CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

CTCN Technical Assistance
Response Plan

Country:	Lao PDR
Request Identification Number:	2016000024

Title:	City Climate Vulnerability Assessment and Identification of Ecosystem based Adaptation Investments

Summary of the CTCN Technical Assistance

Lao PDR has requested CTCN for technical assistance to undertake **city level climate vulnerability assessment of people and ecosystem service provision** in six cities. This technical assistance is required so that city specific **ecosystem based adaptation (EBA)** responses can be identified and subsequently implemented as part of a proposed Green Climate Fund (GCF) project. The knowledge and data obtained from the CTCN technical assistance will strengthen the technological underpinning and design of the GCF project.

Currently, there is no quantitative assessment of the climate risks at the local city level in Laos. Such an assessment is necessary for design of appropriate city level adaptation response plans to climate change. For appropriate ecosystem based adaptation response plans to be developed, it is further necessary to know how climate change is currently impacting, and is likely to impact more in the future, ecosystems –service provision to the populations of these six cities. With a proper vulnerability analysis of ecosystem services in place, adaptation interventions will be more specifically targeted and designed on specific populations and their livelihoods.

This CTCN assistance seeks to quantify city level climate risks in six cities in Laos by carrying out an assessment of the current ecosystem services utilised by the population, producing a vulnerability analysis at city level. This analysis will form the basis for prioritising and designing adaptation actions to increase the resilience of urban infrastructure and livelihoods in urban and peri-urban areas. The CTCN assistance will identify, prioritise and design adaptation technological options for both city centres and peri-urban areas, in the form of strategically prioritised skills, knowledge and equipment.

1. Overview of the CTCN technical assistance

1.1 Technology aspects

CTCN has requested technical assistance to undertake city level climate vulnerability assessment of people and ecosystems at Laos' six most socio-economically important cities. This technical assistance is required so that city specific ecosystem based adaptation (EBA) responses can be identified and subsequently implemented as part of a proposed Green Climate Fund project. The knowledge and data obtained from the CTCN TA will improve the foundations and accelerate the start-up of the GCF project.

It is expected that the urbanisation will take place at a higher speed during the years to come and that the climate changes may negatively impact the urbanization process. A traditional urban development approach will only result in climate related problems being exacerbated, including loss of ecosystem

services unless a re-thinking of urban development is made in which ecosystem based approaches are introduced.

Currently there is no quantitative assessment of the climate risks at the local city level in Laos. Such an assessment is, however, necessary for development of appropriate city level adaptation response plans to climate change. For appropriate ecosystem based adaptation response plans to be developed, it is further necessary to know how ecosystems and –services and populations are impacted by climate change. With a proper vulnerability analysis and ecosystem services assessment in place, adaptation interventions that are ecosystem based can be proposed and developed.

This CTCN assistance seeks to quantify city level climate risks in six cities in Laos and to carry out an assessment of the current ecosystem services utilised by the population, leading to a vulnerability analysis at city level. This analysis forms the basis for proposing appropriate adaptation measures that are ecosystem based. It is the intention of the CTCN assistance to develop a list of ranked intervention options, which will also include whether the intervention is suited for city centres and/or for peri-urban areas.

In each of the cities, it is anticipated that peri-urban areas will typically experience the greater amounts of population growth in coming decades relative to urban centres. It is therefore necessary to focus on the peri-urban areas in order to build resilience into solutions for the cities as a whole and making use of existing or future ecosystem based adaptation interventions for mitigating climate change impacts, while preserving the ecosystem services provided to the city populations. It is expected that the peri-urban areas will have more options for development of both existing and eventually new ecosystem elements, which can be brought into action in creating increased resilience as opposed to the densely populated city centres. Further, the peri-urban areas are thought to have a wider range of ecosystem services offered to the populations than in the centre. Therefore the focus shall be on the peri-urban areas although this technical assistance considers the entire cities and their populations.

Initial consultation with stakeholders in Lao PDR defined that the primary negative impacts of climate change are caused by flooding, with specific impacts on transportation infrastructure, energy supply infrastructure, public and private property, crop loss, and water supply systems due to contamination or the amount of suspended sediments preventing treatment systems to function.

Technological tools that enable the quantification of climate risks shall be deployed and used through this CTCN assistance. The introduction of databases that makes it possible to store important climate related data as part of the assistance is encouraged.

Procedures and tools that enable a systematised approach to organising and interpreting ecosystem services data and information is likewise encouraged. Finally, the usage of impact tools, such as hydraulic modelling and/or digital terrain models for usage in vulnerability analysis and verification of proposed solutions can be part of the assistance dependent on the amount/quality of available data as well as the benefit to the project as a whole.

1.2 Objectives (outcomes)

The CTCN technical assistance will strengthen substantive design of project proposal to the Green Climate Fund (GCF) focused on ecosystem based adaptation in six cities in Lao PDR. This concept for this project has already been approved by the GCF. The assistance will recommend a set of high impact and viable ecosystem based adaption options, as well as defining design considerations and aspects for each of them. These adaptation options will be identified with broad-based input and ownership of national, state and municipal officials and relevant civil society groups. An analysis of the climate change related vulnerability of ecosystem service provision to livelihoods and infrastructure in 6 cities will provide substantive information for identifying, prioritizing and designing the adaptation options. Other considerations in identifying, prioritizing and designing the adaptation options will include cost, timeliness of anticipated impacts; scale of anticipated impacts; ownership of local actors; availability of local expertise to implement; etc.

Benefits of the CTCN assistance include strengthening the technical capacity (specifically knowledge and expertise) of state and municipal authorities in Laos being able to address national and sub-national adaptation priorities as a result of using the vulnerability assessment to inform the design of on-the-ground adaptation action. Part of the delivery of this assistance will include training of state and municipal practitioners on understanding climate related impacts on ecosystem service provision for vulnerability of urban populations and infrastructure.

The initial consultation with stakeholders in Lao PDR defined that the main negative impact of climate change relates to flooding, and that major impacts from flooding were on infrastructure such as roads, public and private property, and the power supply. The main climate change impacts ecosystem service provision were related to crop-loss as well as impacts on the water supply systems whereby water is contaminated or the amount of suspended sediments prevented the treatment systems to function.

