Document No.:

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

PROJECT DOCUMENT

Adaptation of Asia-Pacific Forests to Climate Change – Phase II

University of British Columbia

December, 2015

Basic Information

Project title	Adaptation of Asia-Pacific Forests to Climate Change – Phase II
Executing agency	University of British Columbia
Implementation agency(ies)	Faculty of Forestry, University of British Columbia Local IAs have been listed in the text
Project Director: Dr. John Innes, Dean, Faculty of Forestry, University of British Columbia Tel 1-604-822-3542, Fax 1-604-822-8157, Email john.innes@ubc.ca,	
Target area(s) China, Chinese Taipei, Laos, Malaysia and Myanmar (maps are shown in Annex A)	
Project implementation duration: 01/01/16 to 31/12/18, 36 months	
Total budget(USD)	$899,200
APFNet grant(USD)	$499,200
Counterpart contribution (USD)	$400,000 in-kind

Project description

The impact of climate change on the health and services provided by forest ecosystems is a major concern in the Asia-Pacific region. However, little progress has been made towards developing robust regional forest management strategies to tackle such challenges. A strong scientific basis and credible modeling tools are required to help local and regional forest managers develop and evaluate viable adaptation solutions to address this problem. The first phase of this project has made a solid contribution towards these objectives through the completion of six major outputs, including the development of tools and models and their application to five major tree species and three pilot sites. Phase two of the project will expand and improve upon the tools and models developed in phase one in order to apply the outputs to a broader range of ecosystems and associated communities to further advance the capability of forest policy makers, statutory decision makers and forest managers to promote the management of forest resources in this region. It will work to make these tools and their byproducts more widely available and more accessible for use by local practitioners through continued training, web tools and technology transfer. Together, these represent the main objectives of this phase of the project.

This phase of the project will expand our focus from temperate (China) to tropical and subtropical regions in Southeast Asia, where afforestation is active and/or forest ecosystems and dependent human communities are particularly vulnerable to climate change. It will expand upon the outputs of phase one by downscaling both the spatial scale and temporal resolution of our high-resolution climate model (ClimateAP) and upscaling the application of ecological models from specific pilot areas to the national level. Niche modeling will be extended to include more key forest species and entire ecosystems in selected economies, which will enable us to assess impacts of climate change on all species in these ecosystems. Through the integration of models, development of indicators, and trade-off analyses, adaptive forest ecosystem management strategies will be developed and evaluated in the pilot areas. New features will be added to our high-resolution climate model (ClimateAP) to facilitate modeling of the variability and extremes in climatic conditions, and spatial visualization tools and new datasets will be added to our web-based platform and available for access across economies. Finally, our network and capacity building will be extended through workshops, communications and extension notes into all Southeast Asian economies.

The outputs of this project will build upon phase one to considerably improve the capacity of local and regional forest managers and decision makers to develop robust adaptation strategies to address climate change issues in the Asia-Pacific region. ClimateAP will serve as an essential tool to facilitate and promote research and applications related to climate change. Consensus projections of forest tree species and ecosystems in future climates will provide a solid scientific basis for forest tree species selection to adapt to future climates and for vulnerability assessments of ecosystems and species. Adaptive forest ecosystem management strategies developed for the pilot areas will improve the health and productivity of existing forests and their resilience to a changing climate. Our map-based web platform will make major outputs of the project easily accessible, including spatial visualization and data access. Continued networking and capacity building will ensure effective knowledge transfer and the active participation and involvement of stakeholders including policy and decision makers, forest managers, forest dependent communities and academic/research organizations.

Abbreviations and acronyms

AP	Asia-Pacific region
BC	British Columbia
ClimateAP	A climate model for Asia-Pacific
CAs	Collaborating Agencies
EA	Executing Agency
FORECAST	Management-oriented, Stand-level Forest-growth and Ecosystem Dynamics Model
GCM	General Circulation Model
IA	Implementing Agency
IPCC	The Intergovernmental Panel on Climate Change
TACA	Tree and Climate Assessment Model
UBC	University of British Columbia
UPM	Universiti Putra Malaysia

Project details

1. Background and Rationale

The impact of climate change on the health and services provided by forest ecosystems is a major concern in the Asia-Pacific region. Shifting climate patterns have led to increased drought-related mortality throughout the region (e.g. Allen et al., 2010; Zhao and Running, 2010) and increasing deviations between past and future climate regimes are placing many species and associated ecosystem types at risk. As climate regimes continue to change, species that have adapted to historic climate patterns will be subject to increasing abiotic (e.g., temperature and moisture) and biotic (pests and diseases) stress. Mismatches between adaptation and future conditions may severely compromise the resilience of forest ecosystems and jeopardize the critical ecosystem services they provide. Southeast Asia is particularly vulnerable to climate change in that the health of human communities and forest ecosystems are often closely linked. Forests in many parts of this region have been degraded due to over-harvesting for fuel wood and timber production and due to declines in soil productivity associated with swidden agricultural practices. Despite these risks, little progress has been made towards developing robust regional forest management strategies to tackle such challenges.

During the initial phase of this project, we refined and tested a suite of scientifically credible modeling tools designed to help regional forest managers develop and evaluate the potential impacts of climate change on forest ecosystems within the Asia-Pacific region. Specifically, a regional climate model called ClimateAP was created to address fundamental data gaps and to facilitate the development and application of detailed climate niche models for five major tree species across large, complex landscapes. ClimateAP, using dynamic local downscaling technology, generates high accuracy, scale-free climate data, explaining over 97% of the total variation in temperature and about 90% in precipitation observed by weather stations over the entire region. This model can be used by anyone interested in climate change or climate-related studies and applications in this region. The climate niche models apply a novel composite modeling approach that integrates multiple Random Forest models to model the climate niche of each species at a high accuracy (error rate < 10%). These models are then used to generate consensus projections of the geographic distribution of the climate niche of each species in multiple future climate scenarios. These projections are sufficiently robust to serve as the scientific basis for policy makers and practitioners developing adaptive strategies for forests and forest-dependent communities. In addition, case studies, including the application of a range of process-based forest management models, have been conducted at three pilot sites. The key results and management recommendations from this work have been summarized and presented in the form of multiple research papers, project reports, management notes and at a regional APFNet workshop held in Kunming in July 2014.

The regional focus of the initial phase of the project was on temperate and subtropical ecosystems. To further advance the capability of forest managers to protect and promote forest resources throughout the Asia-Pacific region, the tools should to be extended (e.g., from individual species to entire ecosystems) and applied to a broader range of ecosystems, including tropical regions and associated communities. In addition, more work is required to make these tools and their byproducts more widely available and more accessible for use by local practitioners through continued training and technology transfer. Together, these represent the main objectives of the second phase of this project.

With the unrelenting progression of climate change, policy makers, statutory decision makers and forest managers are under increasing pressure to consider new approaches and adaptive strategies to establish and maintain healthy and resilient forest ecosystems. The development of effective adaptation strategies to reduce the negative impacts of climate change on forest resources requires the application of models that include detailed representations of plant-climate relationships. However, the availability of high quality climate data represents a critical barrier that limits the construction and application of such models. The development of ClimateAP during the initial phase of this project provided an essential resource that will serve as a foundation for future research. Building on the advances of other climate models (WorldClim, ANUSPLIN, PRISM, Climate WNA, etc.), ClimateAP, developed at the University of British Columbia (UBC), provides an essential resource for future modeling endeavors. Its defining features include the projection of scale-free (or high-resolution) data, the inclusion of a broad range of useful climate variables and indices derived from thousands of climate stations, the option to select from multiple climate change scenarios developed from world-class GCMs and widely accepted emissions scenarios, and a web-based, user-friendly interface to ensure data accessibility. In the second phase of the project, we propose to improve the usefulness of ClimateAP by making its outputs available at a national scale and adding annual time series projections into the model.

One of the most straightforward and accessible approaches to the development of adaptive management strategies has been the application of climate niche models. This method is based on the idea that climate regimes, defined using complex statistical analyses of regional climate data, represent a fundamental limiting factor to the distribution of tree species and ecosystem types. The approach was pioneered in western North America by Hamann and Wang (2006) and Rehfeldt et al. (2006), but these original studies were limited in the range of future climate projections included in the analyses. Wang et al. (2012) at UBC generated consensus projections for British Columbian ecosystem types and species based on 20 climate-change scenarios. These projections have been used in developing provincial guidelines for tree species selection and seed transfer in forest resources management. In the first phase of the project, we were able to capitalize on the high-resolution climate maps generated by ClimateAP and existing maps of species distributions to construct bioclimatic envelopes (climate niches) for five key tree species in the Asia-Pacific region. Such information allows managers to evaluate the climate conditions for which species have been successful in the past and make predictions about where they will likely be successful in the future under changing climate regimes. In the second phase of the project, we propose to extend the climate niche models to include 10 new key species in these regions. We will also upscale the analysis to cover entire ecosystems in the selected economies to determine whether existing ecosystem classification schemes will remain robust under changing climate conditions. This is particularly important as it will allow us to associate a large number of individual tree species (not limited to the original 10 species) with the ecosystem classification schemes and to make predictions for all of these species. This will make the method more applicable to subtropical and tropical regions, where a large number of species coexist in the same ecosystem. Furthermore, for the economies without inventory data on individual species, the analysis of existing ecosystem classification schemes can serve as an effective alternative.

In parallel with climate niche models, process-based models also play an important role in evaluating the impacts of climate change on forest productivity, water balance, and

carbon storage. FORECAST Climate (Seely et al. 2014), an extension of the hybrid forest growth model FORECAST (Kimmins et al. 1999), was created in phase one of the project through the dynamic linkage of FORECAST with the stand-level hydrology model ForWaDy (Seely et al. 1997). This linked model is capable of demonstrating the impacts of climate change on forest growth dynamics. TACA is a mechanistic species distribution model (Nitshke and Innes 2008) that facilitates an analysis of the response of trees to climate-driven phenological and biophysical variables. It assesses the probability of a species being able to regenerate, grow and survive under a range of climatic and edaphic conditions. FORECAST Climate and TACA models were employed in pilot sites in temperate and north sub-tropical regions to evaluate the long-term impacts of alternative climate change scenarios on forest growth and development. Results from the models were subsequently utilized in a tradeoff analysis associated with alternative forest management practices. In the second phase of the project, we propose to expand the application of these models and similar tools to include additional forest types, particularly in tropical ecosystems of Southeast Asia, at a larger scale, and to improve the accessibility of tools, byproducts and results.

Successful management strategies and practices must be robust in the context of changing conditions associated with climate change and effective in terms of protecting key ecosystem services for the region and local communities. Scientifically credible decision-support tools built from climate/ecosystem models will provide an essential resource to help policy makers design policies that will aid local decision makers, and help forest managers understand the potential long-term costs and benefits of management choices on forest health and ecosystem services. The experience gained from working with local partners to calibrate and help facilitate the transfer of technologies has laid an effective foundation for the expanded application of these decision-support tools into tropical regions in Southeast Asia. This phase of the project will expand the application range of the decision-support tools established during the previous phase and will enhance the capacity of local forestry communities to use the tools to help them achieve their resource management objectives.

In contrast to phase one, which focused mainly on temperate regions, phase two will focus on Southeast Asian economies, particularly in sub-tropical and tropical regions. Southeast Asia has been identified as one of the most vulnerable regions to climate change, where adaptive strategies are urgently needed. Five economies have been selected: Chinese Taipei and Malaysia to represent well-developed economies, and Laos and Myanmar to represent less developed economics of the Asia-Pacific region. China has been a key focus of this project, as afforestation and reforestation are prevalent and offer a good opportunity to implement forest adaptation by selecting suitable tree species. Partners from China, Chinese Taipei, Laos, Myanmar, and Malaysia will be specifically engaged in the application of tools throughout the project. By providing technical support as well as capacity building and pilot demonstrations extended to tropical and subtropical regions in Southeast Asia, this project will greatly contribute to APFNet's goal of sustainable forest management and ecosystem rehabilitation in the Asia-Pacific region.

