Second National Communication prepared by the Royal Cambodian Government's Ministry of Environment in 2010, and the Cambodian Human Development Report (MoE and UNDP, 2011) were also consulted in putting together Table 4.

Table 4: Projected climatic threats, and the associated ecosystem and socio-economic impacts. This table has been collated from [1]Eastham et al. (2008;), [2]MoE (2010), [3]MRC (2011),and [4]MoE and UNDP (2011).

Climate element	Projected trends	Ecosystem impacts
Temperature	- Increase in the mean annual temperature by 0.7° C – 0.8° C by 2030[1] - Beyond 2030, temperature increases are expected to accelerate[2]	RIVER CHANNELS & DEEP POOLS: • The higher temperatures are likely to lead to increased demands for water for agriculture, which in turn may increase water diversions for irrigation • Changes in water temperature may impact biota GROUNDWATER: • Secondary impacts to groundwater from temperature increases and higher evaporation rates as more groundwater is withdrawn by villagers to meet increasing demand, and less water permeates below the surface before evaporation FORESTS: • Higher evaporation rates lead to drier soils, increased stress on trees, and potentially increased fire susceptibility • Vegetation shifts toward species assemblages that can tolerate increased evapotranspiration rates and consequent biodiversity changes and losses RRO DP SF FF RF TF
Precipitation	- Mean annual precipitation increased by 101-200 mm[1] - Increase in wet season precipitation. Rainfall will be more intense (i.e. more will fall in short time periods)[1] - Dry season precipitation decreased[1]	RIVER CHANNELS & DEEP POOLS • Changes in water availability could lead to reduced water quality, and greater water scarcity, particularly in the dry season. This is turn could have significant impacts on fisheries FORESTS: • Changes in rainfall patterns will affect the survival of seedlings, cropping calendars and crop varieties • Increased risk of soil erosion and degradation of watersheds RC RRO DP SF FF RF TF

Climate element	Projected trends	Ecosystem impacts
Runoff and river flow	- Annual runoff increased[1] - Dry season runoff decreased[1] - Increases in river flow in both the wet season and the dry season[3] - Increase in annual mean flow in the wet season by 4-13%[3] - Increase in the annual mean flow in the dry season by 10-30%, therefore, more water available in the dry season[3] - Largest increases in water volume will be seen from the Chinese border to Kratie (i.e. including the project site). This is caused by (projected) increase in rainfall in the upper parts of the lower Mekong Basin[3]	RIVER CHANNELS & DEEP POOLS: • Changes in runoff and river flows could lead to reduced water quality, particularly in the dry season, which in turn would have significant impacts on fisheries RC RRO DP SF FF RF TF
Extreme events	- Frequency of extreme floods increased from 5% to 76% annual probability[1] - Increased risk of flooding in the wet season and increase in flooding frequency, severity and duration[1]: o The areas affected by flooding due to rainfall and upstream freshwater flow from the Mekong River Basin are estimated to increase by 9%[3] o The area where the flooding depth is high (e.g. 2 m) would increase by almost 40%, meaning that the intensity of the floods is expected to increase[3] - Higher drought risks (2025-2050)[2]	RIVER CHANNELS & DEEP POOLS: • Increase in riverbank erosion leading to a decline in water quality and sedimentation of waterways; this is turn would have significant impacts on fisheries • Erosion reduces the extent of riparian forest and potentially reinforces the cycle of river bank loss FORESTS: • Potential loss or changes in island edge assemblies • Shift to drought-tolerant species and decline of semi- and evergreen forests RC RRO DP SF FF RF TF

Climate element	Projected trends	Ecosystem impacts
Seasons	- Drier and longer dry season[4] - Shift in timing of wet season[4] - Shorter, wetter, wet season[4]	FISHERIES: • Potential (but unknown) shifts in fish migration, due to change in the trigger effect of the timing of the wet season[4] • Some species are able to survive the dry season, as long as there are some viable fish refuges. It is not known how well they will be able to survive for longer, drier, and potentially hotter periods[4] • Reduction of key habitats (e.g. flooded forest) under drier and longer dry season scenarios[4] • Dry season broodstock more exposed to fishing effort[4] • Migration triggers affected by shorter, wetter rainy seasons[4] o It also means a reduced season for breeding and spawning, and reduced feeding – reduced opportunity for juveniles to reach suitable size and maturity to continue migration and life cycle[4] FORESTS: • Exposing forests to a longer dry period might reduce forest productivity and increase the risk of fire. If forests are being logged there is a risk that it will take longer for them to regenerate. With increased risk of fire, forests are at risk of turning into shrub or unproductive lands[4] RC RRO DP SF FF RF TF

Potential socio-economic impacts

The potential socio-economic impacts of the projected ecosystem impacts from climate change scenarios occur across a breadth of ecosystem-impacts and are detailed below.

Water resources

A decrease in dry season water availability will lead to increased competition for water between sectors and among different users. These effects will be felt most acutely by small-scale farmers and fishers (MoE & UNDP 2011). Reduced water quality and availability for domestic use will have enormous impacts on human health, with most rural people still directly dependent on natural water bodies for drinking water (MoE & UNDP 2011). In addition, collecting water from farther afield will be more demanding on labour and time, and most likely felt by women and children (MoE & UNDP 2011).

Fish and other aquatic resources are extremely important for food security and nutrition, contributing up to three-quarters of animal protein in rural diets (Hortle 2007). Fisheries are a significant economic activity; in 2009, fisheries contributed 25.2% of the agricultural sector (MoE & UNDP 2011) and, if anything, this figure is likely to be significantly underreported. Any impacts on fisheries would have disastrous consequences for nutrition, income, and community wellbeing.