This technical assistance will recommend options for addressing increased flooding through adaptation technologies including surface permeability, as well as water storage and absorption in green areas. As such, it is expected that the TA will work with ecosystems to provide the cities with better protection of the freshwater sources for drinking and other human uses. Other ecosystem features in the catchment areas of the cities which produce ecosystem services are vegetation cover and forests. These ecosystem features influence the quantity of available water and can act as sponges to mitigate the impact of flooding. These types of ecosystem-oriented adaptation technologies are expected to be identified and designed through this technical assistance, which can strengthen the resilience of environmental goods and services to a large number of people living in cities.

1.3 Results (outputs expected from CTCN assistance)

The primary outcome of this technical assistance will be strategically prioritised ecosystem based adaptation options for six cities, with broad scale ownership of relevant local stakeholders, and broad steps defined for how to implement them. The CTCN study contains activities that serve to analyse and, to the extent possible, quantify the following key questions:

- How people living in the six cities are currently impacted by climate change and how they will be impacted under future climate scenarios, given that the expansion of the cities will take place in the peri-urban areas
- What ecosystem goods and services are being provided to the city populations; and what is the capacity of these ecosystems to provide services under future climate scenarios

- Identification and overall costing of ecosystem-based adaptation interventions that would be able to respond sufficiently to reducing climate risks faced by cities with special emphasis on the peri-urban areas
- Validation of the findings of the vulnerability and ecosystem assessments at each of the six cities as well as with national stakeholders

It is expected that the climate change impact part will mainly be related to flooding as this seems to be the dominant impact parameter. However, considerations related to droughts shall be made as well.

Further, a limited number of impacts on ecosystem services will be chosen in close corporation with the cities and that these impacts will be assessed to identify common options to mitigate the impacts, mainly looking at existing ecosystem services.

1.4 Expected use of outputs

The CTCN assistance will in general add capacity building where appropriate. It is expected that the municipal authorities of the six cities will be able to incorporate the findings of the methods developed under the CTCN assistance for development of appropriate city level adaptation plans that prioritise the use of ecosystem based solutions. It is envisaged that the work with peri-urban areas and ecosystem services should be replicable to other cities in Lao PDR.

It is further expected that the six cities are able to fully participate in city level climate vulnerability assessment and to be able to participate in the necessary identification, analyses, prioritization and selection of preferred sites for ecosystem based adaptation interventions, which will be implemented under the GCF funded project. The findings and implementation principles will also be available for updates of master plans for all cities in Lao PDR.

The CTCN assistance will further enable the national and sub-national authorities to develop ecosystem-based interventions that have co-benefits, hence to support solutions that serve several or a multitude of purposes.

2. Description of the Assistance

2.1 Activities

Activity 1 – *Inception Workshop and visit*
Initially in the CTCN assistance, an Inception workshop shall be held. The purpose of the workshop is to align scope, deliverables, time-plan, and expectations as described in the Response Plan with a broad set of relevant national, state and city planners and representatives from the 6 cities. Experiences and findings from a scoping mission to Lao PDR conducted in August 2016 shall be used as a reference frame for the inception workshop. It is expected that a further clarification and confirmation of the findings during the August mission will be part of the Inception workshop. Risks involved in the CTCN assistance shall be discussed as part of the workshop. The workshop will likely have a 2-day duration and will allow consultation with major stakeholders, who are responsible for the data needed for the assistance. The scoping mission in August 2016 provided an overview of the types of data available and further actions for the acquisition of this data will be taken as part of the visit.

In addition to the actual workshop, it will be necessary to make field visits to selected cities among the 6 cities involved in the project. The purpose of this visit will be to further discuss and validate the findings from the August mission, and conduct visits to peri-urban areas of the cities.

Activity 1 – Deliverables

Deliverables	**Delivery date**
Short report containing a summary from the inception workshop	*Week 5*

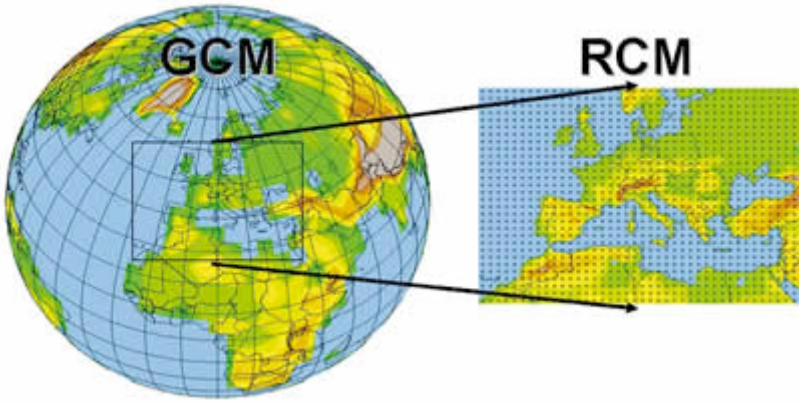
Activity 2 – *Assessment of Climate Change*

An important part of the city level vulnerability assessment of climate change aims at providing quantitative estimates of changes in meteorological and hydrological variables under future climate scenarios relevant to people living in the six cities along the Mekong River. These quantifiable changes translate to hazard information when combined with on-ground data such as topography data, infrastructure data, physical and agricultural maps etc. The hazard information, together with an analysis of the adaptability of the city populations to changes related to climate, is a first step towards a vulnerability assessment.

The primary climate related effect of focus in this CTCN assistance is flooding, with emphasis on the urban and peri-urban areas. However, dependent on the outcome of the climate analyses the focus may include droughts as well. The authorities in Luang Prabang have indicated that they see several impacts caused by droughts, such as loss of riparian vegetation during the flooding periods as the capability of the riparian zone to protect against flooding is reduced.

The basis for projection of climate change impacts are global climate models (GCM) that model ocean-atmosphere dynamics and interactions at spatial resolutions up to approximately 100 km. For adequate assessment of climate change impacts on the city level, this spatial resolution is too coarse.