2. Goal(s) and Objectives

The overall goal of this project is to build upon the successfully completed outputs of phase one and continue to substantially improve the capacity of policy makers and forest

managers in selected economies to develop robust adaptation strategies to improve the health and productivity of forest ecosystems and their resilience to climate change.

Specific objectives of the project include:

1) Improve and expand the essential tools developed in the previous phase of the project, including climate, niche and process-based models, to further facilitate and promote related research and applications in more locations throughout the Asia-Pacific;
2) Continue to build a strong scientific basis and provide adaptive management options to enhance the target economies' capacity for decision making regarding adaptation to climate change;
3) Expand the network built in phase one and continue capacity building through workshops, communication and policy notes to further enhance information sharing and technology transfer.

3. Outputs and Activities

♦ Output 1: ClimateAP with future annual climate projections

ClimateAP can generate high-resolution climate data for historical years (1901-2012) and three future periods (2011-2040, 2041-2070 and 2071-2100). It will serve as an essential tool to facilitate and promote climate change studies in the region. We have used ClimateAP to successfully generate climate data for the use of all models in Phase I. However, the limits imposed by projecting future climates for only three periods have become an issue, as modelers and users expect to project the future on an annual basis to reflect annual fluctuations and extremes. This limitation will be overcome in this phase of the project by adding annual projections into the model. In particular, the expanded version of ClimateAP will allow for annual time series projections to be generated for any location in the region in a single run.

All activities required for this output will be completed within the first year of the project in order to prepare the model for use in the following outputs. Activities will be completed mainly by Dr. Tongli Wang, with support from the rest of the research team. Activities will be completed at the Faculty of Forestry, UBC, using computer programs R, ArcGIS, SAS and Visual Studio.

- Activity 1.1 Data collection and processing

Monthly future climate projection data for the next 90 years (2011-2100) will be downloaded from the IPCC CMIP5 data access portal for two greenhouse gas emission scenarios (RCP 4.5 and RCP 8.5) and three Global Circulation Models (GCMs). In total, 540 (90 years x 2 scenarios x 3 GCMs) climatic layers will be added into ClimateAP. The dataset will include monthly maximum and minimum temperatures and monthly precipitation. The data will be formatted for the calculation of anomalies.

- Activity 1.2 Calculations of anomalies

In order to incorporate future climate data into ClimateAP, the absolute values of the downloaded data need to be converted into anomalies relative to 1961-1990 normals. ClimateAP uses anomaly data to downscale future climate projections through a delta approach. All the climate variables for each month for the 540 climate layers will be converted. The anomaly data will then be downscaled from various spatial resolutions (1 – 3.5°, varying among the GCMs) to 1 x 1° and formatted to meet the requirements of ClimateAP.

- Activity 1.3 Programming and debugging

It is typically very time consuming to deal with climate data. It will take a number of days just to download the future annual projections. A time series function will be added to ClimateAP to allow users to generate climate data for multiple years in a single run, which will save a tremendous amount of time. Programing and debugging for this function will be achieved in this part of the activities.

♦ Output 2: Assessments of the impact of climate change on forest ecosystems, key species and vegetation types

Ecological models, including climatic niche models and process-based models, will be extended to include more species and entire ecosystems in more economies. Future projections for ecosystems will be particularly important as they may serve as a reference for all species associated with those ecosystems. We will also take advantage of our modeling expertise to improve current classifications of existing ecosystems.

These projections will provide assessments of the impact of climate change on forest ecosystems and key species in terms of the shifts in geographic distribution of suitable climate niches, species selection and vulnerability to abiotic and biotic stresses. We will also model the entire ecosystem of the target economies as they can serve as a framework to embed a large number of tree species for consideration of adaptation to climate change. This will be particularly important for economies that do not have adequate information for developing climatic niche models for individual species. We will use the Ecoregions developed by the WWF (World Wildlife Fund) to represent the ecosystems. However, we will use more detailed ecosystem classifications developed by the economies if available. Species, ecosystems and vegetation types to be projected are as follows:

China: two larch (*Larix gmelinii* and *L. olgensis*) species, Scots pine (*Pinus sylvestris*), Yunnan Pine (*Pinus yunnanensis*), black locust (*Robinia pseudoacacia*), Chinese cork oak (*Quercus variabilis*), aspen (*Populus tremula*), moso bamboo (*Phyllostachys edulis*) and entire ecosystems. There are eight species included for China. The selection of these species is based on their importance in terms of ecological and economic value and on the availability and feasibility for developing climatic niche models. Larch, Scots pine and oak species were also recommended at the Inception Meeting and Mid-term Project Review during the Phase I. We will keep in mind that each of these selected species occupies a relatively wide range of geographical and environmental conditions, which is important for developing robust climatic niche models. For ecosystems, we will use Forest Types, which are more detailed than Ecoregions.

Chinese Taipei: *Cyclobalanopsis longinux* (syn. *Quercus longinux*), *Lithocarpus megalophyllus* and entire ecosystems (forest types). In selecting these two species, we have considered the factors mentioned above. We have also based this decision off of discussion

with local collaborators regarding their importance and the availability of species distribution data.

Laos: *Justicia gendarussa, Lagerstroemia balansae, Pinus yunnanensis* and entire ecosystems.

Malaysia: *Dryobalanops lanceolate, Koompassia excels, Parashorea malaanonan, Shorea johorensis* and entire ecosystems.

Myanmar: *Hevea brasiliensis, Pinus yunnanensis, Protium serratum, Tectona grandis* and entire ecosystems.

Note for Laos, Malaysia and Myanmar: Use of these species for modeling and analysis is not finalized; they are all currently being considered based on preliminary research and their environmental and economic importance. The specific species that will be selected for analysis will depend on the input from local partners during the pilot site visit in February 2016, and data availability. Depending on availability of tree species distribution data, development of climatic niche models may not be possible for individual tree species in these economies. Regardless of what individual species are selected, we will model the entire ecosystems in each pilot site, as mentioned above, using Ecoregions to represent the ecosystems (as we work on finding more detailed ecosystem classifications while the project is in process). However, communication with local partners in these economies so far suggests promising data availability for modeling of the individual species.

All activities required for this output will be completed mainly by Dr. Tongli Wang, with support from the rest of the research team. Activities will be completed at the Faculty of Forestry, UBC, using computer programs R, Access and ArcGIS.

- Activity 2.1 Vegetation data collection and climate data generation

Distribution data for ten tree species will be collected for the ecosystems and each of the 10 species from the China Vegetation Map Database (published by Institute of Botany, Chinese Academy of Sciences and National Taiwan University. Digital information for vegetation types (at 1x1 km resolution) for the economies in Southeast Asia will be obtained from the NASA database. Additional vegetation data from other sources will be added whenever possible. These datasets will be processed and formatted for modeling. The coordinates of the data points will be used to generate climate variables using ClimateAP for the reference normal period of 1961-1990. This activity will be completed within the first year of the project so that the data can be used in subsequent development of niche models and consensus projections.

- Activity 2.2 Development of climate niche models

Random Forest, the machine-learning modeling approach used in Phase I of the project, will be used to build climate niche models for each of the 10 species, ecosystems and vegetation types. In the modeling process, we will first select the most important climate variables from over 200 climate variables generated by ClimateAP. The models will then be optimized and validated using out-of-bag (independent) samples. Once the models are built, we will use them to generate climate niche spatial distributions for the objectives modeled. To do this, we also need to generate spatial climate data using ClimateAP for the reference period of 1961-1990. Meanwhile, we will improve the current project classification of ecosystems in China and Chinese Taipei through the machine-learning modeling process and generate a set of climate-based ecosystem classifications, which will

be useful for forestry planning and natural resource management under a changing climate. This activity will extend throughout all three years of the project.

- Activity 2.3 Consensus projections using multiple climate change scenarios

Predicted distributions of the species, ecosystems and vegetation types will be generated for three future periods: 2020s, 2050s and 2080s. To deal with an uncertain future climate, we will project the future distributions with multiple (=>10) climate change scenarios. A consensus projection will be produced for each period based on multiple projections, so that our projections will be more robust than those using a single or a small number of climate change scenarios. For this purpose, we will need to generate a large volume of spatial climate data for each climate change scenario. This activity will be completed within the second and third years of the project.

♦ Output 3: Evaluations of adaptive forest ecosystem management strategies through model integration, development of indicators and trade-off analysis

One of the ultimate objectives of this project is to facilitate policy discussions through scientifically credible evaluation of existing data and information. It aims to help policy makers and practitioners understand the complex systems they are dealing with, as well as provide opportunities for addressing policy and data gaps to formulate alternative adaptive forest management strategies. We will achieve this objective by developing indicators from the results of the integration of process-based (i.e. FORECAST Climate) and niche-based models, as well as input from local partners, to conduct trade-off analyses at five representative pilot areas in Southeast Asia.

Activities within this output will be completed mainly by Dr. Guangyu Wang, Dr. Brad Seely, Dr. Qinglin Li and participants from targeted economies (China, Chinese Taipei, Laos, Malaysia and Myanmar). These activities may benefit from the involvement of APFNet if existing APFNet projects in pilot areas can be used for evaluation.

- Activity 3.1 Model calibration and simulations

FORECAST Climate and other selected modeling tools will be calibrated for key species and ecosystem types within the pilot project areas. We will apply cutting-edge remote sensing technologies to generate cloud-free high-resolution vegetation cover data at pilot areas to obtain parameters (such as leaf area index) for the models. This will serve as an alternative to observations at pilot areas. Representative forest analysis units will be identified within the pilot regions as the foundation for stand-level modeling. A suite of forest management practices, including adaptive management options for use in simulations with input from local partners, will also be identified. Stand-level simulations will be conducted with models utilizing climate change data generated from the expanded version of ClimateAP to reflect annual variability and extremes. This activity will extend throughout all three years of the project.

- Activity 3.2 Model integration and indicator development

A coordinated effort will be enforced during the project implementation to ensure

that the models presented above are formulated with a smooth feedback mechanism in which one's output or input is easily prepared for another's input and output. Thus, climate change, data and policy gaps, and ecosystem responses can be clearly captured during model integration. Furthermore, the results will be used to develop localized indicators, including climatic conditions, species range and presence, biomass and timber production, carbon storage, and disturbances. We will also focus on model integration at the local level to empower practitioners addressing their management challenges in practice, and/or enable them to bring the information gaps to higher levels for policy and planning discussions. This activity will begin at the end of year one, after the development of all models, and extend to year three of the project.

- Activity 3.3 Trade-off analysis

One of the key components of model integration that helps to ensure practical implementation of results is the overall trade-off analysis. The outputs from one model versus another are more often than not contradictory. Consequently, balancing the values and/or management objectives becomes extremely challenging if demands are coming from two or more positions with equal power, especially when decision-makers do not have adequate quantitative measures. Practitioners must carefully identify information gaps, managers must isolate social, economic, and environmental pressures and stresses, and planners must build the challenges into current management plans as known issues, modify the plans to accommodate them, bring them into the next phase of planning, and/or seek policy support.

This adaptive management method will greatly enhance science and technology transfers in practice. In addition, understanding the trade-offs and/or synergies between ecosystem services and society will be critical in fostering policy discussions, which will in turn further improve adaptive management practices. As a result, the trade-off analyses not only address information gaps, social pressures, and environmental stressors, but also offer quantitative measures for each decision in the pilot areas. This activity will take place in years two and three of the project. The output of this activity will be included in a cumulative report that contains results and specific recommendations for each of the five pilot sites. The report will be made available to stakeholders in each economy.