Forest resources

Any loss of productive forests, as well as of biodiversity, will lead to loss of income or livelihood options for forest-dependent communities. This can also lead to atypical insect growth cycles that can further affect agriculture and forests (MoE & UNDP 2011).

Agricultural resources

Studies suggest that, on average, rice yield can be expected to decrease by 10% for every 1° C increase in minimum temperature during growing season (MoE & UNDP 2011). This is because higher temperatures at the time of rice flowering could lead to floret sterility, limiting the grain yield. Impact on rice yield is predicted to be significant. MoE (2010) estimates that rice yields will decrease under both high and low emission scenarios, and will continue to decrease within a staggering range of 70-20% of current production based on different seasons and scenarios (MoE & UNDP 2011).

People

The project site could be on the receiving end of population migration and displacements. Large numbers of people will become climate refugees, and are expected to migrate from the Greater Mekong region into the site, due to its comparatively high levels of natural resources (Warner et al. 2009). This would put significant additional strains on the local environment. Loss of life and property through extreme events may also occur.

Ecosystem vulnerability assessment

The results of vulnerability rankings for each ecosystem component are presented in Table 5. The vulnerability of each ecosystem component, along with potential adaptation strategies, is discussed separately below. Following these, the vulnerability of the Mekong Flooded Forest is discussed holistically. Although we did not assess the site as a single entity during expert consultation, we assume that the key threats to each ecosystem component are also threats to the entire system, and that many site-scale adaptation strategies will address several threats.

The most significant threat to all ecosystem components is the proposed Sambor Dam (all ecosystem components were ranked as extremely vulnerable to it). As this threat is of such broad scope, Sambor Dam and potential adaptation strategies are discussed within the generalized *Mekong Flooded Forest* part of this report below.

Many adaptation options to address threats that increase vulnerability are mentioned in this section. The *Key adaptation strategies to address vulnerability* section provides specific details on these adaptation strategies.

Table 5: Vulnerability rankings for each ecosystem component.

	River channels, rapids & rocky outcrops	**Deep pools**	**Sand formations**	**Flooded forests**	**Riparian forests**	**Terrestrial forests**
Current ecological health	Moderate to high	Moderate to high	Moderate	Moderate to high (tall vegetation) Moderate (shorter vegetation)	Low to moderate	Moderate
Trend	Declining	Declining	Declining	Declining	Declining rapidly	Declining rapidly
Vulnerability	Vulnerable	Vulnerable	Vulnerable	Vulnerable	Highly vulnerable	Highly vulnerable

River Channels, rapids and rocky outcrops

River channels, rapids and rocky outcrops were ranked as vulnerable, with a declining trend in ecological health (Table 5). The most significant threats to this ecosystem are anthropogenic pressures: fishing, and wildlife hunting and trade. In particular, illegal fishing, and the hunting of turtles and waterbirds were considered key threats. As the human population pressure in the study area increases, the impacts of fishing and hunting on river channel fauna will continue to increase. The channels are also considered vulnerable to other human behaviours, such as pollution, mining, and vessel traffic (Table 6).

Table 6: Climate and non-climate threats to river channels, rapids and rocky outcrops, and their relative vulnerability

Extremely vulnerable	Highly vulnerable	Vulnerable
• Hydropower development – proposed Sambor Dam • Wildlife hunting and trade • Fishing	• Increase in the intensity, frequency, and duration of flooding • Decreased dry season runoff • Decreased dry season precipitation • Hydropower development – other dams in the study area	• Pollution • Motorboat traffic • Mining and quarrying

Channels are also highly vulnerable to a range of climatic threats (Table 6). Projected climate scenarios suggest that the impacts of climate change will exacerbate the threats listed in 6. For example, climate change related impacts will result in changing water quantity and quality; this is in turn expected to impact negatively on fish and other aquatic fauna living in river channels, and reduce food security.

Several adaptation strategies are recommended to reduce the combination of threats facing river channels. **Improved fishery regulation** will enhance fisheries sustainability and ability to cope with climate and non-climate stressors. Improving governance and enhancing law enforcement in the Mekong Flooded Forest will help to reduce the impacts of other human activities on the environment. In particular**, improving compliance** and **identifying gaps in fisheries regulations** and wildlife harvesting in collaboration with local agencies may improve fisheries sustainability and reduce vulnerability. The river is highly vulnerable to wildlife hunting and trade, and fishing; therefore it is strongly recommended that **targeted enforcement** of wildlife and fishing laws be undertaken in conjunction with local communities.

It is important to **protect the river from mining** and the detrimental impacts this activity has on the environment. Additionally, increasing motorboat traffic should be addressed by **protecting dolphins from boats**.

Pollution of river channels is expected to increase under climate change because of changes in water quality and quantity; therefore, **improved water management and conservation,** and in particular **improved waste water management** are recommended.

Deep Pools

Deep pools were assessed as vulnerable, with a declining trend in ecological health (Table 5). A significant threat to deep pools is fishing, in particular overfishing and illegal fishing. As population pressure in the study area increases, the impacts of fishing on deep pools is reasonably expected to increase; this may lead to reduced species diversity and declining populations of fish and other aquatic fauna.