Higher resolutions are obtained by dynamical and statistical downscaling. Dynamical downscaling describes the process of nesting high-resolution models within a sub-region of a GCM (e.g. East-Asia). These models are usually referred to as regional climate models (RCM) and typically provide spatial resolutions from 10 km to 50 km (see example figure below).



Giorgi, F., 2008, Regionalization of climate change information for impact assessment and adaptation, WMO Bulletin 2008, 57(2).

Statistical downscaling must be used to further downscale RCMs to a scale adequate for hydrologic impact models, such as on hydrological catchment level or city level.

Activity 2.1 Data collection and processing

Existing hydro-meteorological data such as precipitation, evaporation, temperature and wind from hydro-meteorological stations in the catchments of the six cities will be collected. In addition, existing information on water levels and flows in the Mekong River from official stations and relevant tributaries will be collected. All time series should preferably cover at least 20 years and will be approved data. The NDE will support the collection of data to be used under the CTCN assistance, by issuing introductory and support letters. The "data-owners" were identified during the mission in August 2016 and the procedures for acquiring data was clarified. Hydro-meteorological data needs to be purchased with the price per year for one station and for one variable is 20.000 KIP except for river discharge, where the price is 40.000 KIP/year/ station. The price for other type of data, not related to the hydro-meteorological data, has not been determined.

A common software platform in which the various data types can be stored in database(s) is of high value to the local municipalities. It will be investigated to which extent such a system already exists. In case there is lack of such a system, the consultant may choose to propose specific software as part of the delivery of this CTCN assistance. The software can be provided as a local installation in each of the six cities or may be accessible via an online network. Part of the data processing will be to incorporate the data in the established databases as much as possible within the CTCN assistance period.

The consultant shall propose a fall back mechanism to be applied in case the requested data cannot be provided within the specified period, or if the price for the data is prohibitively high.

The output from this activity is hydro-meteorological data collected to the extent possible within the first half of the study period, and possible installation of software containing databases for storing the collected hydro-meteorological data. Due to the fact that certain types of data are subject to payment, it is not expected that such data will be shared in a database system, but will stay with the consultant, once the payment has been done. The data stored in the databases will therefore likely be processed data, such as climate-projected precipitation, which will come out as a result of the study. During the data collection process and in conjunction with the workshops held in Lao PDR training in data processing will be provided to the extent possible.

Activity 2.2 Assessment of climate change at regional level

The CTCN assistance will generate a quantitative overview of projected climate changes in the regions containing the six cities along the Mekong River based on state-of-the-art RCMs recently published through the Coordinated Regional climate Downscaling Experiment (CORDEX).

Changes must be estimated for variables such as extreme rainfall, dry periods, temperature, evapotranspiration etc. to determine the suitability of proposed ecosystem based interventions and to inform decision makers as well as society on the projected impacts in the six cities.

Climate projections inherit numerous uncertainties that need to be considered, when formulating adaptation strategies. Therefore, the CTCN assistance should follow an ensemble approach to express the uncertainty in the estimation of the projected climate changes. Ensembles are generated using different combinations of GCMs, RCMs and climate forcing scenarios.

Maps and tables showing current and projected climate parameters are the main outputs of this work.

Activity 2.3 Assessment of climate change at city level

For all six cities, the CTCN assistance will provide statistically downscaled, projected inputs for analysis or application in hydrologic impact models. The projected inputs would be an ensemble and consequently the uncertainty in the hydrologic impacts can be expressed similar to the uncertainty in meteorological projections.

Statistical downscaling methods such as the delta change method and distribution mapping shall be deployed. A software system that links RCM data, statistically downscaled model inputs and impact model outputs seamlessly shall be utilized as part of the project.

Output from this activity is statistically downscaled projected inputs for analysis or application in impact models. The principles behind the downscaling as well as aspects of the usability of downscaled inputs for analysis will be part of capacity building activities and training in conjunction with the second workshop held for the project.

Activity 2 – Deliverables

Deliverables	**Delivery date**
Installation of database software (optional)	*Week 4*
Procurement of selected hydro-meteorological data	*Week 8*
Processing of hydro-meteorological data	*Week 10*
Tables and maps showing projected changes in climate variables	*Week 12*
Statistically downscaled projected inputs for analysis or application in hydrological impact models	*Week 12*

Activity 3 – *Ecosystem Services Assessment*

Ecosystem services are services provided by nature to humans. These services range from materials needed to meet basic human needs, such as water and energy, to providing settings for recreational, experiential, and spiritual activities. In addition, ecosystems mediate the impacts of natural and human-caused nuisances, including floods, droughts, noise, and toxic wastes. In some cases, ecosystem services can be complementary, while in other cases, use of one service may impact the supply of another. For example, water abstracted from the environment for drinking or agriculture may have impacts on a water body's ability to provide fish, shellfish and other products. Similarly, water bodies are often settings for recreation and tourism, which may be impacted by the use of water for irrigation and energy production. A systematic approach to evaluating ecosystem services is useful for identifying trade-offs and identifying management strategies that maximize social benefits.

For urban populations, green areas provide a number of ecosystem services. Green areas provide settings for recreational and leisure activities, and also act as cooling elements. Soil and rainwater provide opportunities for small-scale gardening and household vegetable crops. Green areas and natural surfaces also have a role to play in storm water management, where they can be used to retain floodwaters and facilitate groundwater infiltration of storm water.

A useful classification system, parts of which were introduced with the Millenium Ecosystem Assessment in 2005, divides ecosystem services into "provisioning", "regulation and maintenance", and "cultural" services. In this framework, provisioning services represent materials and other inputs to production provided by nature to humans, such as water, soil, and fuels for energy. Regulation and maintenance services represent ecosystem processes that attenuate the impacts of nuisances and hazards, such as pollution, flooding, or heat. Cultural services refer to benefits received by people who use natural landscapes as settings for recreational and experiential activities. In the European Union, this classification scheme has been refined into the "Common International Classification of Ecosystem Services" (CICES), which subdivides the three groups mentioned above. An overview of three highest level of CICES scheme is provided in Table 1.

Table 1. The CICES list of Ecosystem Services.