♦ Output 4: A web platform for data access and visualization for the five pilot economies: China, Chinese Taipei, Laos, Malaysia, and Myanmar.

A Google Maps based web tool has been developed (climateap.net) to provide a platform for data access and spatial visualization of model outputs. It facilitates and promotes the outreach of project outcomes to users. Due to the large area and the large number of economies in the region, it will be very difficult to interpret these maps if all outputs of the project are piled up on the same map. It is also difficult to visualize local variations on a large map due to limits in color spreads. Economy-specific maps (covering each of the five pilot economies) using the same platform will be developed in this project to make the spatial visualization and data access more effective.

Activities within this output will be completed mainly by Dr. Tongli Wang and project assistants in the Faculty of Forestry, UBC. These activities will extend throughout all three years of the project in order to keep web resources up to date with project outputs and

findings.

- Activity 4.1 Generation of maps

Projection maps will be individually generated in ArcGIS and processed to meet the requirements for overlaying on Google Maps. Color regimes will need to be configured to optimize the effects of spatial visualization. Map legends will need to be separately processed so that their sizes are not affected by zooming.

- Activity 4.2 Development of economy-specific web platforms

As the web-based platform is an integration of spatial visualization and ClimateAP, the economy-specific web platform will have the same functions, but it will zoom in on the specific area for each economy, without overlays for other economies.

- Activity 4.3 Map uploading and web maintenance

All the economy-specific web platforms will be hosted by the same domain, climateap.net, while each economy-specific web platform will be located at a sub-domain. The website will be maintained on a regular basis.

♦ Output 5: Networking and capacity building

A comprehensive network, involving scientists, policymakers, decision-makers, practitioners and other stakeholders will be extended, and the capacity of stakeholders will be enhanced through a suite of approaches designed to address the needs of different types of stakeholders. In particular, the capacity of government officials and local forest managers will be enhanced in the area of policy making and policy implementation related to forestry adaption to climate change using the methods described below.

All activities within this output will be completed mainly by Dr. Guangyu Wang, Dr. John Innes and project assistants, with support from the rest of the research team. The participation of APFNet could be beneficial for this output, such as involvement with workshop organization and promotion. Activities will extend throughout all three years of the project in order to maximize communication of project findings and involvement of stakeholders.

- Activity 5.1 Workshops and Meetings

A one day event for this phase of the project will be held as a side event at Asia-Pacific Forestry Week in the Philippines in February 2016. The event will consist of a half day workshop open to the public to share the findings and tools/models developed in Phase I with stakeholders from local economies who are in attendance, as well as share the goals and objectives of Phase II. This will be done through presentations, a panel discussion, and a Q&A session. Additionally, the other half of the day will be a closed door inception meeting for Phase II with local partners and UBC representatives. At this meeting, annual milestones and monitoring and evaluation guidelines will be discussed and set. The event will help to increase education about climate change adaptation and awareness about our project in the local target economies. It will also provide an opportunity to get together with local stakeholders to discuss Phase II of the project and to strengthen relationships

with valuable local partners. Five representatives from UBC will be attending the event, and travel costs are accounted for in the project budget.

Two workshops will be held in year one of the project with the assistance and support of APFNet for the economies in Southeast Asia. These workshops will cover the application of tools and models developed in the project. The first has been held on September 8-10, 2015, in South Africa, as one of the sessions of the XIV World Forestry Congress. This session shared the project and outcomes of Phase I with the international community at the World Forestry Congress to promote ways to integrate scientific tools with forest management, and to develop better decision-making strategies at both the management and policy level.

Several of our research team members and renowned researchers around the world outlined their work and explained their area of expertise. The topics covered include:

1. Policies for sustainable forest management under climate change.
2. Applications of high-resolution climate models for improved forest management.
3. Techniques for conducting tradeoff analysis of management strategies.
4. Tools to manage carbon storage under climate change.
5. Improving watershed and landscape level forest management under climate change.

This event was consistent with the objectives of the XIV World Forestry Congress in that it provided technical and scientific tools to promote sustainable forest management and improve policy and decision-making in the face of climate change. The research and tools presented represent cutting-edge developments and innovations in the field of forest management and adaptation to climate change. Through this event, we were able to share these advances with the broader scientific and political communities so that the best possible policies and management strategies can be developed to ensure the continued productivity and vitality of the world's forests.

The second **training workshop** will be held in Kunming, China in May, 2016, co-organized by the Research Institute of Resources Insects, Chinese Academy of Forestry. This workshop will invite government officials, local foresters, and community managers from the AP region to participate. It will be similar to the Phase I training workshop held in Kunming in 2013, which successfully increased the knowledge and capacity of participants to use the models and tools developed in this project to help address climate change adaptation. This workshop will be focused on these technical applications, management and decision-making methods in order to increase the capacity of participants to conduct forest adaptation to climate change in their own domestic situation.

A Phase II **completion workshop** will be held in December 2018 in Malaysia. The purpose of this workshop will be to share the findings and tools/models developed throughout this phase of the project with local stakeholders. The workshop will showcase the extensive scientific knowledge of tree species, ecosystems, and future climate impacts in the AP region generated by this project. It will demonstrate increased scientific capacity associated with the project through its cutting-edge models and tools for local predicted climate change scenarios, forest adaptation strategies, and ecosystem dynamics. This

workshop will further facilitate and promote real action on climate change in the region, by using specific economies as examples, allowing the identified gaps in science, technology, and policy regarding adaptation of forests to climate change to continue to be addressed.

Project team meetings will be held in each year of the project and will include the UBC research team as well as local partners from the targeted economies. The first meeting will be held in February 2016 at Asia-Pacific Forestry Week in the Philippines. Prior to this, from February 13-21, five representatives from the UBC project team will visit the pilot sites and project partners in Laos, Myanmar, and Malaysia for 2-3 days at each location. The objective is to ensure the sites meet the necessary criteria to achieve the project's research objectives, to determine concrete research and collaboration plans with each local partner, and strengthen relationships between this international research team. The cost of site visits is accounted for in the budget (Annex G "Overall Project Work Plan and Budget"). The other project team meetings (February 2017 and February 2018) will be held at UBC, with video-conferencing in of any members that cannot be present. The purpose of these meetings will be to ensure that all project team members are on track with their research, confirm that the project is progressing according to the timeline and budget, as well as discuss project progress reports. These meetings will provide an opportunity for the team to evaluate the progress of the project regularly over the next three years.

Two evaluation meetings will also be held in this phase of the project – a midterm evaluation meeting in July 2017 and a completion evaluation meeting in December 2018. These meetings will be held at UBC, with video-conferencing in of any members who are unable to attend. The purpose of these meetings will be to discuss the project with an external evaluator to ensure that the project is progressing according to the research objectives, timeline and budget. The anticipated cost of these evaluation meetings is $30,000. Please see Section 7 for more details on these evaluations.

Project Steering Committee (PSC) meetings will be held four times throughout this phase of the project (March 2016, March 2017, September 2017 and March 2018). They will be held at UBC with video-conferencing in of any members who are unable to attend. These meetings have been scheduled at the time that the 6 month, 18 month, 2 year and 30 month progress reports are due to APFNet, as the purpose of these meetings will be to receive feedback and suggestions from PSC members regarding the progress of the project (progress reports will be sent to all members beforehand for evaluation). The exact meeting dates may be adjusted depending on the actual start date of the project, but the time interval between will remain constant.

Please see Appendix D for a complete list and timeline of workshops, meetings and reports to be completed throughout the project.

- Activity 5.2 Network extension and policy notes

The network of scientists, policymakers, decision-makers, practitioners and other stakeholders will be further expanded in this phase of the project, with a focus on local foresters and young practitioners. This activity will be completed throughout all three years

of the project in order to maximize network expansion. It will be achieved through the hosting of workshops, participation in international conferences, presence on social media, updating and promotion of project website and web tools, and collaboration with IAs and CAs in local economies. Similar to Phase I, UBC is also currently hosting 20 young research scientists from multiple universities in China (with varying lengths of stay) to continue to expand our network and strengthen our relationship with researchers in the region. This exchange program is partly funded the Faulty of Forestry, UBC, with the remainder covered by the research assistants' home university where they research and study in a similar field.

A second research questionnaire (an extension of the questionnaire used the first phase) regarding gaps in climate policy, technology, actions (both regional and international) and community engagement will be conducted to further investigate the need for climate adaptation.

Regional sustainable forest management policy notes will be delivered in the later stage of the project based on the outcomes of the training workshop and network development. Several types of notes will be produced, aimed individually at policy makers, statutory decision makers and practitioners.

- Activity 5.3 Conferences and publications

Other than the abovementioned workshops, project achievements will be presented at regional and international conferences. Several team members attended the World Forestry Congress in Durban, South Africa in September 2015. A training workshop was held as one of the sessions at the conference. This session was intended to share Phase I project and outcomes with the international community at the World Forestry Congress, to promote ways to integrate scientific tools with forest management, and to develop better decision-making strategies at both the management and policy level. There are also plans to attend Asia-Pacific Forestry Week in the Philippines, February 2016; the IUFRO Regional Congress for Asia and Oceania in Beijing, October 2016; and to host another training workshop in Kunming, China, May 2016.

We also expect to produce about ten scientific papers and the technical reports/guidelines to be published in peer-reviewed journals. Furthermore, as a means of raising public awareness about the project and its outcomes, we will develop guidelines adaptation and mitigation of forests to climate change based on research at the pilot sites, and use these locations to develop case study examples with photos and graphics to illustrate the advantage to using tools developed by the project. Photos and graphics will also be used to more simply illustrate complex ideas on the project's website and at conference presentations. As well, a policy brief will be distributed to the head of each economies' Department of Natural Resources (or local equivalent), informing them of the tools available to develop effective adaptation and mitigation strategies, as well as outlining areas of their work and research that could be improved through the use of the project's outputs.

4. Risks and Assumptions

In general, this project is low risk. This is because the major tools and technologies have been developed in the previous project, and the main objective of this project is to extend these tools and technologies to a broader region. However, due to limited availability of inventory data in the Southeast Asia areas, the applications of tools and models may encounter some challenges, especially the process-based models. To address this concern, we will apply state-of-the-art remote sensing technologies to generate high-resolution and cloud-free vegetation data to obtain parameters required by the models as an alternative to forest inventory data. We have communicated with our partners and they have agreed to provide relevant inventory data.

5. Institutional Management and Management Activities

The project management structure and communication mechanism is illustrated in Annex E "Project organizational chart". All management activities, including workshops, meetings and progress reports are provided with a timeline in Annex F "Project management activities timeline".*Project Steering Committee (PSC):*

The project steering committee will remain the same as in the Phase I of the project, with the exception of one addition from National Normal Taiwan University. Dr. Shyue-Cherng Liaw has been added to the committee as his expertise in tropical forest ecosystems and forest management will be of great benefit to this phase of the project. The PSC members who were also a part of Phase I will continue to provide valuable guidance in this phase of the project, as they are leading climate change researchers in the field and are already familiar with the research completed in Phase I, including the goals and objectives of the project. The steering committee now consists of:

- **Dr. Hosny El-Lakany (Chair of PSC)**, Director of the CIFOR Board of Trustees, Former Assistant Director-General of FAO/Head of the Forestry Department
- **Dr. Rod Keenan**, Director Victorian Centre for Climate Change Adaptation Research Centre, Department of Forest and Ecosystem Science, University of Melbourne
- **Dr. Ir. Hendrayanto**, Professor and Former Dean, Bogor Agricultural University, Indonesia
- **Dr. Awang Noor Bin Abd. Ghani**, Professor and Former Dean, Faculty of Forestry, University Putra, Malaysia
- **Dr. Shyue-Cherng Liaw,** Professor, Department of Geography, National Normal Taiwan University

Project Team:

Professor John Innes is Dean of the Faculty of Forestry at UBC and, as such, is responsible for an annual budget of approximately $22 million. This involves the management of approximately 150 full-time staff and 1200 students, as well as two research forests. He has been responsible for the management and completion of more than 30 research projects, funded by a range of international funding sources. He has previously worked on four projects based in China, including a project looking at the

sustainability of the Min River Basin, a project looking at the introduction of certification and its association with forest tenure reform, and a project looking at the impacts of climate change on forests in Jiangxi Province. The proposed project lies well within the financial range of projects that Professor Innes has successfully managed in the past, and he has previous experience of work in China. Professor Innes has close links with forestry schools throughout the region, and will involve these in the extension of the results to a broader area within the region.