The key climate change related threats to deep pools are decreased precipitation in the dry season and decreased dry season runoff. These threats will result in changing water quantity and quality, and will in turn impact negatively on fish and other aquatic fauna living in deep pools. There are also a range of human induced threats to deep pools such as fishing, pollution (primarily through

agricultural and industrial use), and mining. These threats are expected to increase with infrastructure development and population growth.

Many of these threats, both human-activity and climate-induced, are expected to impact the role of deep pools as slow-water refuges for fish in the dry season.

Table 7: Climate and non-climate threats to deep pools, and their relative vulnerability

Extremely vulnerable	Highly vulnerable	Vulnerable
• Hydropower development – proposed Sambor Dam • Fishing	• Decreased dry season runoff • Decreased dry season precipitation • Hydropower development – other dams in the study area • Mining and quarrying • Motorboat traffic • Pollution	• Increase in river flow in wet and dry season

Several adaptation strategies were suggested to address deep pool vulnerability. **Applying appropriate zoning to balance conservation and development**, by identifying deep pools in need of critical protection and providing additional protection to these, will help mitigate the projected climate threats. This is important as deep pools provide essential habitat for many aquatic species during the dry season. In particular, deep pools are considered crucial to maintaining fisheries.

In all community workshops, fish were ranked in the top 10 environmental assets (Figure 6). A range of suggested adaptation strategies address fisheries management, such an **improving regulations** and **promoting sustainable fisheries.**

Sand Formations

Sand formations are considered vulnerable, with a declining trend in ecological health (Table 5). They were assessed to be the least vulnerable of all ecosystem components. This is likely due to the inherent dynamic nature of sand formations and the regular seasonal disturbances to which they are accustomed, as well as having minimal resources subject to exploitation.

The most significant threat to sand formations is mining and quarrying. Mining and quarrying are currently carried out commercially around the Mekong Flooded Forest (sand dredging downstream and a major rock quarry to the East), as well as rapidly increasing numbers of artisanal gold miners during the dry season in the channel areas of the southern and central parts of the site.

Sand formations are vulnerable to other anthropogenic pressures, including land clearance (for new settlements), hunting, and the introduction and spread of invasive species. Sand formations are also highly vulnerable to a range of climate threats (Table 8), such as those that would lead to their erosion and modification. Changes in river flow and flooding will alter the extent and location of sand formations, and in some areas their extent may be greatly reduced.

Table 8: Climate and non-climate threats to sand formations, and their relative vulnerability

Extremely vulnerable	Highly vulnerable	Vulnerable
• Hydropower development – proposed Sambor Dam • Mining and quarrying	• Clearance for new settlement • Wildlife hunting and trade • Invasive species • Hydropower development – other dams in the study area • Increase in the intensity, frequency, and duration of flooding • Increase in river flow in wet and dry season	• Increased annual temperature

A range of recommendations have been developed to address threats to sand formations. To minimise the impact of mining, uptake and enforcement of forthcoming United Nations Development Programme (UNDP) mining regulations is recommended, in conjunction with **improved enforcement** of existing mining regulations. It is also key to **understand and manage sand extraction** to inform the development of regulations on sand extraction and identification of existing gaps in regulation.

Flooded Forests

Flooded forests are assessed as vulnerable, and the ecological health of flooded forests is declining (Table 5). Flooded forests play a boundary role and can thus be impacted by processes effecting both the terrestrial and aquatic environments.

The most significant threats to this ecosystem are anthropogenic pressures: smallholder expansion, unregulated timber extraction, burning, fishing, and hunting (Table 9). As the human population in the study area increases, the impacts of fishing and hunting on river channel fauna will continue to increase. It is likely that threats resulting in clearing of this forest type (namely burning and settlement) pose the most significant and widespread impacts.

Table 9: Climate and non-climate threats to flooded forests, and their relative vulnerability

Extremely vulnerable	Highly vulnerable	Vulnerable
• Hydropower development – proposed Sambor Dam	• Hydropower development – other dams in the study area • Smallholder cultivation and expansion • Unregulated timber extraction • Burning • Fishing • Wildlife hunting and trade • Invasive species • Pollution • Mining and quarrying • Expanding road networks	• Clearance for new settlement • Economic land concessions • Increased annual temperatures • Increase in river flow in wet and dry season • Increased risk of forest fires

Flooded forest is also vulnerable to a range of climate threats (Table 9) that may exacerbate existing non-climatic threats. The greatest impacts of climate change on flooded forests will be an increased annual temperature, which combined with decreased dry season precipitation will lead

to an increased risk of forest fires (to which flooded forests are vulnerable). They are also vulnerable to changes in hydrology – in particular an increase in river flow in both wet and dry season (as projected for the Mekong Basin).

To address these vulnerabilities, **protection and restoration of forests** is essential to mitigate the impacts of changes in hydrology and increased river flow. Increased forest cover may also reduce the impact of rising temperatures. Flooded forests are considered key fish habitats, and therefore it is important to **promote sustainable fisheries** and **improve fisheries regulation** to preserve the integrity of flooded forests. In conjunction, communities could self-monitor fish catch to **demonstrate food security benefits**. Flooded forests are also highly vulnerable to invasive species, so it is essential to **manage invasive species**, this may include further research into effective control methods of *Mimosa pigra*.

Riparian Forests

Riparian forests are assessed as highly vulnerable, with rapidly declining ecological health (Table 5). Riparian forests are frequently subject to degradation through anthropogenic activities and although they occur in restricted locations, these are the same areas that are favoured by people for settlement and movement through the landscape. Key human-induced threats include expanding road networks, hunting, introduction and spread of invasive species, burning, unregulated extraction, and clearance for new settlements or expansion of cultivated land (Table 10).