Section	Division	Group
Provisioning	Nutrition	Biomass
		Water
	Materials	Biomass, Fibre
		Water
	Energy	Biomass-based energy sources
		Mechanical energy
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota
		Mediation by ecosystems
	Mediation of flows	Mass flows
		Liquid flows
		Gaseous / air flows
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection
		Pest and disease control
		Soil formation and composition
		Water conditions
		Atmospheric composition and climate regulation
Cultural	Physical and intellectual interactions with ecosystems and land-/seascapes [environmental settings]	Physical and experiential interactions
		Intellectual and representational interactions
	Spiritual, symbolic and other interactions with ecosystems and land-/seascapes [environmental settings]	Spiritual and/or emblematic
		Other cultural outputs

During the mission in August, the consultation team met with authorities from the six partner cities to identify important ecosystem services in each city, along with threats to the continued provision of these services. The majority of the services identified in the stakeholder consultation were of the "Provisioning" – type.

Together with the authorities, the project will identify which of these services are likely to be affected by changes in flood frequencies and magnitudes. Some potential impacts include flooding of small-scale agricultural plots, impacts on drinking water quality, damage to fisheries, or damage to cultural heritage sites, with impacts on tourism.

Activity 3.1 Data collection

The ecosystem services assessment will identify indicators to measure the provision and use of ecosystem services. Ecosystem service provision indicators measure the extent to which services are provided by nature, while use indicators measure the extent to which these services benefit people. An example of a provision indicator could be the infiltration capacity of green areas in a peri-urban area, while the associated use indicator could be the change in expected flood damages caused by use of green areas for infiltration of storm water. The distinction between provision and use is comparing the potential provision of ecosystem services to the actual use.

Quantification of ecosystem service indicators will be based on spatial and temporal analysis of available data, and may include modelling to identify, for example, how processes like infiltration may contribute to storm water management. The quantification of indicators will also facilitate prioritization of interventions to protect and enhance ecosystem services (Activity 5).

The principles for quantification of ecosystem service indicators will be part of the training provided in connection with the mid-term workshop to be held as part of Activity 5.

Activity 3.2 Ecosystem services in the six cities

The mission in August 2016 identified 30 different ways that flooding damages ecosystem services. Some were linked to the city centers, some to the peri-urban areas and some to the rural land. The table below summarizes damages identified in each of the cities.

Eco system damages	VTE	PKS	LPB	SVK	PAK	THK
Impacts on rubber/Cassava/sugarcane tree plantations	x	x				
Loss of trees for landslide protection			x			
Food supply chain affected	x	x				
Changes in water flow	x	x				
Changes in water quality			x			x
Reduced biodiversity	x	x				
Less firewood				x		
Change of water channel corridor (change in the physical place of the river channel)	x	x			x	
Damage to non-timber forest products	x	x		x		
Erosion	x	x			x	
Affecting the agriculture: Impacts on seeds, livestock, Products, Crops, vegetables	x	x		x		
Decrease in wild plants and wildlife			xD[1]	x		
Affect insect habitats	x	x		x		
Lack of budget to prevent bank erosion	x	x				
Ruining habitats (??)	x	x				
Fewer food sources for livestock			xD			
Damage to vegetables and herbs	x	x				
Damage to aquatic animals	x	x				
Damage to aquatic plants			x			
Damaged fish cages	x	x				
Flooded fish farms	x	x				
Damage to natural mushroom	x	x				
River bank erosion	x	x				
Soil fertility goes down				x	x	
Affected water plants (Green plants or water facilities??)	x	x				
Affected green areas	x	x				
Damaged wells and drinking water facilities	x	x		x		
Forest fires			xD			
Trees die due to higher temperatures			xD			
Shallow fish-filled pools disappear during flooding			x			

The technical assistance will use the above list as a starting point for investigating the types of ecosystem services that can be enhanced by adaptation interventions, with consideration for the resource constraints of the project. It is expected that a limited number of demonstration projects will be identified and prioritized to be carried out under the GCF project. It is also expected that the lessons learned during this project can be taken further in the Green Climate Fund project afterwards. This identification and prioritization will be done with relevant national, state and city planners and decision makers, to ensure local ownership and knowledge.

Activity 3 – Deliverables

Deliverables	Delivery date
Qualification of identified ecosystem services involving local expert opinion	*Week 8*
Collaborative ranking of ecosystem services in the six cities	*Week 12*

[1] D = drought

Activity 4 – *Vulnerability Assessment*

Climate change affects ecosystem service provision to urban and peri-urban areas, with impacts on ecosystem services related to infrastructure and livelihoods of people living or using these areas. A vulnerability assessment will determine to what extent ecosystems (exposure and sensitivity), and will also include an assessment of the adaptive capacity of both ecosystems and people. In addition, this vulnerability assessment will identify a suite of specific adaptation options that can either reduce the sensitivity of the ecosystems, or increase the adaptive capacity of the infrastructure and livelihoods of the people.

Activity 4.1 Flood (and drought) hazard mapping

Topography data for 2-3 selected cities shall be provided by the national stakeholders for usage in the assistance. The amount, resolution and quality, as well as timing of delivery of such data, will determine the quality of the basis for a quantitative assessment of flood inundation. If the data are of either poor quality or coarse in resolution, this will lead to a less accurate assessment of the flood inundation.

The assessment can be made using topographical data alone and/or be made using hydraulic modelling of the city surfaces.

The assessment will result in maps showing the physical extent and possibly depth and duration of flooding. A reasonable extreme event or condition must be selected for the assessment.

If the topographical data are either unavailable or of poor quality, the assessment may be conducted by a combination of interviews with relevant people and information from previous studies.

Output from this activity will be various maps showing e.g. flood extent, and if possible with information on depth and duration. The maps shall cover all areas in the selected cities including peri-urban areas that are impacted.

Activity 4.2 Sensitivity and resilience mapping

A first step in the vulnerability assessment is a mapping of the sensitivity of both city populations and ecosystems to hazard exposure (flooding) as well as a mapping of resilience. The sensitivity describes how resistant either city populations or ecosystems are to a given hazard (flooding). Due to the nature of the assessment the sensitivity can be dealt with in a relative simple manner, grouping people and ecosystems into having e.g. low, medium and high sensitivity, with an associated score. The resilience mapping is concerned with mapping of the ability to cope, adjust and adapt to a hazard. The ability to adapt to a certain impact or to recover from a hazard is dependent on a variety of factors of which some are physical/biological and other social/socio-economic. The CTCN assistance does not aim to provide a detailed assessment of the resilience, but to develop overall and simple categories such as low, medium and high resilience.

