CLIMATE CHANGE RESILIENCE MEASURES

1. Subprojects in Khammouane, Luangprabang and Oudomxay consist of infrastructure improvements such as road upgrades, development of small ferry piers, and improvements to tourist amenities and sanitation at established tourist sites (Table 1). A detailed description of the proposed subprojects is in the Project Administration Manual. The sustainability of the completed subprojects depends in part on the resilience of the infrastructure to climate change. Of particular interest are the General Circulation Model (GCM) projected changes to average rainfall intensity and wind which will alter the incidence of inland high water levels in rivers, flooding, and land erosion and landslides.

2. The GCMs forecasts warming trends across the whole country with regional variations in magnitude. Mean annual temperatures are projected to increase 0.1 - 0.3 degrees centigrade per decade[1] with warming occurring in all seasons.[2] The greatest rainfall increases will occur during the wet season while dry season periods are projected to become longer. Projected increases in rainfall are 10-30% in the eastern and southern part of the country, which will see an increase in the frequency and severity of storm events.

Table 1. Summary of Planned Infrastructure Subprojects

Subproject	Location and Description
Xang Cave Access Improvements	**Thakhek City, Khammouane.** The subproject will: (i) improve the 4 km rural access road leading to the site; (ii) upgrade existing green space, walking paths and the cave's internal lighting system; and (iii) construct vendor kiosks, parking, and public toilets.
Chomphet Heritage District Access Improvements	**Chomphet District, Luangprabang.** The subproject will: (i) upgrade the Mekong ferry terminal and 2 km of internal roads in Ban Xieng Maen; (ii) construct 500 m embankment retention, drainage, and public toilets; and (iii) rehabilitate 4 concrete landings beneath the temples north of the village.
Ban Xang Hai–Pak Ou–Tham Ting Cave Access Improvements	**Pak Ou District, Luangprabang.** The subproject will: (i) improve the 10 km rural access road leading to the site; (ii) rehabilitate about 1,000 m of internal footpaths and drainage and 4 concrete landings; and (iii) supply 6 modular steel pontoons.
Chom Ong Cave Access Improvements	**Xay District, Oudomxay.** The subproject will (i) improve the 54 km rural access road from Oudomxay Town to the cave; (ii) construct public tourist amenities at the site; and (iii) install a 1,000 m network of illuminated walking paths inside the cave.
That Sikhottabong Environmental Improvement	**Thakhek City, Khammouane.** The subproject will (i) rehabilitate 2 km of internal roads, 2 bridges, and the existing tourist information center; and (ii) construct a solid waste transfer station, small materials recovery facility, public toilet blocks and parking area to service up to 10,000 visitors daily.

3. Changes to the rainfall regime are particularly relevant to the subprojects in Khammouane and Luangprabang, due to their proximity to the Mekong River. The 4th International Panel on Climate Change (IPCC) report indicates that maximum monthly flows in the Mekong Basin are expected to increase by 35-41% with minimum monthly flows decreasing by 17-24% over the current millennium. The resultant changes to the hydrograph of the river will substantially increase flooding, and flood damage risk in the wet season, and water scarcity in

[1] UNEP/AIT Regional Resource Centre for Asia & the Pacific. 2013. *Assessment, Gaps and Needs for SE Asian Countries for Addressing Impacts, and Vulnerability to Climate Change*

[2] *In* FAO 2011. *Managing Climate Change Risks for Food Security in Lao PDR*. Rome

the dry season. The climate resilience measures included in the infrastructure subproject's preliminary design are summarized below.

A. Xang Cave Access Improvements

4. The subproject component most susceptible to flooding and erosion is the upgraded access road and bridge. The foundation of the upgraded road will be raised above present grade to an elevation that will be immune to the most severe flooding that could be expected in the adjacent low lying areas as per GCM projections for the region. The preliminary designs call for a rise of 1 m in the road elevation. The ford that will be constructed across the stream near the cave entrance will withstand increased stream velocities and levels during extreme rainfall or flooding events.

B. Chomphet Heritage District Access Improvements

5. The climate change sensitive aspects of the subproject is the improved ferry terminal/ramp on the Mekong river embankment at Xieng Mene village; the footpaths to the temples north of Xieng Mene; and the upgraded pedestrian steps from the Mekong River up to the temples. The upgraded ramp and temple steps will be constructed of reinforced concrete with foundations and surface materials that will accommodate greater and extended periods of high water levels in the Mekong River during the rainy season, which also will withstand the greater shoreline currents that will accompany the higher water levels.

C. Ban Xang Hai–Tham Ting Caves Access Improvements

6. The technology and installation of the planned modular floating pontoon piers at the Tham Ting caves will accommodate a greater range of water levels and nearshore current speeds in the Mekong River due to increased regional rainfall. Similar to the Chomphet Heritage District subproject, the upgraded steps to the river will also withstand elevated water levels and shoreline currents. The upgrades to the road between Pak Ou and Xang Hai will be designed to avoid potential subsidence in certain sections. Specially designed concrete anti-erosion and embankment structures will be placed along the road where needed.

D. Chom Ong Cave Access Improvements

7. The activity that is susceptible to climate change is the upgrade to the 54 km road to Chom Ong Cave. The design of the road will include adequate grading and drainage in lowland-areas to prevent flooding. Bank stabilization along steep-sloped sections of the road will be placed to prevent erosion and subsidence. The upgraded bridges along the road will withstand increased river levels and flows anticipated from increased regional rainfall.

E. That Sikhottabong Environmental Improvement

8. The new and upgraded buildings, internal roads and footpaths, and other facilities in the Stupa compound will be set on foundations that are high enough to avoid possible future flooding in the area from extreme rainfall events.

F. Reduced Greenhouse Gas Footprint

9. The subprojects incorporate climate-friendly infrastructure technology that will reduce greenhouse gas emissions and the carbon footprint of the tourist facilities. Strategies to reduce greenhouse gas emissions are, for example, installation of energy efficient lighting technology at all tourist sites; enforcing directives for tourism transport providers to comply with speed limits along the upgraded access roads; promotion of low-carbon transportation in tourist sites

(electric vehicles and human-powered vehicles/walking); and the application of energy efficient technologies for solid waste and wastewater management at the tourist sites. In particular is the application of anaerobic baffled reactor (ABR) septic and infiltration field technology to treat wastewater. The replacement of pit latrines and poorly maintained septic tanks with the in-field ABR systems will reduce emissions of greenhouse gases (i.e., methane) to the atmosphere. The project will also support the national and provincial tourism authorities to implement the green hotel standard/certification program agreed by the Association of Southeast Asian Nations (ASEAN).[3]

[3] ASEAN Secretariat. 2008. *ASEAN Tourism Standards.* Jakarta. There are 6 standards: (i) green hotel, (ii) food and beverage services; (iii) public restroom, (iv) home stay, (v) ecotourism, and (vi) tourism heritage.