Table 10: Threats to riparian forests, and their relative vulnerability

Extremely vulnerable	Highly vulnerable	Vulnerable
• Hydropower development – proposed Sambor Dam	• Hydropower development – other dams in the study area • Increased risk of forest fires • Increase in river flow in wet and dry season • Increase in the frequency, intensity and duration of flooding • Expanding road networks • Invasive species • Wildlife hunting and trade • Economic land concessions • Burning • Unregulated timber extraction • Smallholder cultivation and expansion • Clearance for new settlements	• Decreased dry season run-off • Decreased dry season precipitation • Increased annual temperature • Mining and quarrying • Fishing

There are several climate pressures that make riparian forests highly vulnerable. The greatest impact is expected to result from an increase in river flow, which will potentially lead to erosion of river banks and riparian vegetation.

Riparian vegetation is important for maintaining bank stability. Therefore, it is essential to **protect and enhance riparian buffers** and **restore degraded habitats** to maintain ecosystem resilience, prevent bank erosion, and provide shade, habitat and other amenities. Effective enforcement of the 150m riparian buffer zone for economic land concessions, and creating space for retreat of the riparian forests would further prevent riverbank erosion. Riparian

buffers will be particularly important if any proposed hydropower development occurs upstream of the site, therefore it is imperative to protect riparian buffers, and replanting them may be necessary to restore degraded areas to create buffers from any changes in water flow as a result of dam construction.

Terrestrial Forests

Terrestrial forests are the most vulnerable ecosystem component, with rapidly declining ecological health (Table 5). These forests are extremely vulnerable to infrastructure development, poor land-use planning, and population growth, such as threats from economic land concessions, expansion of road networks, and land clearance for new settlements or cultivation expansion. As population pressures increase in the study area, climate change will exacerbate these impacts. It is imperative to ensure that further detrimental impacts from loss of terrestrial forest cover and biodiversity do not occur.

Table 11: Climate and non-climate threats to terrestrial forests, and their relative vulnerability

Extremely vulnerable	Highly vulnerable	Vulnerable
• Hydropower development – proposed Sambor Dam • Clearance for new settlement • Smallholder cultivation and expansion • Economic land concessions • Expanding road networks	• Hydropower development – other dams in the study area • Burning • Wildlife hunting and trade • Invasive species • Mining and quarrying • Increased annual temperature • Decreased dry season precipitation • Increased annual runoff • Increased risk of forest fires	• Unregulated timber extraction • Increased annual precipitation

The greatest impacts of climate change on terrestrial forests will be an increase in temperature (which will impact the deciduous forests in particular) and a reduction in dry season precipitation, which in combination with an increase in temperature will lead to increased forest fires.

As the climate-related threats are expected to exacerbate the human-induced pressures on terrestrial forests, several adaptation strategies are recommended. Conservation of terrestrial forests is essential for adaptation at the site, as forests are one of the main environmental assets for villages in the Mekong Flooded Forest (Figure 6). Therefore, **improved management and conservation** of terrestrial forest is imperative. This action should also include **improved community awareness of environmental protection**.

Another major threat to terrestrial forests is burning, and therefore it is imperative to **reduce burning** to protect forests from further destruction.

The Mekong Flooded Forest

Although the site was not assessed as a whole, threats are common to many of the ecosystem components, and many actions and strategies were developed that addressed numerous

components. All ecosystem components are vulnerable to a range of projected climate change impacts. As the communities in the Mekong Flooded Forest are highly tied to environmental goods and services, it is important to enable these communities to adapt to both current and future threats by reducing vulnerability. The best way to provide for these communities is to protect the environmental assets and services on which they depend.

All ecosystem components are extremely vulnerable to the threat of the proposed Sambor Dam and the majority of ecosystems were considered highly vulnerable to the threat of the proposed large scale hydropower development upstream. If the Sambor Dam is built as outlined currently, almost all of study area would be inundated (except for the centre of the very large Koh Rohngeav Island) and the environmental and socio-economic values of these natural ecosystems would be lost.

Key adaptation strategies to address vulnerability

Reducing vulnerability requires strategies to reduce exposure to a threat, sensitivity to a threat, or to build the capacity of communities to adapt – i.e. to minimize the threat in some way. During expert consultation we asked participants to identify strategies and actions that would result in reduced vulnerability to the range of threats discussed. Identified actions focussed on four key themes that underlay the majority of threats, namely: undervaluing of the site and its resources, weak governance and natural resource management at the site, a lack of appropriate land-use planning processes, and the looming threat of hydropower development, especially at Sambor.

Subsequently, points of action to reduce vulnerability were organized around four key strategies:

1. **Improve governance and natural resource management at the site,**
2. **Improve land-use planning in and around the site,**
3. **Raise the profile of the site and improve understanding of its value, and**
4. **Address the threat from hydropower development.**

By addressing the core factors that underlie virtually all significant threats, these strategic areas directly reduce the threats to local communities and the environment on which they depend. Below we expand on these strategies with a series of prioritized actions, and describe some steps toward them based on brainstorming sessions during expert consultation. We also describe how each action reduces threats to the community and the landscape, and provide suggested steps for each action.