Output from this activity will be tables and by maps for the selected cities of sensitivity and resilience feeding into the vulnerability assessment.

Activity 4.3 Vulnerability mapping

The vulnerability assessment combines the hazard (flood) mapping with the sensitivity/resilience assessment. The result of the activity will be maps showing levels of vulnerability for the climate effects considered (in this case floods) for the selected cities.

Activity 4 – Deliverables

Deliverables	Delivery date

Maps showing flood extent and possibly depth	*Week 14*
Maps and tables showing sensitivity and resilience	*Week 16*
Maps showing levels of vulnerability to climate change for selected cities	*Week 16*

Activity 5 –*Identification, prioritization and initial design of Ecosystem Based Adaptation options*

The ecosystem services assessment (Activity 3) and vulnerability assessment (Activity 4) will form the basis for identifying a long list of ecosystem-based adaptation interventions and then prioritizing them in a participatory manner with relevant stakeholders based on objective criteria.

The ecosystem services assessment will produce a list of prioritized ecosystem services for urban and peri-urban areas in the selected cities and how provision of these ecosystem services are being impacted by climactic changes. The ecosystem services and associated benefits they provide to infrastructure and livelihoods in urban and peri-urban areas will be linked to specific city areas and/or city populations or may involve the city and its population as a whole.

The vulnerability assessment will provide identification of urban populations and areas that are susceptible to impacts from climate change by changes in the provision of ecosystem services, along with estimates of the adaptation potential of the infrastructure and livelihoods of these populations. The vulnerability assessment will assist with the selection of appropriate adaptation solutions.

Activity 5.1 Identifcation of adaptation interventions in the six cities A prioritized list of possible adaptation interventions to be implemented will be targeted at vulnerable infrastructure and livelihoods of urban and peri-urban populations under both the current and the future climate conditions. A long list of adaptation options will be identified and prioritized by and with a broad set of national, state and local planners and stakeholders. This activity will also use the UNEP Green Infrastructure[2] guidelines as an additional source of potential interventions.

The long list of adaptation options will be collaboratively prioritized with objective criteria including practical considerations such as cost, scale of likely impact, timeliness of impact, availability of financial and human resources to implement, etc.

Cost estimates of adaptation interventions shall be made. Cost estimates are likely to include uncertainties as not all the elements necessary for implementation of the interventions can be covered and since the costing will be based on judgment.

A catalogue of ecosystem-based adaptation interventions and their costs will be developed and will, to the extent possible, categorize these as short-term, medium-term and long-term interventions. The list will also include an assessment of the amount of time required for interventions to become effective.

Activity 5.2 Mid-term workshop
A mid-term workshop shall be held in which the findings to date in the project will be presented and discussed with the NDE and local municipalities. A special focus is on the ecosystem-based adaptation interventions. Back-to-back with the workshop training will be conducted in 1) basic operation of the database system and 2) basic principles for ecosystem services and ecosystem based adaptation interventions as well as vulnerability analysis will be provided.

Output from the activity will be a short mid-term workshop summary report.

[2] UNEP (2014): Green infrastructure. Guide for water management.

Activity 5.3 Prioritising adaptation options in terms of anticipated impact and cost in a participatory manner with relevant local, state and national actors
The proposed interventions under Activity 5.1 will be ranked on basis of their effectiveness and costs. Interventions that have high effect at low costs are naturally favorable, whereas low effect interventions at high cost will rank low.

A scoring system that enables ranking of the interventions considering effect, cost, and feasibility must be developed.

The output from this activity is a ranked list of ecosystem based adaptation interventions for the six cities, together with proposed next steps to deploy the interventions.

Activity 5 – Deliverables

Deliverables	**Delivery date**
Draft catalogue of ecosystem based intervention adaptations with ranking	*Week 16*
Mid-term workshop summary report	*Week 18*
Ranked list of ecosystem based adaptation interventions	*Week 20*
Training report for activities conducted	*Week 18*

Activity 6 – *Input to GCF Project documents*

The main purpose of the CTCN assistance is to provide a better substantive technological foundation for the upcoming GCF funded project on eco-system based adaptations. In this connection the CTCN assistance must support the preparation of the GCF proposal. Hence findings and results from the CTCN assistance is expected to be utilized as support to the GCF proposal.

Activity 6.1 Identification of CTCN assistance outputs for supporting project documents
In consultation with the NDE, the outputs from the CTCN assistance, which can directly be used to update the current GCF proposal will be identified. The update is envisaged to be a further substantiation of elements of the GCF proposal or to be used to prioritize activities laid down in the GCF proposal.

The output from this activity is an overview of CTCN assistance outputs to be used for supporting the GCF project documents.

Activity 6.2 Project document support
Based on the overview developed in Activity 5.1, the project will provide relevant support to the GCF project documents.

The output from this activity is support to the GCF project documents. The consultant team must be prepared to provide input to the GCF proposal along with the execution of the CTCN assistance.

Activity 6 – Deliverables

Deliverables	**Delivery date**
Overview of CTCN assistance outputs suitable for project document support	*Week 20*

Project document support	*Week 24*

Activity 7 – *Final workshop*
A final workshop shall be held in which the CTCN assistance findings and recommendations are presented and discussed.

Output from this activity is a short summary report containing the main outputs/deliverables produced, conclusions and recommendations, as well as lessons learned and technological innovations of relevance to other countries, from the CTCN assistance as presented in the workshop.

Activity 7 – Deliverables

Deliverables	**Delivery date**
Short summary report from the final workshop	*Week 26*

2.2 Synergies and Baseline Setting

Please identify past and ongoing public and private sector initiatives at the local, national or regional level that the CTCN assistance will specifically build on and link to. Please succinctly describe the situation (or state) that the CTCN assistance will be initiated from (i.e. its baseline).