Dr. Guangyu Wang is Assistant Dean in the Faculty of Forestry at UBC. Dr. Wang has extensive experience in managing collaborative projects, particularly with partners in China. He has worked with Dr. Innes as a research associate on research projects in China for more than seven years. His research has been recognized by the international community. Dr. Wang will be responsible for project management including coordination of team members, progress monitoring and budget management. He is also responsible for impact assessment, best management practice and forest related policy development, as well as the integration of sustainable forest management under a changing climate. His efficient coordination skills will ensure a smooth implementation of the project plan in a timely manner.

Dr. Tongli Wang is an expert in climate and ecosystem modeling. He is the designer and developer for the widely used climate models ClimateBC and ClimateWNA. His work on modeling forest ecosystems and forest tree species distributions for climate change has been well known and influential in BC and in North America. Dr. Wang has developed the climate model "ClimateAP" for the APFNet project and will add new features to it. He will also be responsible for the development of climate niche models for forest ecosystems and species ranges and consensus projections for the future periods. Dr. Wang will also be responsible for developing the economy-specific Google Maps based platform for data access and spatial visualization of the results generated from this project.

Dr. Brad Seely is a research associate in the Department of Forest Resources Management at UBC. He has 20 years experience in the development and application of forest ecosystem management models and is one the developers of the FORECAST Climate model. Dr. Seely has been involved in several international projects examining the potential impacts of climate change on forest growth and development and has participated in several training workshops for the application of decision-support tools. He will oversee application of the process-based models within the pilot demonstration areas and will help conduct the training workshops.

Dr. Qinglin Li is an expert in carbon modelling and forest inventory analysis with the government of British Columbia. He is one of the government carbon experts in forest carbon science, climate change research, and modelling. He is also interested in forest management and related policy, ecosystem science and landscape ecology. His expertise in carbon modelling, climate change adaptation and management practice at landscape and regional levels will greatly enhance the project outcomes.

Haijun Kang is a lecturer at Fujian Agricultural and Forestry University. His research interests include sustainable forest management, forest asset management and forest resource asset evaluation. His current research involves the development of adaptive strategies for sustainable forest management in the context of climate change.

Brianne Riehl is a graduate of the Faculty of Science at UBC. She has experience with

international collaborative research and communication as a research assistant in UBC's Liu Institute for Global Issues and completion of an undergraduate thesis in collaboration with WWF. She is project coordinator and a communication officer of this project, in charge of coordinating and maintaining consistent communication between the PSC, IAs and CAs, as well as planning and organizing trips, meetings, and workshops, and completing progress reports throughout the project. She will also focus on communication of project findings to the international community through educational outreach including workshops, conferences, social media, and publications.

Shari Mang is a graduate of the Faculty of Science at UBC. She is a communication officer of this project, in charge of coordinating and maintaining consistent communication between the PSC, IAs and CAs, as well as planning and organizing trips, meetings, and workshops, and completing progress reports throughout the project. She will also focus on communication of project findings to the international community through educational outreach including workshops, conferences, social media, and publications.

Management Activities:

A timeline of all management activities planned for smooth completion of this project is given in Appendix D. Please see Activity 5.1 in Section 3 and Section 7 for a more detailed description of each activity. The management activities include:

Management Activity 1: Workshops
- 1.1 Inception Workshop
- 1.2 Completion Workshop

Management Activity 2: Meetings
- 2.1 Project Team Meetings
- 2.2 Project Steering Committee Meetings
- 2.3 Project Evaluation Meetings

Management Activity 3: Reports
- 3.1 Project Document
- 3.2 Annual Work Plans
- 3.3 Progress Reports
- 3.4 Completion Report
- 3.5 Audit Reports
- 3.5 Technical Report

Organizations:

Please see Annex I "Roles and Responsibilities of Project Agencies" for an explanation of the different agencies that will contribute to this project, including the roles and responsibilities of each.

Executing Agencies (EAs):
University of British Columbia: As one of the world's leading publicly-funded universities, UBC's location in Vancouver, Canada's gateway to Asia, together with the large population of people of Chinese origin in Vancouver, makes Vancouver a strong location

for collaborative ventures with China. As the EA of this project, UBC will be responsible for coordination of all implementing partners to ensure that project objectives are achieved. With extensive experience and expertise in organizing and implementing international research projects, and since the main IA is located at UBC, the university is in an ideal position to act as EA of this project.

Implementing Agencies (IAs):

Main IA:
UBC Faculty of Forestry is one of the most prestigious faculties of forestry in the world, and a key player in climate change research and related studies. The Faculty is a leading player in the development of high-resolution climate models, modeling and predicting potential impacts of climate change on forest ecosystems and species ranges, and developing adaptation strategies for forests. As the main IA, the Faculty will be in charge of completing the main research activities associated with project outcomes and overseeing the completion of project activities by local IAs and Collaborating Agencies. Through previous climate change-related studies completed by the Faculty throughout North America, it has developed a framework that can now be applied to the AP region for successful completion of this project.

Local IAs:
School of Agriculture and Forestry, National Ilan University, is one of the oldest institutions of higher education in Chinese Taipei. As a local IA, this university will contribute to the project through recommendation and access to a local pilot site in Chinese Taipei, as well as provide assistance in implementation of research activities in that pilot site. Local knowledge and expertise will be provided by this university in order to determine the most important research question and vegetation types to be studied, as well as the most effective modeling strategy to be applied in the region. With previous completion of local research projects related to sustainable forest management, and an increasing interest in climate change and adaptation, National Ilan University will benefit the project greatly as a local IA.

Faculty of Forestry, University Putra Malaysia (UPM), Malaysia is one of the most established tropical forestry education and research institutions in this region, and the most complete forestry school in Malaysia. As a local IA, this university will contribute to the project through recommendation and access to a local pilot site in Malaysia, as well as provide assistance in implementation of research activities in that pilot site. Local knowledge and expertise will be provided by this university in order to determine the most important research question and vegetation types to be studied, as well as the most effective modeling strategy to be applied in the region. With widespread completion of forestry research projects as the leading forestry education center in Malaysia, as well as an extensive network with many universities and agencies abroad and locally, UPM will provide a valuable addition to the project as a local IA. The university is also represented on the PSC and will provide feedback on project progress through evaluation of progress reports and participation in PSC meetings.

Faculty of Forestry, National University of Laos is the main location for higher education in forestry in Laos. It is an ideal institution to act as local IA for this project, as the faculty conducts scientific research on forestry, sustainable natural resource management, environment and socio-economic development. The faculty has also established a Research Center on Natural Resource Management and Climate Change

(NRMCC), which provides both research/technical services and capacity building to the region. Using this experience and expertise, as well as the resources and frameworks established through these activities, the university will be a positive contribution to our project as a local IA. The university will provide recommendation and access to a local pilot site in Laos, as well as provide assistance in implementation of research activities in that pilot site. Local knowledge and expertise will be provided by this university in order to determine the most important research question and vegetation types to be studied, as well as the most effective modeling strategy to be applied in Laos.

Research Institute of Resources Insects, Chinese Academy of Forestry is directly under the State Forestry Administration and is a comprehensive, multidisciplinary, national research institution. The academy has developed a strong relationship with UBC and the project research team through previous collaboration and exchanges/visiting scholars. As a local IA, the academy will contribute to the project through recommendation and access to a local pilot site in Yunnan, China, as well as provide assistance in implementation of research activities in that pilot site. This institute has access to Yunnan pine data for modeling in our pilot site, and local knowledge and expertise will be provided by the academy in order to determine the most important research question to be studied, as well as the most effective modeling strategy to be applied in the region. The academy completes extensive research that emphasizes China's forestry development and ecological construction, and has established cooperative relationships with more than 20 national and international organizations. As such, the academy will benefit this project greatly as a local IA.

Fujian Agricultural and Forestry University, China is a key university in its province, with focus on production forestry. The university has developed a strong relationship with UBC and the project research team through previous collaboration and exchanges/visiting scholars. It has a long history working on climate change and its impact on local forest tree species. As such, the university will provide beneficial guidance and feedback as a local IA, as well as assistance with application of research activities in our local pilot site in China.

Hebei Agricultural University (HAU), China is located in Baoding City, Hebei Province, China, and is a cross-disciplinary university, with a focus on agronomy, forestry and agriculture. As a local IA, HAU will provide species distribution and inventory data for the larch species we will analyze in the China pilot site, as well as beneficial guidance and feedback on the progress of our project.

Collaborating Agencies (CAs):

Ministry of Forests, Lands and Natural Resource Operations of British Columbia is the government agency to manage forests, lands and all natural resources in the province. Forestry plays an important role in this province, with leading edge climate change and forest adaptation research being conducted and applied. The Ministry is represented on the project research team by Qinglin Li. This strong connection with the Ministry will allow the project to incorporate the expertise gained from previous research projects completed by the Ministry into our project. As a CA, the Ministry will contribute this knowledge and experience to provide valuable and reliable feedback and suggestions throughout the progress of the project.

Department of Forestry (DOF), Ministry of Agriculture and Forestry, Laos is responsible for national forestry inventory, planning, monitoring, evaluation and

development. As a CA, the Department will provide the data and any other resources necessary to complete the project research activities within our local pilot site in Laos.

Federal Forestry Department Peninsular Malaysia (FFDRM) is responsible for the management, planning, protection and development of national forests and is responsible for the formulation of forestry policies, and providing technical advice, assistance and training to the State Forestry Departments. As a CA, the Department will provide the data and any other resources necessary to complete the project research activities within our local pilot site in Malaysia.

Ministry of Environmental Conservation and Forestry, Myanmar (MECF) is a ministry in the Burmese government responsible for the country's forestry and logging sectors. As a CA, the Ministry will provide the data and any other resources necessary to complete the project research activities within our local pilot site in Myanmar.

6. Project resources, financial management and audit

For a detailed budget, please refer to Annexes G "Overall Project Work Plan and Budget" and H "Project Budget by Category". All capital will flow first through the EA in order to ensure quality control and monitor use. It will then be distributed accordingly by the EA to all IAs and local IAs. UBC and the Faculty of Forestry would like to contribute $400,000 in kind to the research. UBC has a rigorous financial management system controlled centrally by professional accountancy staff, and an effective financial and research management control framework for monitoring the use of funding. Funding will be managed by the UBC Central Office and reimbursements will occur through the department's financial reporting systems.

The project will follow systematic approaches to project management, including reporting, review, monitoring, and evaluation (explained in further detail in Section 7), and UBC and the Faculty of Forestry will ensure that these approaches are adopted by the local IAs and CAs to ensure successful implementation of the project. The project team will follow the established procedures of providing annual plans, bi-annual progress reports, two external project evaluations, and regular project meetings and video conferencing (Annex F "Project management activities timeline") to identify any gaps between the actual and planned situations. Timely corrective actions will follow to ensure the efficiency and effectiveness of project implementation and to achieve the ultimate objectives of the project.