Improve governance and natural resource management at the site

The majority of threats focus around natural resource management – such as illegal clearing, illegal logging and burning, unsustainable fishing and hunting, and mining. Climate change is expected to exacerbate these threats – namely that the impacts of droughts, floods and changes in rainfall and temperature patterns will reduce groundwater retention and the absence of physical ecological barriers will exacerbate the impacts of extreme weather events. For example, these physical buffers include natural benefits such as the heat-reducing effect of trees compared with bare ground or artificial structures, or the ability of vegetation to prevent erosion.

During expert consultation participants agreed that a strategy to improve natural resource management in the area – and the many and varied actions that this implies – is most likely to be effective in increasing the ability of the community and environment to adapt in the future while reducing threats contributing to vulnerability. Actions within this strategy are detailed in Table 12, along with some steps, and the priority level of the action (based on the matrix in Figure 5), and how this action will reduce threats that exacerbate vulnerability.

Table 12: Adaptation options to improve governance and natural resource management at the site, ordered by priority level.

Action	Suggested steps	Priority	How the action will reduce vulnerability
Enhance riparian buffers	• To prevent riverbank erosion, enforce the law requiring a 150 m riparian buffer around economic land concessions. • Manage and enhance this buffer as a biodiversity corridor. • Rehabilitate degraded riverbanks: establish a nursery for supplying native species and engage communities in the restoration of degraded riverbanks. • Conduct a study to assess the success of natural regeneration through direct seeding, as continuous cover is required for riverbank stability. • Protect intact riparian forest and restore select areas of riparian forests to maintain ecosystem resilience, prevent bank erosion, and provide shade, habitat, and other amenities. • Raise awareness of the importance of riparian forests and the services they provide.	High	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with threats • Reduce erosion • Maintain fisheries
Develop payments for environmental services for biodiversity conservation schemes	• Rationalise/make sustainable hunting/trade by, amongst other things, entraining hunters to become rangers via education, awareness raising and provision of incentives for alternative livelihoods (e.g. payments for nest protection). • Investigate REDD+ feasibility – connect with Prey Long.	High	• Provide financial incentives to maintain ecosystem services that maintain resilience • Improve ability of ecosystems to cope with threats
Protect and restore forest	• Ensure coordination with FA by hiring RECOFTC training. • Protect intact riparian forest and restore select areas of riparian forests to maintain ecosystem resilience, prevent bank erosion, and provide shade, habitat, and other amenities. • Raise awareness of the importance of riparian forests and the services they provide. • Increase the emphasis on the protection of riparian forests (i.e. retain the existing riparian forest).	Medium	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climate threats • Reduce erosion • Increased forest cover may reduce the impact of rising temperatures • Stabilise landscape and retain topsoil • Provide sustainable resources (NTFPs, some timber)

Action	Suggested steps	Priority	How the action will reduce vulnerability
Investigate alternative conservation and management initiatives	• Pair Royal University of Phnom Penh study + action/research to incorporate LEK and involve community members. Combine with NTFP awareness.	Medium	• Improve ability of ecosystems to cope with climate and non-climate threats
Improve community awareness of environmental protection	• Collaborate with Association of Buddhists for the Environment and other groups to increase appreciation of the value of wildlife and promote community stewardship of natural resources.	Medium	• Improved stakeholder understanding of climate change
Target enforcement	• Work with communities, government, and other stakeholders to reach consensus on critically important areas where governance/enforcement of laws (fisheries, forestry, wildlife hunting, trade, and fire use) should be enhanced as a priority.	Medium	• Improved law enforcement • Community, government and other stakeholder engagement in law enforcement • Improved sustainability of resource use
Improve fishery regulations	• Identify gaps in fisheries regulation and enforcement, and seek to improve compliance, efficient enforcement, and revise regulation – in collaboration with local communities, the Fisheries Administration and other relevant agencies. • Improve management of fisheries and fish habitat in the Mekong Flooded Forest	Medium	• Improve sustainability of fishery resources • Improve environments on which fisheries resources depend • Improved enforcement of regulations • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of fisheries to cope with threats
Protect the river from mining	• Enforce existing regulations on gold mining and identify regulatory gaps to protect high biodiversity areas from rapid destruction due to increasing dry season extraction. • Minimize the impact of mining on fishery and aquatic resources through the uptake and enforcement of forthcoming United Nations Development Programme mining regulations (when available).	Medium	• Improved water quality • Decreased contaminant runoff • Decreased incidental degradation (burning, hunting, fishing, logging, clearing) • Decreased disturbance of river banks
Promote fishery sustainability	• Educate and raise awareness about sustainable fishing practices. • Conduct a comparative analysis of fish catch within the study area through community self-monitoring to establish baseline information.	Medium	• Improve sustainability of fishery resources • Improve environments on which fisheries resources depend • Improved enforcement of regulations • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of fisheries to cope with threats

Action	Suggested steps	Priority	How the action will reduce vulnerability
Protect dolphins from boats	• Showcase best practice management of vessel traffic around cetaceans, and develop strategies to minimize the impact of vessel traffic on dolphins in the Mekong River with communities around key dolphin habitats and relevant government agencies.	Low	• Reduced stress on dolphins
Improve waste water management	• Promote better regulation and/or adoption of best practice standards for waste water discharge.	Low	• Improved water quality
Reduce burning	• Construct a series of fire towers and initiate fire brigades to facilitate enforcement of fire laws. • Use the FAO's education and outreach strategy to reduce burning.	Low	• Improved law enforcement • Increased community understanding of impact of burning on the environment
Understand and manage sand extraction	• Conduct research into the impact of sand mining on the river channel to inform the development of regulations on sand extraction.	Low	• Maintain sand formations in the site
Improve water management and conservation	• Implement actions to improve water quality and quantity to ensure clean supplies for communities and sufficient environmental flows. • Improve sanitation within villages. • Implement a water quality monitoring program. • Implement water conservation initiatives. • Promote organic farming methods, which reduce reliance on harmful chemicals in agriculture	Low	• Improved water quality • Improved health and quality of life for local communities • Improved availability of water and reduced impact on water supply
Investigate alternative livelihoods	• Conduct comprehensive livelihood analysis and create opportunities for sustainable livelihood improvement and diversification.	Low	• Improved health and quality of life for local communities
Manage invasive species and/or climate refugee species	• Implement a program to control invasive species in priority locations, particularly targeting *Mimosa pigra*. • Research effective control methods for *M. pigra*.	Low	• Improved ecosystem health • Mitigate the impacts of changes in hydrology and increased river flow on ecosystem components