Past studies and initiatives:
The following studies and reports will provide the basis for the CTCN assistance. During the initial phase of the project it will be investigated if additional study sources is available.

- National Adaptation Programme of Action (NAPA), 2009
- National Strategy on climate change, 2010
- Climate Change Action Plan 2013-2020, 2013
- USAID/CIFOR, Motivation for payments for ecosystem services in Laos – the essential alignment, 2014
- National Biodiversity Strategy and Action Plan, 2016-2025
- GIZ, PROCEED brochure, 2014 USAID, Valuing Ecosystem Services in the Lower Mekong Basin: Country Report for Lao PDR, 2015
- ADB, Lao PDR – Urban Development Sector Assessment Strategy, and Road Map, 2012
- The Project for Urban Development Master Plan Study in Vientiane Capital, JICA & Nippon Koei
- Water Supply and Wastewater Management Master Plan of the Lao PDR, MONRE by KEITI
- Feasibility Study for Pakse Town Wastewater Treatment System and Water Supply Project, Final Report, Department of Public Works and Transport, October 2013
- Technical Assistance for the Design and Conduction of Master Plan for Drainage and Sewerage System of Luang Prabang. UDAA Luang Prabang. Final Report. March 2013.

The CTCN study will link to the upcoming GCF funded project on ecosystem based interventions.

2.3 Timeline

Activity	Month (after project start)											
	1		2		3		4		5		6	
1 Inception workshop												
2 Climate Change Impact Assessment												
2.1 Data collection and processing												
2.2 Climate change at regional level												
2.3 Climate change at city level												
3 Ecosystem Services Assessment												
3.1 Data collection												
3.2 Ecosystem services in the six cities												
4 Vulnerability assessment												
4.1 Flood (and drought) hazard mapping												
4.2 Capacity for adaptation												
4.3 Vulnerability mapping												
5 Ecosystem based adaptation interventions												
5.1 Possible adaptation interventions in the six cities												
5.2 Mid-term workshop												
5.3 Ranking of interventions in terms of effect and costs												
6 Support to GCF Project Documents												
6.1 Identification of CTCN assistance output												
6.2 Project document												

support												
7 Final workshop												

2.4 Expertise required

Activity 1	
Expert 1	*Project Manager/Senior Climate Expert, 8 man/days*
Expert 2	*Senior Ecosystem Expert, 8 man/days*
Expert 3	*Local expert, 8 man/days*
Event 1	*Estimation of resources needed, number of participants, etc.*
Materials	*Workshop expenses including material, lunch, meeting room*
Others	*Local transport, translator, travels, accommodation and DSA*
Activity 2	
Expert 1	*Project Manager/Senior Climate Expert, 7 man/ days*
Expert 2	*Climate Expert, 7 man/ days*
Expert 3	*Local expert, 5 man/ days*
Others	*Data acquisition*
Activity 3	
Expert 1	*Senior Ecosystem Expert, 8 man/ days*
Expert 2	*Ecosystem Expert, 15 man/ days*
Expert 3	*Local expert, 6 man/ days*
Activity 4	
Expert 1	*Project Manager/Senior Climate Expert, 8 man/ days*
Expert 2	*GIS and Remote Sensing Expert, 42 man/days*
Expert 3	*Local expert, 16 man/ days*
Activity 5	
Expert 1	*Project Manager/ Senior Climate Expert, 10 days*
Expert 2	*Senior Ecosystem Expert, 10 man/ days*
Expert 3	*Local expert, 6 man/ days*
Materials	*Workshop expenses including material, lunch, meeting room*
Others	*Local transport, translator, travels, accommodation and DSA*
Activity 6	
Expert 1	*Project Manager/ Senior Climate Expert, 4 man /days*
Expert 2	*Senior Ecosystem Expert, 4 man /days*
Expert 3	*Water Policy Advisor, 12 man /days*
Activity 7	
Expert 1	*Project Manager/ Senior Climate Expert, 3 days*
Expert 2	*Senior Ecosystem Expert, 3 days*
Materials	*Workshop expenses including material, lunch, meeting room*
Others	*Local transport, translator, travels, accommodation and DSA*

2.5 Main partners

Stakeholder	Role to support the implementation of the CTCN assistance
/Department of Disaster Management and Climate Change/ Ministry of Natural Resources and Environment (MONRE)	*National Designated Entity (NDE), coordinating institution*
Municipal Authority Representatives at each of the 6 cities	*Coordinate the TA at each city and providing access to data on urban classification,*
Department of Housing and Urban Planning / Ministry of Public Works and Transport	*Providing access to data on urban planning, climate maps, flood damage records, various study reports*
Public Works Institute / Ministry of Public Works and Transport	*Providing data in relation to urban planning*
Department of Water Supply/ Ministry of Public Works and Transport	*Providing access to data and maps of water supply and waste water utilities, retention basins etc.*
Department of Land Planning and Development/ MONRE	*Providing access to topographical data, general flood maps, satellite images, remote sensing data, land use data on forest, agriculture, soils, crop types*
Department of Meteorology and Hydrology	*Facilitating acquisition of basic hydro-meteorological data*
Department of Water Resource	*Providing information on water resource and facilitating access to data on water resource*
Department of Forest Resource Management	*Providing information on forest management*

2.6 Indicative budget

Activities	Estimated Budget (USD)
Activity 1	40.000
Activity 2	20.000
Activity 3	30.000
Activity 4	55.000
Activity 5	60.000
Activity 6	25.000
Activity 7	20.000
Total	**250.000**

The estimated budget includes personnel costs for International and Local Experts as well as costs in relation to the planned visits. The budget does not include salary for the NDE or any stakeholders in Lao PDR.

2.7 Gender considerations

There is no particular attention to gender aspects in the technical assistance. However, the establishment of ecosystem based adaptation interventions, which this TA will ultimately provide the basis for, will likely benefit the people who are particularly vulnerable the most.