Consistent monitoring of project resources and budget will be completed throughout the project and reported in various reports submitted to APFNet. Annual work plans will provide detailed information about project planning and yearly budgets. Biannual and annual progress reports will cover the expenditures, progress, and achieved outputs according to the annual plan in the middle and at the end of each project year. External Audits and financial statements will also be submitted by the EA to APFNet to indicate the opening balance, expenditure incurred to date, and the closing balance for the project account.

7. Reporting, monitoring and evaluation

A systematic and comprehensive approach, including reporting, review, monitoring, and evaluation, has been developed and adopted by the EA in previous projects and was following in Phase I of this project. This phase of the project will also follow the management approaches that were developed and used in the first phase. The EA will ensure that these approaches are applied in all IAs and CAs to ensure successful implementation of the project.

Internal monitoring and evaluation

Internal monitoring and evaluation will be completed regularly in order to ensure the efficiency and effectiveness of project implementation, to achieve the ultimate project objectives, to avoid encountering unexpected delays in such areas as output delivery, and to ensure the timing and actual availability of planned input items (e.g., personnel, equipment, funds). Internal monitoring and evaluation will be completed by the EA, as well as the project leader and project manager at the main IA.

A periodic progress review will be conducted by the EA to guarantee that the project implementation is on track to achieve the anticipated objectives. This will be done using the associated logical framework matrix and work plan (Annex G "Overall Project Work Plan and Budget") in the project documents as a reference. By actively interacting with project staff involved in the project implementation, and by assessing the progress of the project according to the annual plan, recommendations and changes in actions will be suggested in order to better support the success of the project. Regular project team meetings will be held according to Annex F "Project management activities timeline" and regular progress reports will be discussed by the project team to ensure all project activities are on track. UBC's finance team will also monitor research related progress and will diligently monitor the project's budget. Mid-Term and Terminal audit reports will be completed right before midterm and terminal reviews of the project, utilizing UBC's meticulous financial tracking system to evaluate how well the project's budget is being controlled.

Internal monitoring and evaluation will be completed by the PSC through evaluation of regular progress reports. Feedback on these reports will be provided by these agencies in order to ensure all project activities are progressing according to the original objectives, timeline and budget.

External monitoring and evaluation

Two external evaluations of the project will also be conducted by an independent consultant hired by APFNet. A midterm evaluation and terminal evaluation, including evaluation meetings with the consultant at UBC, will be held in July 2017 and December 2018 (Annex F "Project management activities timeline").

Reporting

Upon completion of the project, the EA will produce a completion report to summarize the activities, inputs, expenditures, achieved outputs and objectives during the entire implementation phase and will identify any major differences between planned and realized budgets. All reports will be completed according to the timeline given in Annex F "Project management activities timeline" and will follow the document templates and requirements provided by APFNet. All reports to be completed throughout this phase of the project include:

1. Project Document
2. 1st Annual Work Plan
3. *1st Project Progress Report (1PPR) (Financial Statement)*

6th Month

4. *2nd Project Progress Report (2PPR) (Financial Statement)*

12th Month

5. 2nd Annual Work Plan
6. *3rd Project Progress Report (3PPR)*

18th Month

7. Mid-Term Audit Report – March 2017
8. *4th Project Progress Report (4PPR) (Financial Statement)*

24th Month

9. 3rd Annual Work Plan
10. *5th Project Progress Report (5PPR) (Financial Statement)*

30th Month

11. Technical Report – 36th Month
12. Project Completion Report – 36th Month
13. Terminal Audit Report – 36th Month

8. Dissemination, duplicability and sustainability

The key to the second phase of this project is to disseminate the major outcomes achieved during the first phase to the AP region through wider demonstration, and modeling integration and application. Various workshops, conferences, inclusion in teaching materials, policy briefs, journal articles, brochures, booklets, guided visits of pilot sites, and online tools will be used to disseminate project results. The key at this stage is to communicate with a broader range of stakeholders through application, demonstration, capacity building, and also community engagement in the five partnering economies – China, Chinese Taipei, Laos, Malaysia, and Myanmar. The scientific knowledge and application of results will be widely disseminated to all stakeholders, especially to strategic and decision-making bodies in the region. By hosting 20 visiting scholars at UBC from various Chinese universities, we are enabling this communication, strengthening our relationship with researchers in the region, and maintaining open communication regarding use of our project outcomes and tools.

The tools developed in Phase I of the project, to be expanded and improved in this phase, are user-friendly and widely applicable to allow for effective dissemination of knowledge and capacity in the region. ClimateAP can generate scale-free climate data for over 100 climate variables at high accuracy for any locations in the AP. The model has a user-friendly interface and can be used by anyone (i.e. it does not require any specific knowledge). It is so far the best climate model available for the region. It has the potential to be used in any climate change or climate-related study or application. Potential users are

not only limited to foresters and policy makers, but also include hydrologists, climatologist, agriculturists, city planners and builders, as has been the case with the use of ClimateWNA in North America. As well, ClimateAP will be beneficial to those directly involved in the project, and those indirectly involved or unable to directly participate in the project. It will serve as an essential tool and will considerably improve climate change-related studies in the region. The remaining issue is to make users aware of the availability of this tool. This issue will be addressed below. The climate niche models and their future projections previously generated and to be generated in this phase of the project have applied state-of-the-art modeling technologies and considered uncertainties in the future climate. The use of these models will boost the AP region to the forefront of progress in this research area. Together with outputs from process-based models, these projections will provide a solid scientific basis for scientists, policy makers and local practitioners in the target economies to formulate forest adaptive strategies.

8.1 Communication Strategy

The project team has developed a comprehensive communication strategy to ensure that the results are disseminated and of use to the broader scientific community, government bodies, policy makers, resource managers, as well as APFNet and their partner projects. We aim to promote ClimateAP and all other models and tools developed by the project to researchers studying climate change, forestry, natural resource use, agriculture, and ecology from at least 50 universities, and forest resource managers within government natural resource departments in Cambodia, China, Chinese Taipei, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. As well, we're aiming for a 20% increase in the use of the project's models and tools by the previously mentioned target audience and economies. Furthermore, we aim to increase the number of visitors, such as researchers and students studying the aforementioned topics, as well as forest resource managers from any economy, to the online ClimateAP model by an average of 150 visits per month from the Mid-Term to 6 months after project completion.

8.1.1 Communication tools and activities

The communication objectives will be met through the use of several overlapping tools and activities. For a complete outline of the communications work plan and associated budget, please see Annex C "Communication Strategy Work Plan and Budget". Conferences and workshops will be a key activity to disseminate knowledge, communicate project outputs to local stakeholders, promote APFNet and the project, as well as gain feedback. A main promotional event for this project was a side event at the 2015 World Forestry Congress in South Africa, aimed at forest policy makers globally. Based on the IUFRO Conference in 2014 in Salt Lake City, USA, we integrated our colleagues from different climate research fields around the globe together to promote the project. We will attend Asia-Pacific Forestry Week in the Philippines in February 2016, where we will host a side event to further communicate the scientific tools and models developed in this project with foresters and local decision-makers (Full description in Section 3, Activity 5.1). Additionally, we plan to attend IUFRO Regional Congress for Asia and Oceania in Beijing, China in October 2016, and host a training workshop in Kunming, China in May 2016 and the Phase II completion workshop in Malaysia, 2018. Presentations will be developed for each event, targeting the specific audience and event objectives. Forest professionals attending these workshops will increase their knowledge regarding climate change and related issues and be informed of our latest project results and publications.

At these events, we will distribute a ClimateAP booklet containing a description of ClimateAP and its application capacity, and links to the GoogleMap based online ClimateAP [http://climateap.net/], and the downloadable desktop version [http://climateap.forestry.ubc.ca/downloads/index.html]. As well, at each event we will distribute a Phase II brochure covering the key outputs from Phase I, the expected outputs of Phase II, and the relevance and capacity of these outputs to the scientific and management community in the AP region.

We will also develop a policy brief and project promotional note to be distributed to government natural resource departments heads, and heads of university faculties within the target economies. The policy brief will be distributed upon project completion to inform government personnel in the target economies of the availability and benefit of using the project's models/tools to develop more effective mitigation and adaptation strategies for forest management. The promotional note will be distributed to universities within 2 months of the project Mid-Term to update persons on the progress of the project, any tools that have become available, and the benefits of the final outputs, so that they are aware of the project's tools for future research projects. An updated note will be sent out upon project completion. Both the policy brief and promotional note will be distributed through email, and posted on the APFNet and project websites.

The ClimateAP and project websites will be used to promote and communicate information to our target groups. Both were developed during Phase I, and will be updated as progress is made. The section for each model/tool on the project website [http://asiapacific.forestry.ubc.ca] will be updated at Mid-Term, and upon project completion to incorporate information regarding improvements, research outcomes, and published papers. The ClimateAP website [http://climateap.net/] will be updated within 1 month of any major changes to the model function or development throughout the entirety of the project. Links to both of these websites will be provided at all conference presentations and workshops, in the policy brief and promotional note, as well as in any correspondence (such as email) where the project and its models/tools are discussed.

Furthermore, the project outcomes will be compiled into a series of scientific manuscripts for publication in peer-reviewed, open access journals and books. This is an important part of the project, as publication in peer-reviewed literature will demonstrate the scientific credibility of the results. It will also enable incorporation of the results into future IPCC reports, and other intergovernmental policy and documents. In addition to scientific publications, various reports will be prepared and submitted to APFNet, so that network participants can gain better insight into important outcomes and deliverables from the project.

8.1.2 Monitoring and Evaluation of Communication Objectives

Several monitoring strategies and success indicators have been determined to track the progress of the communication strategy, and evaluate whether objectives are met. Monitoring will take place throughout the project, following events, as well as after project completion. For specific methods, timeline, and success indicators for monitoring and evaluation, please see Annex F "Project management activities timeline".

We will use verbal feedback from participants at our inception, training and completion workshops, to make our website and web tools more accessible and effective. To evaluate the success of ClimateAP and model/tool promotion, we will request feedback from attendees at conference/workshop presentations. We aim to have 40% of attendees indicate they will try ClimateAP or another output model/tool in the near future

either for their personal interest, or in relation to a research/management project. This will be determined by a short paper survey distributed at the end of the presentation.

We are striving to have 50% of the people who received the policy brief or promotional note to have visited the ClimateAP website, project's website, and/or are aware of projects within their department that are using, or have plants to use, one or more of the project's models/tools. We will obtain this information through an email questionnaire to brief and note recipients 6 months after distribution.We aim to have a 20% increase in the use of the project's models and tools by university researchers and government forest resource managers within the target economies. To determine this, we will distribute an email survey to researchers at the target universities, and department heads at target government agencies to identify if they were using one of the project's models or tools prior to Sept. 2015 (from the results of Phase I), and if they are currently using any of the project's models or tools. The survey will be conducted 1 year after project completion. The number of visits to the project's various websites will also be used to determine the success of promotional activities. For the 'Research' section on the Phase II website [http://asiapacific.forestry.ubc.ca/research-approaches/], we aim to have a minimum of 300 visits a month from the Mid-Term to 6 months after project completion. For the ClimateAP website [http://climateap.net/], we're aiming for a minimum of 1000 visitors a month up to the Mid-term, increase on average by 150 visits per month until 6 months after project completion.

8.2 Sustainability

Sustainability is a significant feature of this project. A large number of peer-reviewed journal publications, technical reports and educational materials have been produced in Phase I of the project, and more will be produced in this phase. These publications have enriched the knowledge base regarding forestry adaptation to climate change in this region. The knowledge and capacity fostered in participants of our workshops will remain beyond the timeline of this project and benefit the region through the future research endeavors of these local stakeholders. The tools developed by this project are accessible online, with ClimateAP being available for download as a desktop version and also accessible as a Google Maps-based version. Projections for species ranges in current and future climates are also available online for spatial visualization and download. Projections of ecosystems and their associated forest tree species, to be generated in this phase of the project, will also be uploaded onto these web-based tools. Even after the project is completed, these tools and outputs will still be available to users, including policy makers and practitioners.