Improve land-use planning in and around the site

Another key theme threatening the communities' dependence on the ecosystem is conflicting land-use and inadequate planning and zoning, in particular inappropriate clearing at both the smallholder and industrial scale. More coordinated and strategic land-use planning is the obvious solution.

Clearing of the natural ecosystem reduces its resilience to climate change impacts by reducing the resilience of the system to supply ecosystem services, and thus reduces the many benefits these services provide to local and broader communities, both now and into the future. Participants

recognized, at least tacitly, that some land-use change in and around the site is inevitable, especially through clearing. Structured strategic land-use planning, which balances economic development with other important values that landscapes can provide, is essential to maintaining the adaptive capacity of the ecosystem and reducing threats that increase vulnerability. In particular, the riparian zones are the focus for strategic protection in the site.

Table 13: Adaptation options to improve land-use planning at and around the site, ordered by priority level.

Action	Suggested steps	Priority	How the action will reduce vulnerability
Designate the Mekong Flooded Forest a 'special management site'	• Designate the Mekong Flooded Forest as a 'special management site'. • Ensure that appropriate regulations accompany designation. • Build enforcement capacity. • Provide incentives for communities to honour the zoning designations. • Ensure zoning maintains floodplain • Enact a zoning and management plan in the site	High	• Raise awareness of the importance of Mekong Flooded Forest and the biodiversity values and communities it supports • Improve management and sustainability of natural resource use • Retain ecosystem services at the site
Promote integrated planning	• Promote increased integration in planning from the community to national level, including promoting inter-agency coordination in land-use planning. This would involve working with officials and communities on commune development plans, and coordination with provincial planning units	High	• Community, government and other stakeholder engagement in land-use planning • Retain ecosystem services at the site
Apply appropriate zoning to balance conservation and development	• Designate sanctuaries/work lots/community production forests within land-use plans. • Designate appropriate and inappropriate areas for mining and quarrying to occur. • Designate and implement vegetation protection 'zones' on islands and hilltops. • Identify priority areas of flooded forest and designate them for community fish conservation zones; to be developed, managed, and monitored by communities. • Identify deep pools in need of critical protection and provide additional protection to these pools.	High	• Protect essential habitat for many aquatic and terrestrial species • Improve ability of ecosystems and communities to cope with climate and non-climate threats • Community, government and other stakeholder engagement in land-use planning • Retain ecosystem services
Develop appropriate road networks	• Promote 'feeder' roads rather than roads running parallel to the riverbank and ensure that the road network is integrated into land use planning. • Manage accelerated in-migration if roads are built.	High	• Retain riparian buffers • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climate threats • Reduce erosion
Protect riparian buffers	• Create space for the retreat of riparian forests by ensuring that no permanent structures are developed within the riparian zone.	High	• Mitigate the impacts of changes in hydrology and increased river flow

Action	Suggested steps	Priority	How the action will reduce vulnerability
			• Increased groundwater retention • Enhance physical buffers to extreme weather events • Reduced erosion
Restore degraded habitat	• Identify important forest areas, which have been degraded and designate them as priority restoration areas.	High	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climate threats • Reduce erosion • Increased forest cover may reduce the impact of rising temperatures
Integrate climate change into planning	• Ensure land-use plans take into account the potential impacts of climate change (and other changes) on: o groundwater, and include provisions to buffer groundwater (to the extent possible) from climate change by maintaining vegetation structure in priority areas. o formation and persistence of sandbars and other sand formations by maintaining optimal vegetation structure and composition to increase resilience to erosion	High	• Improve ability of ecosystems and communities to cope with climate and non-climate threats • Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Reduce erosion
Offer incentives to complement planning	• Develop/offer incentives to maintain intact landscape around the Mekong Flooded Forest: o REDD+ feasibility (Prey Long) and/or community forests/sanctuaries o Offer incentives to not develop communities in the Mekong Flooded Forest and prevent unofficial settlements.	Medium	• Improve ability of ecosystems and communities to cope with climate and non-climate threats • Manage threat of increased population pressure on the environment • Generate sustainable income
			• Improve sustainability of resource management • Improved enforcement of regulations • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems and • Communities to cope with climate and non-climate

Action	Suggested steps	Priority	How the action will reduce vulnerability
Improve regulations	• Improve and accelerate the community forest designation process. • Assist communities within the study area with land registration to prevent land-grabbing, and as a tool to minimize ongoing settlement	Medium	• threats • Manage threat of increased population pressure on the environment

Raise the profile of the Mekong Flooded Forest

Many of the major threats stem from short-sighted use of land and natural resources. These were in part attributed to undervaluing or less than full understanding of the ecosystem benefits the site provides to the local community. Improving knowledge of these benefits and raising the profile of the area both nationally and locally is expected to provide impetus for improving the management of the area and significantly smooth the way for those actions that may appear to conflict with short-term economic benefit.