2.8 Risk identification and risk mitigation

Risk	Consequence	Probability	Mitigation measure
Permission to obtain data is difficult to get	Project delayed/halted	10%	NDE to play an active role to obtain permissions
Data is either absent/insufficient/not received in due time or of poor quality	The basis for the TA will not be sufficient for proper quantitative assessments	20-30%	The consultant may use assumptions and qualitative information in combination with actual data

3. Long-term impacts of the assistance

3.1 Expected climate change-related benefits

	CTCN climate technology impact	Anticipated contribution from CTCN assistance
1	Climate technologies adapted to national context are identified and prioritized to enable their deployment and/or transfer in the requesting countries	Downscaling of climate data to regional and local level is performed via the TA. Hence a quantification of the climate impact both on regional and at local city level is made. The principles for the climate impact work is transferred to the NDE during a workshop and final result.
2	New national Technology Needs Assessment (TNA) and Technology Action Plan (TAP) as a result of the response	A TNA/TAP update can be initiated as a result of the technical assistance results
3	Progress made against mitigation objectives (i.e. energy and carbon intensity reduction) as a result of the response	NA
4	Progress made against adaptation or resilience objectives (e.g. climate vulnerability index improvement) as a result of the response	The technical assistance provides suggested ecosystem based adaptation interventions for the cities leading to lower vulnerability
5	New mitigation or adaptation technology projects/initiatives implemented as a result of the response	The combined approach for climate vulnerability assessment and ecosystem services assessment can potentially be recommended to other cities
6	New or strengthened policies/ laws	Ecosystem based adaptation principles for

	developed, approved and enacted as a result of the response	mitigating climate impacts could potentially be adopted into urban planning regulations and – principles in Lao PDR
7	New policies/laws where climate change was mainstreamed as a result of the response	New local bye-laws may de designed to include climate change aspects
8	Country integrating climate change mitigation and/or adaptation issues into its planning and policies as a result of the response	It is anticipated that the Ministry of Natural Resources and Environment and its Disaster Management and Climate Change Department will adopt the EbA principles into their guidelines and regulations
9	New or strengthened Public-Private Partnerships (PPP) created directly as a result of the response	None within Lao PDR itself, but the TA requester (public) and the TA implementer (private) will most likely have a strengthened relation
10	New or strengthened twinning arrangement created as a result of the response	It is possible that the Municipalities of the cities involved in the TA will enhance their co-operation on climate and ecosystem aspects as a result of the response.
11	Capacities to access and attract public and private finance increase to enable financing of technology deployment	Part of the TA is devoted the enhancement of a Green Climate Fund (GCF) proposal, which has the aim to implement EbA interventions in the cities involved in this TA.
12	Post-response intervention funding attributable to the response.	NA
13	Framework and analysis of local production developed to enable deployment of national production of climate technologies	The climate and EbA principles developed in this TA at local city level may be escalated to national level and be incorporated into regulations/guidelines for urban planning. The data bases which may be implemented during the TA at city level and holding local city data, may be a first step towards a country-wide data base holding climate related data.

3.2 Co-benefits

	Sustainable Development Goal	**Contribution from CTCN assistance**
1	End poverty in all its forms everywhere	Reduce impacts on private property and on small-scale peri-urban farmers
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	Improve use of land in the zone between the rural and the peri-urban area for e.g. food production
3	Ensure healthy lives and promote well-being for all at all ages	Reduce the flooding-related water borne diseases by reducing impacts from

		flooding
4	Ensure inclusive and equitable quality education and promote life-long learning opportunities for all	NA
5	Achieve gender equality and empower all women and girls	NA
6	Ensure availability and sustainable management of water and sanitation for all	Reduce impacts on the water supply systems during flooding
7	Ensure access to affordable, reliable, sustainable, and modern energy for all	Reduce impacts from power cuts
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	By promoting EbA to reduce the vulnerability of city populations a better foundation of economic growth is provided for
9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	The TA promotes the usage of EbA which includes the usage of Green Infrastructure as part of the urban planning, which increases resilience.
10	Reduce inequality within and among countries	By decreasing the vulnerability, the poor part of the city populations will benefit in particular, wherefore inequality will reduce.
11	Make cities and human settlements inclusive, safe, resilient and sustainable	Reducing damages from floods will make the 6 cities more resilient
12	Ensure sustainable consumption and production patterns	The TA determines the ecosystem services provided to the city populations and how these can be sustained under a future climate.
13	Take urgent action to combat climate change and its impacts	Reduction in flood patterns will help combatting impacts from Climate change
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	NA
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	Improve conditions for ecosystem services as they will play an important part of flooding resilience.
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	All city population groups will benefit from the TA.
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development	By reducing climate vulnerability in the cities using EbA, a sustainable development is promoted in Lao PDR which could spread to the region and globally.

3.3. Post-assistance plans and actions

The CTCN project will provide a comprehensive overview of the current and future impacts in 6 cities in Lao PDR and will provide a basis for enabling the authorities to work with better mapping of the impacts in the cities and mapping potential ecosystem services, which can be used to combat all or part of the present damages to the cities. After the finalisation of the CTCN project activities will be continued under the Green Climate Fund-based project, where financial means will enable larger demonstration projects to be made.

3.4 Monitoring and Reporting of technical assistance results and impacts

The progress of the project will be monitored at regular meetings with participation of the consultant and with representatives from the NDE and the six cities. Meetings will be held on-site when the consultant visits Lao PDR according to the activity schedule, and on-line otherwise. The actual frequency will be agreed upon during start-up of the project. Given a short timeframe of 6 months, a close and frequent dialogue between the NDE and the consultant is necessary.

A note to the table below:

The budget as well as the short duration of the project means that actual implementation of demonstration projects is not expected to be carried out. Hence the output from the project as far as adaptation interventions is concerned will mainly be conceptual solution proposals, such as describing which ecosystem based adaptations can be used and the expected effects from implementing them for mitigation of flooding impacts in the peri-urban areas.

The adaptation interventions formulated as proposed conceptual solutions are provided in the table below, all taking the use of ecosystem services into account:

- Adaptations for protecting water supply from being impacted by floods, using ecosystem services
- Adaptations for reducing the impact to roads and increasing the capacity of flood-prone roads during the rainy season, using ecosystem services
- Adaptations for improved protection of public and private property, using ecosystem services
- Adaptations for assessing which ecosystem services are most vulnerable to climate changes.