The interaction between academia and government departments facilitated by this project, and the application of climate adaptation to local pilot areas, will increase understanding and will lead to better formulation of scientific outcomes in policy making. This, in turn, may result in changes to policy and legislation, may enhance the adoption of better management practices, and may foster better forest law enforcement and governance in these regions. The results of this project could be extended to all economies in the AP region to help adapt their forests to climate change.

Annex A: Project sites map and relevant information

The areas involved in this project include the following economies:

China: China is a large and diverse economy with a wide range of forest resources ranging from boreal mixed woods in the northeast to temperate coniferous forests in the east and on the Tibetan plateau to subtropical mixed and tropical forests in the south. As of the 2009 national forest inventory, about 195 million ha were identified as forested. Plantation forests represent a large percentage of the total forest area and reforestation has been a priority in recent years. Forest degradation represents a problem in many parts of China, largely due to over harvesting of fuel wood and conversion to agriculture. Large-scale afforestation is a significant feature, which offers an opportunity to select forest species for future climates.

Chinese Taipei: Located off the southeast coast of mainland China, Chinese Taipei has a large forest area relative to its size (~36,000 km²). It contains more than 2 million ha of forestland including several forest types, ranging from tropical hardwoods in the lowland areas to cold temperate conifer forests along a gradient of increasing elevation. Chinese Taipei has a well-developed industrial economy and an established plantation forestland base designed to support a variety of ecosystem services including wood production, carbon storage, watersheds, and conservation of biodiversity.

Laos: Laos, an economy with a total land area of 236,800 km², is particularly rich in commercially valuable and ecologically unique forests. In 2002, the total forest area was estimated at 41.5% or about 9.8 million ha. By law, these forests are classified into five categories: (i) Production Forest, (ii) Conservation Forest, (iii) Protection Forest, (iv) Regeneration Forest, and (v) Degraded Forest. Production forest covers 33% (3.2 mill. ha) of the forest area, while protection forest and conservation forest covers 10% (1.03 mill. ha), and 49% (4.8 mill. ha), respectively. Regenerated and degraded forests cover the remaining areas. Like many places in Southeast Asia, forest resources and associated ecosystem services in Laos are closely linked to local communities. There has been extensive degradation of forestland due to a long history of swidden agriculture practices, but forest restoration has been identified as a future priority. The tropical hardwood forest types in Laos are representative of those in other economies in the Southeast Asia region.

Myanmar: The Republic of the Union of Myanmar (Myanmar) is situated at the western end of Southeast Asia. Myanmar is the largest economy in Southeast Asia, covering approximately 676,578 km² and extending 800 km east to west and 1,300 km north to south. Forests in Myanmar play a vital role in stabilizing environmentally critical areas such as coastal areas, dry zones, and hilly regions by providing protection against natural disasters. Myanmar forests have extremely high floral and faunal diversity. They harbour about 7,000 species of vascular plants including 1,696 species of climbers, 65 species of rattans, and 841 species of orchids. 85 species of trees have been identified as being premium sources of timber.

Malaysia: With more than 18 million ha of its total land area (32.6 million ha) covered with natural forest, Malaysia enjoys one of the highest percentages of forested land among tropical economies. Consequently, the timber and timber products industry are very important and play a significant role in Malaysia's economy. At the same time, there is increasing recognition of the protective roles that forests play, such as the conservation of biodiversity, protection of soil and water resources and stabilization of the climate. Forestlands in Malaysia are dominated by dry inland Dipterocarp forests but also include mangroves and peat swamp areas. More than 75% of forestland in Malaysia has been designated as permanent forest reserve and is managed for conservation, timber production, and protection of ecosystem services. However, deforestation and degradation remain a problem for forest managers.

Annex B: Project logical framework

Items	Intervention logic	Objectively verifiable indicators of achievement	Sources of information and means of verification	Assumptions
Goal	To considerably improve the capacity of forest managers and policy makers to develop robust adaptation strategies to improve the health and productivity of forest ecosystems and their resilience to a changing climate, thereby helping forest ecosystems mitigate and adapt to climate change in the Asia Pacific region.	1. Essential tools to conduct studies and applications for forestry adaptation to climate change; 2. Scientific basis to assess the impacts of climate change and to choose adaptive management options; 3. Personnel with enhanced capacity for adaptive decision-making.	1. Tools will be delivered and accessible to the public; 2. Scientific basis and adaptive management options will be documented; 3. Reports, extension notes and publications will be delivered.	The project is based on experiences obtained from the previous project. No factors are beyond our control so far.

Annex B: Project logical framework

Objectives	1. Improving the essential tools developed in phase I of the project to further facilitate and promote related research and applications; 2. Building and extending a scientific basis and adaptive management options to enhance the target economies' capacity in decision making for adaptation to climate change; 3. Expanding network and capacity building through workshops, communications and policy notes to further enhance information sharing and technology transfer.	1. ClimateAP to generate annual climate projections for the future; 2. Consensus projections of climate niches for ecosystems, key species and vegetation types for the future; 3. Adaptive forest ecosystem management strategies developed through model integration, development of indicators and trade-off analysis; 4. An accessible web platform for data access and spatial visualization; and 5. An extended network and enhanced capacity for adaptation of forestry to climate change.	1. ClimateAP will be delivered to APFNet at the end of the project; 2. The web platforms will be uploaded and accessible at climateap.net 3. The Consensus projections will be uploaded on the web platform; 4. Adaptive forest ecosystem management strategies will be reported and demonstrated at a local workshop; 5. Reports, extension notes and publications will be submitted to APFNet	The same as above.
Output 1	ClimateAP with future annual climate projections	ClimateAP to generate annual climate projections for2011-2100.	The ClimateAP package to be delivered.	N/A

Annex B: Project logical framework

Activity 1.1 Activity 1.2 Activity 1.3	• Data collection and formatting • Calculations of anomalies • Programming and debugging	• Future monthly climate data to be collected and formatted 90 years x 2 scenarios x 3 GCMs • Anomalies to be calculated for all climate layers • Time series function implemented and tested	• Semi-annual and annual reports • Semi-annual and annual reports • ClimateAP software package	N/A
Output 2	Assessments of the impacts of climate change on forest ecosystems, key species and vegetation types	Consensus projections of climate niches for ecosystems, key species and vegetation types for future climates in 5 selected economies	The Consensus projections will be uploaded on the web platform, which will be accessible with a browser.	N/A

Annex B: Project logical framework

Activity 2.1 Activity 2.2 Activity 2.3	• Vegetation data collection and climate data generation • Development of climate niche models • Consensus projections using multiple climate change scenarios	• Present-absent species data, spatial ecosystem data and vegetation types collected, and climate data generated • Climate niche models for 10 species, ecosystems in two economies and vegetation types for five economies in Southeast Asia • Huge volume of climate data will be generated using ClimateAP for 10 climate change scenarios, consensus projections for species, ecosystems and vegetation types generated	• Semi-annual and annual reports • Modeled spatial distributions of species, ecosystems and vegetation types to be presented • Consensus projections to be visible on the web-based platform (installed on the database), as well as provided in a Projection Report	The accuracy of the vegetation data may not be desirable, but it will be the best available.

Annex B: Project logical framework

Output 3	Adaptive forest ecosystem management strategies through model integration, development of indicators and trade-off analysis	Model integration of process-based and niche-based models, indicators developed from the model integration and trade-off analysis for alternative management strategies	Implementation at pilot sites (see Annex J "Description and Criteria for Pilot Sites" for details about each site)	Inventory data will be available. Otherwise, high-resolution remote sensing data will be used.
Activity 3.1 Activity 3.2 Activity 3.3	• Model calibration and simulations • Model integration and indicator development • Trade-off analysis to provide qualitative measures for each management decision	• FORECAST Climate and selected modeling tools will be calibrated for key species and ecosystem types. Stand-level simulations will be conducted • Localized indictors of forest resource values • Qualitative evaluation of adaptive management decisions	• Output of model simulations and high-resolution cloud-free vegetation dataset • Localized indictors and results of trade-off analysis to be reported • Specific recommendations for adaptive management decisions for each pilot site	The same as above

Annex B: Project logical framework

Output 4	Economy-specific web platform for data access and visualization	A functional web platform	Verifiable through a browser (e.g. website visits – see Annex D "Communication Strategy Monitoring and Evaluation" for details)	Google Maps is working or an alternative map application with similar API becomes available.
Activity 4.1 Activity 4.2 Activity 4.3	• Generation of maps • Development of economy-specific web platforms • Map uploading and web maintenance	• Maps and legends with specific color regimes for overlaying • Web platforms ready to host climate data and projections • All the economy-specific web platforms deployed and mirror sites at APFNet being setup	• Reports and demonstrations	N/A
Output 5	Network and capacity building	• A network involving scientists, policymakers and stakeholders; • Workshops, extension notes, conferences and publications	Reports and workshops	N/A

Annex C: Communication Strategy Work Plan and Budget

Activity	Tool/Product	When	Who	Estimated Budget (USD)	Notes
Development and production of communication tools/products	ClimateAP Booklet containing description of ClimateAP, GoogleMap based online ClimateAP, link to download desktop version.	Immediately. ClimateAP description within the booklet and website links will be updated at Mid-term and upon project completion.	Dr. Tongli Wang, Communications Officer	400	
	Policy Brief	Within the last 2 month of the project	Communications Officer	300	
	Presentations	1 month prior to meeting or conference. Each event will have its own presentation to ensure it is properly targeted to the event and audience	Communications Officer	400	
	Promotional note	Project Mid-term and upon project completion	Communications Officer, Dr. Tongli Wang, Dr. Brad Seely	300	
	ClimateAP webpage write up on project website	Already developed. Updated at Mid-term and upon project completion	Communications Officer, Dr. Tongli Wang	400	
	ClimateAP website	Already developed. Updated within 1 month after any major change to the model function or development through entirety of the project.	Dr. Tongli Wang	400	
	Tools and models webpage write ups on project website	Already developed for all model and tool webpages. Updated at Mid-term and upon project completion.	Communications Officer and project team member affiliated with the model and tool of interest.	300	
	Brochure	1 month prior to distribution	Communications Officer	200	
Pretesting of tools/products	ClimateAP Booklet containing description of ClimateAP, GoogleMap based online ClimateAP, link to download desktop version.	1 months prior to distribution	Project Team, Project Director	200	
	Policy Brief	1 month prior to distribution	Project Director and Qinglin Li with the Government of Canada	300	
	Presentations	2 weeks prior to presentation	Project Director and members of research team who will be present at the conference/workshop/presentation	100	

Annex C: Communication Strategy Work Plan and Budget

	Promotional note	2 weeks prior to distribution	Heads of the equivalent target university departments at UBC, and Qinglin Li with the Government of Canada	100	
	ClimateAP webpage write up on project website	Pre-testing of website was completed in Phase I	N/A	0	
	ClimateAP website	Pre-testing of website was completed in Phase I	N/A	0	
	Tools and models webpage write ups on project website	Pre-testing of website was completed in Phase I	N/A	0	
	Brochure	2 weeks prior to distribution	Project Director and 2 members of UBC's Faculty of Forests not on the research team.	100	
Dissemination of tools/products	ClimateAP Booklet containing description of ClimateAP, GoogleMap based online ClimateAP, link to download desktop version.	Conferences such World Forestry Congress in Durban, South Africa, Sept. 2015; Asia-Pacific Forestry Week in Pampanga, Philippines, February 2016; and IUFRO Regional Congress for Asia and Oceania in Beijing, China, October 2016, as well as workshops such as the training workshop in Kunming, China, May 2016.	Project team members giving presentations and running workshops	100	Travel and salary related expenses for conferences are already accounted for in project budget
	Policy Brief	Upon project completion	Project Director	0	Distribution is online - no printing costs.
	Presentations	Conferences such World Forestry Congress in Durban, South Africa, Sept. 2015; Asia-Pacific Forestry Week in Pampanga, Philippines, February 2016; and IUFRO Regional Congress for Asia and Oceania in Beijing, China, October 2016, as well as workshops such as the training workshop in Kunming, China, May 2016.	Project director and team members attending presentations and workshops	0	Travel to conferences is already accounted for in project budget
	Promotional note	Within 2 months of Mid-term and project completion	Project Director	0	Distribution is online - no printing costs.