Table 14: Adaptation options to raise the profile of the Mekong Flooded Forest, ordered by priority level.

Action	Suggested steps	Priority	How the action will reduce vulnerability
Dialogue with government	• Targeting key government agencies, use both an indirect approach, through provincial coordination processes and dialogue with government partners and other stakeholders, as well as more overt 'showcasing' such as media, communications opportunities, etc.	High	• Improved management of natural resources at the site • Impetus to retain adaptive capacity via ecosystem services
Advocate against land concessions in the Mekong Flooded Forest	• Develop a case to present to government to convince it that it should not grant economic land concessions in Mekong Flooded Forest.	High	• Retain ecosystem services in the site • Retain sustainable natural resource uses
Dialogue with community	• Dialogue with stakeholders, as well as more overt 'showcasing' such as media, communications opportunities, etc.	Medium	• Community engagement in future planning for the Mekong Flooded Forest • Grassroots impetus to retain the values of the site
Demonstrate food security benefits	• Emphasise/demonstrate role of flooded forests in food security in terms of the life cycles of fish and other aquatic fauna.	Low	• Improve sustainability of natural resource extraction • Retain fisheries • Retain NTFPs

Address the threat from hydropower

The proposed Sambor Dam is considered a key threat, with all ecosystems considered highly or extremely vulnerable, by local communities and experts alike; the dam threatens all ecosystem services, livelihoods and biodiversity values of the site. The proposed dam would alter the site beyond recognition and reduce or obviate virtually all benefits the site now provides. Addressing

the threat from hydropower, and in particular the Sambor Dam, is a critical step to reducing this looming threat to vulnerability.

Although there are a series of proximate effects from some of the actions proposed here – that we list under *how the action will reduce the vulnerability* (Table 15), ultimately the underlying aim for the major actions is to reduce the vulnerability of the site by retaining its existence. The consequence then, is that to maintain resilience, the Sambor dam in the very large form it is currently planned should never be built.

Table 15: Adaptation actions that address the threat from hydropower development, ordered by priority level.

Action	Suggested steps	Priority	How the action will reduce vulnerability
Develop advocacy strategy	• Coordinate among civil society groups, local communities, and other organizations to generate joint advocacy and policy positions related to dam developments in the Mekong Flooded Forest and around the region. • Promote the investigation of alternatives to large destructive dams (e.g. Thakho, or 'Little Sambor' – diversion canal)	High	• Influence decision making • Bring attention to the plight and vulnerability of local communities and ecosystems to stakeholders and policy • Retain the biodiversity and socio-economic values of the site
Investigate alternative energy sources	• Investigate alternative energy sources. • Investigate the 'demand' and economic benefit of selling this electricity.	High	• Bring cost effective, ecosystem-harmonious alternatives to the discussion table • Reduce reliance on unsustainable natural resource use
Support a strategic approach to development	• Encourage, support, and facilitate a more strategic approach to hydropower development, such as consideration of which combination of dams and or alternative power generation sources would yield the best combination of environmental and socio-economic benefits. • Encourage adherence to MRC agreement of 1995 and Procedures for Notification, Prior Consultation and Agreement. • Encourage adherence to Procedures for Maintenance of Flows in the Mainstream (PMFM).	High	• Improve long-term sustainable management of ecosystems • Strengthen risk analysis and benefit sharing • Maintain ecosystem services at the basin level, while encouraging development opportunities with minimal degradation
Re-plant riparian buffers	• Plant riparian vegetation at new margins if the dam is built.	Medium	• Increased groundwater retention • Enhance physical buffers to extreme weather events • Mitigate the impacts of changes in hydrology and increased river flow • Improve ability of ecosystems to cope with climate and non-climatic threats • Reduce erosion

Discussion Points

Ecosystem-based adaptation is a means to help people and their landscape adapt to climate change and other threats using ecosystems and biodiversity. The communities in the Mekong Flooded Forest are intrinsically linked to the environment. Their reliance on natural resources for much of their livelihoods makes this a very direct relationship. Under such circumstances, ecosystem-based adaptation is very clearly an efficient and effective means of reducing the vulnerability to the impacts of climate change. As we have outlined, we believe our approach, in addressing ongoing and predicted threats, both from climate change and otherwise, is the most feasible and realistic way to adapt to climate change in a rapidly changing physical, social, and economic landscape.

The methods applied here involve coarse-grained, simple analyses, rapid elicitation of lay and 'expert' opinion. Nonetheless, with the broad consultation at both village and expert level, and the use of other available data, we believe that this approach fulfils our stated aim: to identify strategies to reduce the vulnerability of the communities and landscape at our target site to climate change and other threats. There are some limitations to our method however, that warrant discussion.

For instance, many of the adaptation strategies presented address the adaptive capacity potential of human communities, rather than the adaptive capacity of the ecosystem component (one cannot change the inherent adaptive capacity of an ecosystem component). This presents a difficulty in drawing explicit links from vulnerability to adaptation strategies directly. We do not consider this an issue, as in general, the actions presented here are clearly linked to our aim of reducing the impact of climatic and other threats.