Due to the information received from workshops that were carried out in August 2016, there may be different wishes than those listed above and the consultant should be prepared to change the focus under the clear expectation that this must come as a request from the NDE and the six involved cities.

Performance indicators of CTCN Assistance				
Response output *(linking to sec 1.2)*	**How output will be used to ensure creation of result**	**Expected result**	**Expected outcome of result** *(linking to sec 1.1)*	**Anticipated impact that outcome will produce** *(linking to section 3)*
Impacts on water supply in peri-urban areas	*Identify local water supply systems and their structure in peri-urban areas and ecosystem services available for use in the protection*	*Assessment of water supply systems to investigate methods to secure the water during flooding*	*Improved security on water supply infrastructure by use of ecosystem services to protect well areas*	*Improved water quality with fewer cases of contaminated supply systems. Better under-standing of how to utilize ecosystem services to protect the supply systems*
Impacts on roads in peri-urban areas	*Identify available ecosystem services to be used in reducing impacts on the roads (e.g. green areas for storing water)*	*Analyzing reasons for flooding and proposing solutions by use of ecosystem services to reduce flooding and damages*	*Improved climate-resilient road design in peri-urban areas, integrating ecosystem services*	*Reducing costs for repairing road damages and improving access to roads during flooding. Methods replicable to city areas with similar ecosystem services available*
Impacts to public and private properties (housing)	*Identify ecosystem services available for protecting property.*	*Analyzing reasons for flooding of properties and finding solutions by use of ecosystem services to reduce flooding and damages in peri-urban areas*	*Reduced potential for public and private properties for being flooded in peri-urban areas.*	*Improved livelihood for public and private property owners, reduction in costs for repairing property after each flooding event. Methods replicable to city areas with similar ecosystem services available*
Damages to ecosystem services	*Identify ecosystem services which are vulnerable to climate change*	*Assess the types of impacts that are threatening the survival of specific ecosystem services*	*Assess whether the impacts on the ecosystem services are reversible and identify means to mitigate the impacts*	*Ensuring access to special ecosystem services in near future under climate change*

4. Signatures

Signatures of the requesting country

NDE	**Request Proponent**
Name: Mr. Syamphone SENGCHANDALA Title: Director General of DDMCC, MoNRE Date: 16/11/2016	Name: Mr. Syamphone SENGCHANDALA Title: Director General of DDMCC, MoNRE Date: 16/11/2016
Signature: 	Signature: 

Signatures of the CTCN

CTCN Director	**Climate Technology Manager**
Name: Jukka Uosukainen Title: CTCN Director Date: 14/11/2016	Name: Title: Date:
Signature: 	Signature:

Annex 1: Response Logframe

Activity *(link to sec 2)*	**Description of sub-activities conducted by the CTCN**	**Output/ Deliverable**	**Expected Outcome** *(link to sec 3)*	**Main national partners involved**	**Objectively Verifiable Indicator** *(see Annex 5 guidance)*	**Means of Verification** (data source, method of collection, responsibility and periodicity)
Activity 1: Inception workshop and visit	*NA*	Initial work shop and visit conducted	The NDE, stakeholders and consultant aligned with project content Key climate and ecosystem issues addressed for peri-urban areas	NDE, municipalities, stakeholders	Summary of workshop results and findings during visits available	NDE has received and approved the summary report
Activity 2: Climate Change Impact Assessment	*Activity 2.1 Data collection and processing* *Activity 2.2 Climate change at regional level* *Activity 2.3 Climate change at city level*	2.1: Hydro-meteorological data collected, (optional) database software installed 2.2: Maps and tables showing projected climate parameters 2.3: Statistically downscaled project inputs	Foundation for quantification of climate change impact at city level established	NDE (facilitating data collection) Department of meteorology and hydrology	Hydro-meteorological data available on digital media/or in data base system Maps and tables available Time series of city level statistically downscaled inputs available on digital media	Data, maps and tables, and time series delivered to NDE and Municipalities
Activity 3: Ecosystem Services Assessment	*Activity 3.1 Data collection* *Activity 3.2 Ecosystem services in the six cities*	3.1: Ecosystem data and information collected 3.2: Ecosystem services	Overview of the most important types of ecosystem services in the six	NDE, PONRE's Department of Land Planning and	Organised and prioritised data on ecosystem services in the six cities including future ability to	Ecosystem data delivered to NDE and municipalities

		indicators identified, and ranked	cities and their sustainability under a future climate	Development Department of Forest Resource Management	provide service	
Activity 4: Vulnerability Assessment	*Activity 4.1: Flood hazard Mapping* *Activity 4.2: Sensitivity and resilience mapping* *Activity 4.3: Vulnerability Mapping*	Maps showing flood extent Maps of sensitivity and resilience Vulnerability maps	Foundation for assessment of city climate change vulnerability	NDE, Ministry of Public Works and Transport MONRE, Department of Land Planning and Development PONRE's Municipalities	Maps available	Maps delivered to NDE and Municipalities
Activity 5: Ecosystem Based Adaptation Interventions	*Activity 5.1: Possible adaptation interventions in the six cities* *Activity 5.2: Mid-term workshop* *Activity 5.3: Ranking of interventions in terms of effect and costs*	Catalogue of possible ecosystem based adaptation interventions for the six cities Workshop conducted and summary report produced Ranked list of ecosystem based adaptation interventions	Overview of possible ecosystem adaptation interventions that are ranked with respect to effectiveness and costs	NDE, PONRE's Municipalities	Catalogue, Summary Report, and Ranked List available	Catalogue, Summary Report and Ranked List provided to NDE and Municipalities
Activity 6: Input to GCF	*Activity 6.1: Identification of CTCN assistance outputs for*	Overview of CTCN assistance outputs	Updated and enhanced GCF project document	NDE	Inputs for GCF project document prepared	Input document available and made available to CTCN/NDE

Project documents	*supporting project documents* *Activity 6.2: Project Document Support*	Actual support to the GCF project document				
Activity 7: *Final workshop*	*NA*	Workshop summary report	Overview of CTCN assistance findings	NDE Stakeholders Municipalities	Workshop summary report available	Workshop summary report delivered to CTCN/NDE