Annex C: Communication Strategy Work Plan and Budget

	ClimateAP webpage write up on project website	Reference and link to the project's website will be provided at all conference presentations, all workshops, in briefs, in promotional notes, and in any correspondence where ClimateAP is discussed.	Communications Officer, Tongli Wang, Project Director, and any project team members attending workshops or corresponding about ClimateAP	0	Cost is included in events and material that have already been accounted for in the project budget.
	ClimateAP website	Reference and link to the ClimateAP website will be provided at all conference presentations, all workshops, in briefs, in promotional notes, and in any correspondence where ClimateAP is discussed.	Communications Officer, Tongli Wang, Project Director, and any project team members attending workshops or corresponding about ClimateAP	0	Cost is included in events and material that have already been accounted for in the project budget.
	Tools and models webpage write ups on project website	Reference and link to the project's website will be provided at all conference presentations, all workshops, in briefs, in promotional notes, and in any correspondence where project outputs are discussed.	Communications Officer, Project Director, team members in charge of the model/tool of interest, and any project team members attending workshops or corresponding about project's models/tools.	0	Cost is included in events and material that have already been accounted for in the project budget.
	Brochure	Conferences such World Forestry Congress in Durban, South Africa, Sept. 2015; Asia-Pacific Forestry Week in Pampanga, Philippines, February 2016; and IUFRO Regional Congress for Asia and Oceania in Beijing, China, October 2016, as well as workshops such as the training workshop in Kunming, China, May 2016.	Project Director and team members attending presentations and workshops	50	Travel to conferences is already accounted for in project budget
Monitoring and Evaluation	ClimateAP Booklet containing description of ClimateAP, GoogleMap based online ClimateAP, link to download desktop version.	At event where it is distributed and 3 months after distribution	Project team members attending event and Communications Officer	200	
	Policy Brief	3 months after distribution	Communications Officer	200	
	Presentation	During presentation	Project team members in attendance	0	Travel to conferences is already accounted for in project budget
	Promotional note	3 months after distribution	Communications Officer	200	

Annex C: Communication Strategy Work Plan and Budget

	ClimateAP webpage write up on project website	Monthly from the Mid-term to 6 months after project completion	Dr. Tongli Wang	400	
	ClimateAP website	Monthly from the Mid-term to 6 months after project completion	Dr. Tongli Wang	400	
	Tools and models webpage write ups on project website	Monthly from the Mid-term to 6 months after project completion	Communications Officer	200	
	Brochure	Immediate feedback on persons thoughts and opinions about the research and relevance of the tools to their work	Project team member attending conference/meeting	0	
TOTAL				**5250**	

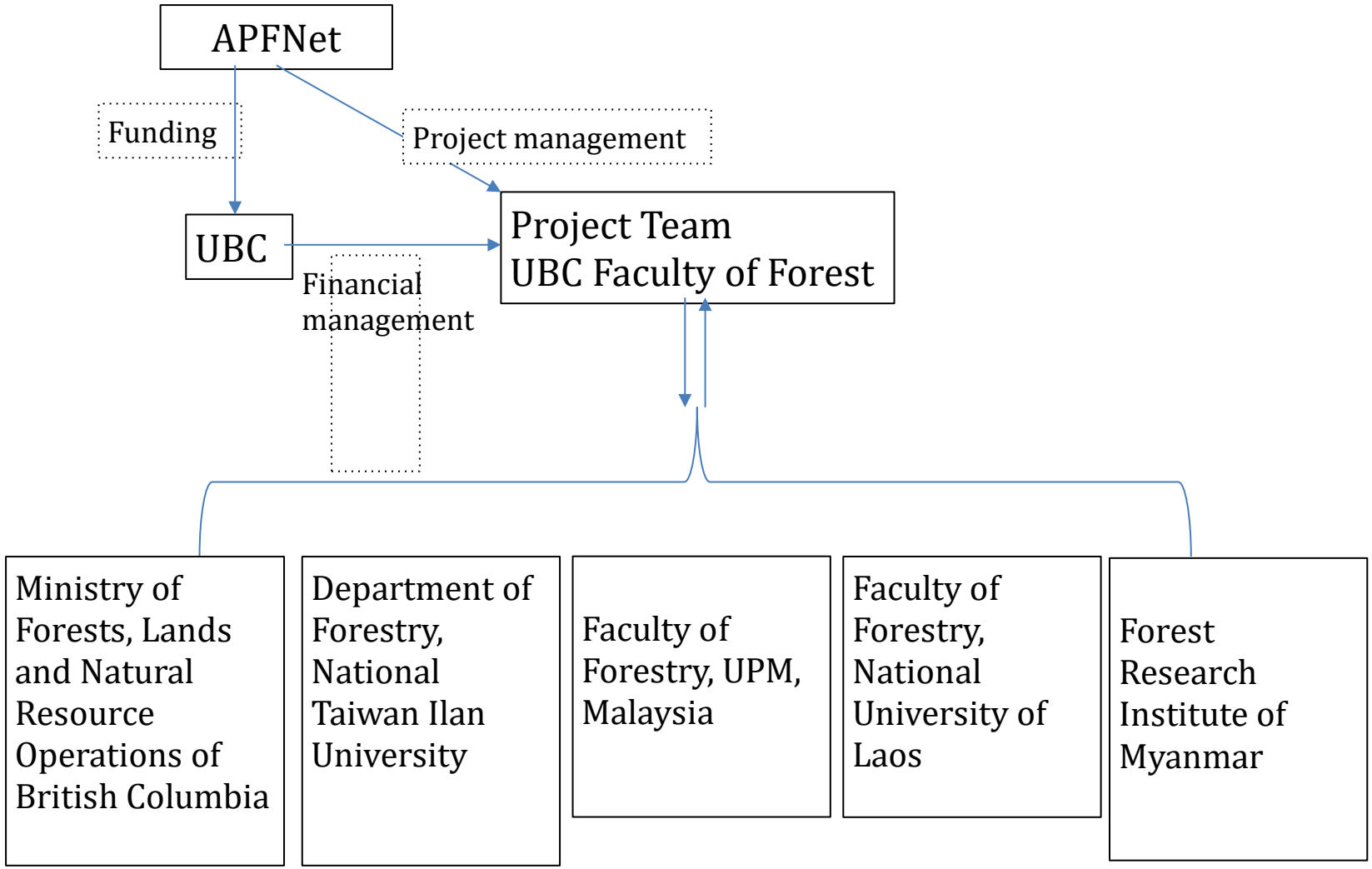
Annex D: Communication Strategy Monitoring and Evaluation

Communication Objective	Success Indicators	What information to collect	How to collect information	Who will collect the information	When to collect information
1. Promote the use of ClimateAP to researchers studying climate change, forestry, natural resource use, agriculture, and ecology from at least 50 universities and forest resource managers within government natural resource departments in Cambodia, China, Chinese Taipei, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.	At least 50% of persons who received the brief or promotional note have visited the ClimateAP website and/or are aware of projects within their department that are using ClimateAP or have stated plans to use it in a project proposal.	Number of people who visited ClimateAP website, and number of projects using or proposing to use ClimateAP	Email questionnaire to policy brief and promotional note recipients.	Communications Officer	6 months after distribution of policy brief and promotional note.
	40% of attendees at conference presentations indicate they will try ClimateAP.	Count number of attendees who indicate they will use ClimateAP.	Paper survey distributed at the end of presentations.	Project team members at presentation and conference	At the end of presentation.
	Minimum 300 hits a month on the project's 'Research' section of the website.	Number of site visits per day.	Website's built in user tracking tools	Tongli Wang	Monthly starting at the Mid-term and continuing till 6 months after project completion.
	Minimum 1000 hits a month of the ClimateAP website up to Mid-term, and then increasing by an average of 150 per month from Mid-term to 6 months after project completion.	Number of site visits per day.	Website's built in user tracking tools	Tongli Wang	Monthly starting at the Mid-term and continuing till 6 months after project completion.
2. Promote the use of all models and management planning tools developed by the project to researchers studying climate change, forestry, and natural resource use from at least 50 universities, and forest resource managers within government natural resource departments in Cambodia, China, Chinese Taipei, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.	At least 50% of persons who received the brief or promotional note have visited the project's website and/or are aware of projects within their department that are using one or more of the project's models/tools or have plans to use it in a project proposal.	Number of people who visited project's website, and number of projects using or proposing to use the project's models/tools	Email questionnaire to policy brief and promotional note recipients.	Communications Officer	6 months after distribution of policy brief and promotional note.
	40% of attendees at conference presentation indicate they will try the project's models and tools.	Count number who say they will use the tools/models.	Paper survey distributed at the end of presentations.	Project team members at presentation/conferenc e	At the end of presentation.

Annex D: Communication Strategy Monitoring and Evaluation

	Minimum 300 hits a month on the project's 'Research' section of the website.	Number of site visits per day.	Website's built in user tracking tools.	Communications Officer	Monthly starting at the Mid-term and continuing till 6 months after project completion.
3. Increase the number of visitors, such as researchers and students studying climate change, forestry, natural resource use, agriculture, and ecology, as well as forest resource managers from any economy, to the online ClimateAP model by an average of 150 per month from the Mid-term to 6 months after project completion.	From Mid-term to 6 months after project completion, there is an average increase of 150 visitors per month to the ClimateAP website.	Number of people visiting the site per month	Website's built in user tracking tools.	Communications Officer	Monthly starting at the Mid-term and continuing till 6 months after project completion.
4. Increase, by a total of 20%, the use of the project's models and tools by university researchers studying climate change, forestry, and natural resource use from at least 50 universities in total, and forest resource managers within government natural resource departments in Cambodia, China, Chinese Taipei, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam within 1 year of project completion.	There has been a 20% increase in the use of the project's models and tools by university researchers and government forest resource managers within the target economies.	Identify if a person was using one of the project's models or tools prior to Sept 2015 (from the results of Phase I), and if they are currently using any of the project's models or tools.	Email survey to researchers and staff at target universities and government agencies.	Communications Officer	1 year after project completion.

Annex E: Project organizational chart



Annex F: Project management and activity timeline

Activity	Date	Location	
Project Start	**Sept, 2015**		
Phase I outcomes introductory workshop	Sept, 2015	Durban, SA (WFC)	
Project document	Nov, 2015		
Annual work plan 1	Nov, 2015		
Inception workshop	Feb, 2016	Philippines (AP Forestry Week)	Year 1
Project team meeting	Feb, 2016	China, Chinese Taipei, Laos, Malaysia, Myanmar	
6 month progress report（PPR1）	Mar, 2016		
Steering committee meeting	Mar, 2016	UBC and video conference	
Training workshop	May, 2016	Yunnan, China	
Annual work plan 2	Nov, 2016		
12 month progress report (PPR2)			Year 2
Project team meeting	Feb, 2017	UBC	

LEGEND

Workshop

Meeting

Report

Annex F: Project management and activity timeline

18 month progress report（PPR3）	Mar, 2017		
Internal audit report	Mar, 2017		
Steering committee meeting	Mar, 2017	UBC and video conference	
Midterm evaluation meeting	July, 2017	UBC	
2 year progress report (PPR4)	Sept, 2017		
Steering committee meeting	Sept, 2017	UBC and video conference	
Annual work plan 3	Nov, 2017		Year 3
Project team meeting	Feb, 2018	UBC	
30 month progress report (PPR5)	Mar, 2018		
Steering committee meeting	Mar, 2018	UBC and video conference	
Completion workshop	Dec, 2018	Yunnan, China	
Completion evaluation meeting	Dec, 2018	UBC	
Project completion report, final audit report, technical report	Dec, 2018		

Annex F: Project management and activity timeline

Project End	**Dec, 2018**		

Annex G: Overall Project Work Plan and Budget

Please see the attached feedback document for an explanation of why this budget has not been edited to remove a $50,000 monitoring and evaluation cost. It has been agreed with APFNet that this money will be provided separately and will not come from the project grant.