The vulnerability for specific components was calculated as the arithmetic average of the vulnerability to all of its threats. Indexing in this way is not ideal as it assumes equality and tradability among threats such that a high level of vulnerability to a relatively major threat and a low vulnerability to a relatively minor threat will score as equal to the converse, when common sense suggests otherwise. Furthermore, this method ignores the compounding effect of additional threats, which makes ecosystem components increasingly vulnerable. Future applications of our methods may want to consider dealing with this issue. Additionally, there was very limited consideration given during expert consultation to assess how the vulnerability of ecological components relates to socio-economic vulnerability. This is an important point, and one that has been tacitly presumed in this work. Future investigation of this interrelation would be of value to similar assessments in the future.

A range of cross-comparisons of more fine scale could also add value to the process, for prioritizing and targeting actions in more depth. Although we did assess the relative vulnerability of different ecosystem components, it would also be useful to gain a deeper understanding of this. For example, which area of riparian forest is more vulnerable than another area of riparian forest, or another deep pool, or reach of river channel. This may aid identification of where particular threats manifest themselves, and therefore adaptation strategies can be more targeted and effective.

Realistically, this would be expected to align with areas already degraded and closest to proximate threats, which may or may not be the best target for a given action (e.g. degraded river bank may be well suited to revegetation, but not to designation as a conservation zone). It would also be valuable to pinpoint the greatest environmental and socio-economic values in the landscape, in order to assist in the prioritisation of adaptation strategies. Some of this information is available, and will be of relevance to future work with communities in adopting and implementing adaptation strategies.

This document and the strategies developed herein are not considered an end point, but rather an initial step in what is hoped to be the ongoing development and integration of ecosystem-based adaptation measures in the Mekong Flooded Forest and surrounding areas. We detail this process in the following section.

Next Steps

In this vulnerability assessment we have attempted to identify the major threats to the Mekong Flooded Forest and develop strategies that reduce the vulnerability of local communities and ecosystems to these threats both now, and under future projections of climate change. In most cases, threats are anthropogenic and stem from infrastructure development, land-use, and natural resource exploitation. As population pressure in the study area increases, the impacts of these threats will continue to degrade the Mekong Flooded Forest with negative impacts on ecosystem health and productivity that will have flow-on negative effects on local communities. There are also a range of climate change impacts that are expected to exacerbate existing threats.

We have developed a range of adaptation strategies to reduce vulnerability, by either reducing exposure or sensitivity to threats, by enhancing the adaptive capacity of the ecosystem, or by increasing the ability of communities to use the environment sustainably whilst maintaining or enhancing existing ecosystem structure. The aim following this report is to implement these strategies. Some of this will be through organizational policy and projects. The key, however, is to achieve on-the-ground implementation. This will require careful consultation and support to those relevant government agencies responsible for local-scale natural resource management.

The application of these strategies will take three directions:

- **Supporting community and commune level planning and development processes at the site,**
- **Supporting institutional governance at the site, and**
- **Directing WWF policy and strategic planning.**

Commune investment/development plans are the basis for local scale land-use and management. The incorporation of high priority actions into commune investment plans is considered to be the most efficient means of achieving on the ground change. The next phase of this project will focus on working carefully with relevant communities and commune councils to identify gaps that reduce or prevent priority action occurring, assess means of bridging these gaps, and integrating key actions and strategies into the commune-level planning process. The initiation of this process has already begun.

Working with relevant institutions, including the provincial governments in both Kratie and Stung Treng, the Fisheries Administration, the Forestry Administration and others, WWF and partners will continue to support improved governance at the site and support the integration of priority actions into management processes. Such support will include the enforcement of natural resources laws, and identifying further strategic options to protect and manage the site. *For example*, a series satellite images have been obtained to determine the rate of deforestation in the area and identify hotspots of deforestation. These images will be used to benchmark the status of some ecosystems components and thus monitor changes into the future. This forms part of WWF's commitment to improve management of water resources in the Mekong River, and focus on the river channel landscape section from Kratie to Siphandone in Lao PDR.

Finally, organizational policy directions, such as strategic approaches to hydropower development, strategic funding priorities, etc., will be advised, at least in part, by the overarching strategies and high level actions identified here.

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Appendix 1: Experts Consultation Attendees

Name	Organization	Role
Brian Lund	Oxfam America	Participant
Peter-John Meynell	Independent Consultant	Participant
Mam Kosal	WorldFish	Participant
Thanapon Piman	University of Canterbury, NZ	Participant
Taber Hand	Conservation International	Participant
Bou Vorsak	BirdLife International *In Indochina*	Participant
Sum Phearun	BirdLife International *In Indochina*	Participant
Kong Kimsreng	IUCN	Participant
Chheng Phen	IFReDI	Participant
Meas Seanghun	Royal University of Phnom Penh	Participant
Hean Pheap	CRDT	Participant
Hou Kaylan	RECOFTC	Participant
Geoff Blate	WWF Greater Mekong	Facilitator
Erin Nash	WWF Greater Mekong	Facilitator
Melissa Rodgers	WWF Cambodia	Participant
Gerry Ryan	WWF Cambodia	Participant
Nou Chanveasna	WWF Cambodia	Participant
Gordon Congdon	WWF Cambodia	Participant

Siphandone-Stung Treng-Kratie Landscape in Numbers

3rd

largest population of White-shouldered Ibis in Cambodia and the world present in the Mekong Flooded Forest, with a minimum of 124 individuals

190km

of dolphin habitat remains from Kampi in Kratie to the Laos border

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+56km

long section of the Mekong Flooded Forest between Kratie and Stung Treng towns is recognized as a biodiversity hotspot of international significance

4

communities fisheries supporting 623 households

Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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