Annex H: Project Budget by Category

Annex I: Roles and Responsibilities of Project Agencies

This project will be completed as a collaborative, international effort between 14 organizations throughout the study area. These organizations are divided into Executing Agency (EA), Implementing Agencies (IAs), Collaborating Agencies (CAs) and Supervisory Agency (SA) depending on the level and nature of their involvement in the project.

Agency	Roles and Responsibilities
Executing Agency (EA)	The project EA is responsible for coordination of all implementing partners to ensure that project objectives are achieved. Their role is to oversee all IAs and CAs in order to ensure effective and efficient completion of research activities.
Implementing Agencies (IAs)	
Main IA	The main IA is in charge of completing the main research activities associated with project outcomes and overseeing the completion of project activities by local IAs and CAs.
Local IAs	The local IAs are also responsible for completing research activities, but only in their local economy. They are responsible for providing expertise and assistance for local application of research activities. They are also responsible for providing local resources necessary to complete project activities, such as pilot site locations.
Collaborating Agencies (CAs)	CAs are responsible for providing feedback and guidance, or data and other necessary resources for completion of project activities. In some cases, they are responsible for collaborating with the local IA to ensure all resources are available for completion of local research activities.

Annex J: Roles and Responsibilities of Project Agencies

1. Pilot Site Criteria and Indicators

The key indicators and selection criteria for partnership and pilot site selection are as follows:

1) The pilot site should be at least 10,000ha in size and have available:

- Inventory data (at least 2-3 cycles of 5 or 10 year intervals)
- GIS map
- A forest management plan
- Hydrological/climate/meteorological historical data
- Vegetation map

2) A partner institution with strong community involvement and a good relationship or contacts with government, decision-makers and forest managers in the region.

3) Within the pilot site, the research will evaluate:

- Current forest management objectives/issues/challenges
- Climate change issues related to the forest ecosystem

At the pilot site, we will:

1) Propose forest management plans for different climate change scenarios and management objectives

2) Provide a detailed management plan and tools

3) Propose regulations/policy/management revisions for adaptation to climate change

4) Provide some financial support for data collection, field visits and workshop training

2. Pilot Site locations

2.1 Malaysia

Danum Valley Conservation Area (DVCA) is located in the southeast corner of the Malaysian state of Sabah on the Island of Borneo, and covers 43,800 hectares. It is within the Yayasan Sabah Forest Management Area covering over 1 million hectares, which includes approximately 750,000 hectares of forest under management for timber production, and 150,000 hectares of protected primary forest (including Danum Valley, Maliau Basin, and Imback Canyon Conservation Areas).

Annex J: Roles and Responsibilities of Project Agencies

Figure 1: Danum Valley is located on the island of Borneo, in the Malaysian State of Sabah

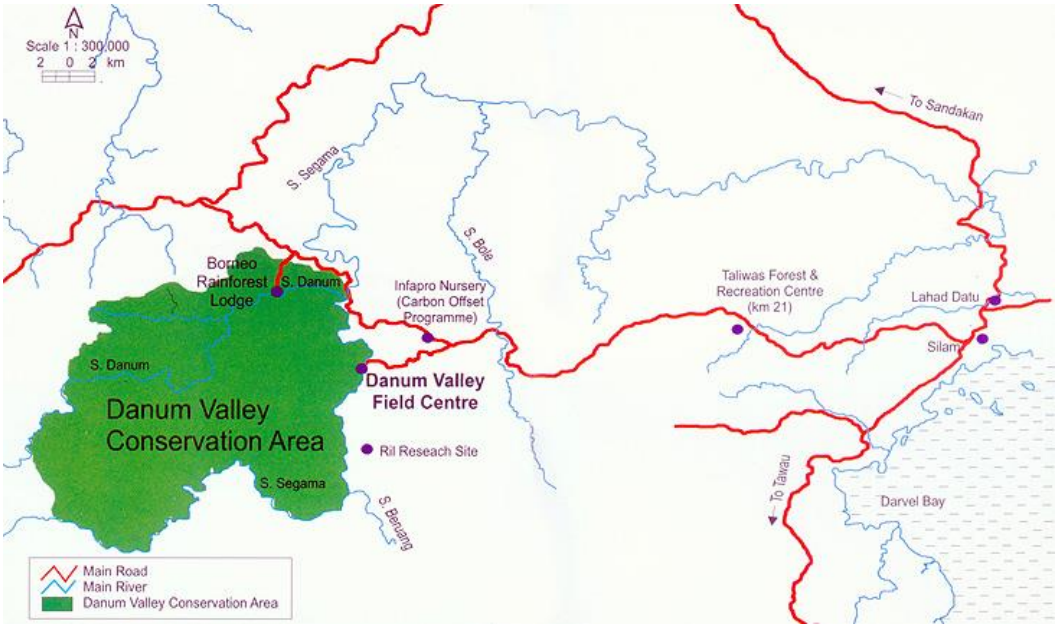


Figure 2: Danum Valley Conservation area is 43,800 hectares within the Yayasan Sabah Forest Management Area. The Danum Valley Field Centre is located within the conservation area.

The ecosystem at Danum Valley Conservation Area is a Lowland Dipterocarp forest, with approximately 1,300 species. The forest is dominated by Dipterocarpaceae, specifically *Parashorea malaanonan, Parashorea tomentella, Shorea johorensis*. Other dominant genera other than Dipterocarps include *Koompassia, Diospyros, Durio, Macaranga,* and *Combretum*. The region experiences rain throughout the year, with the max rainfall occurring in January, and the minimum in April. The temperature fluctuates only about 1.7°C throughout the year, averaging about 26.9°C.

Annex J: Roles and Responsibilities of Project Agencies

The Southeast Asia Rainforest Research Partnership (SEARRP) established by the Royal Society is based out of Danum Valley Field Centre. They have agreed to provide us with their long term climate and vegetation data, as well as the all the required GIS, hydrological, and management data. The project's partners Dr. Siti Nurhidayah Abu Bakar and Dr. Siti Nurhidayah of the Universiti Putra Malaysia have also agreed to provide any other supplementary data that is required.

2.2 Myanmar

The pilot site is located in Toungoo District in Bago Yoma Region in the northwestern part of Kayin state, and covers an area of 1,064,939 ha. The pilot site research will focus on the Yedashe Township within the district, where ITTO has a projection demonstration site.

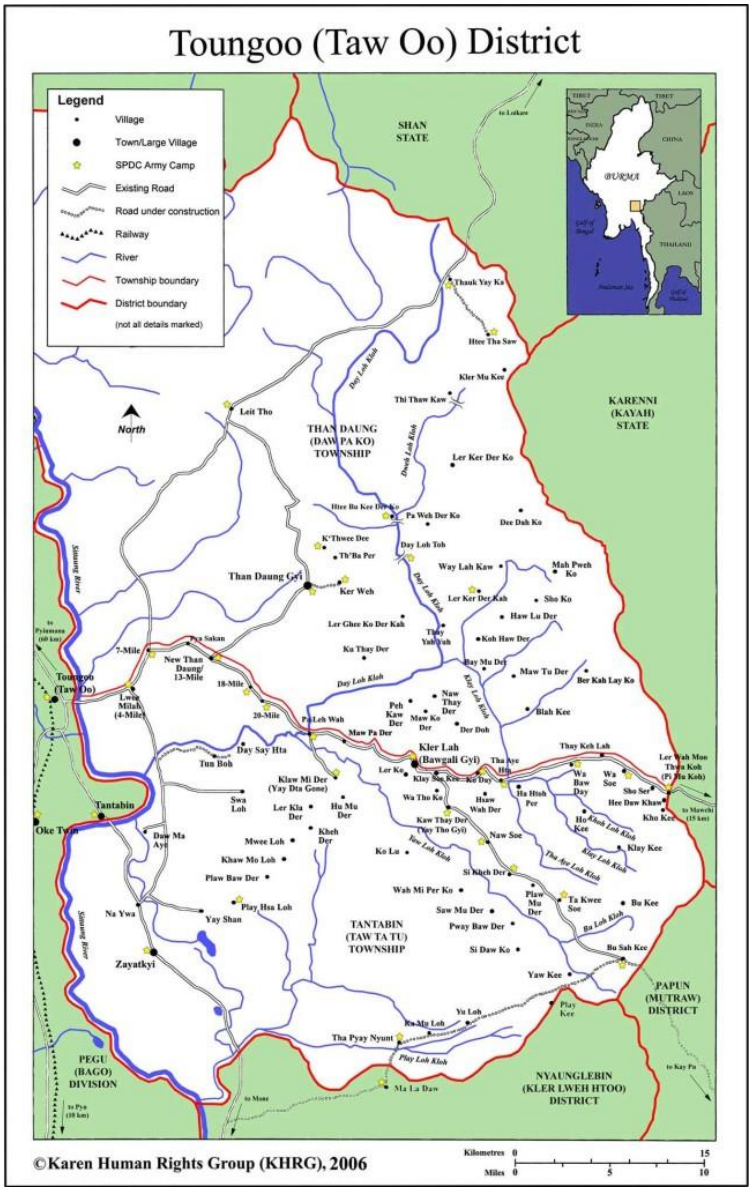


Figure 3. Map of Toungoo District

Annex J: Roles and Responsibilities of Project Agencies

Deciduous forest is major forest type in the Toungoo District. Within this type of forest, moist deciduous forest, semi-evergreen forest and patches of dry deciduous forest are also found. The key species we will focus on are Teak (*Tectona grandis*), and rubber (*Hevea brasiliensis*), as they are the two most economically important species in the region, and Thadi (*Protium serratum*) for its ecological importance. The Toungoo District has a tropical monsoon climate with rainy and dry seasons. The temperature is fairly consistent with a mean monthly temperature of 27.5°C. The region's rainy season is from May to October, with a mean annual rainfall of 1775.5mm.

Table 1. Forest cover of Toungoo District in Bago Yoma Region (ITTO 2011)

Forest type	**Toungoo District**	
	Area (ha)	**Percentage**
Evergreen	26,698.0	3.46
Moist upper mixed deciduous forest (MUMD)	539,283.4	69.8
Dry upper mixed deciduous forest (DUMD)	34,422.6	4.5
Lower mixed deciduous forest (LMD)	19,101.2	2.5
Bamboo and dipterocarp forest	52,002.2	6.7
Protected area	7,190.5	0.9
Plantation	43,744.3	5.7
Scrub lands	49,695.4	6.4
Total forest land		772,137.3

The local partner from Myanmar, Mr. Thaung Naing Oo of the Forest Department within the Ministry of Environmental Conservation and Forestry, has agreed to provide the necessary data as specified in the pilot site criteria. As well, remote sensing and GIS data is available for use through the Land Survey Department, the Ministry of Agriculture and Irrigation, and the Ministry of Science and Technology.

2.3 Laos

Nam Kading National Park is located in Bolikhamxai Province at an elevation of 160-1600 m. It has an area of 144,225 ha.

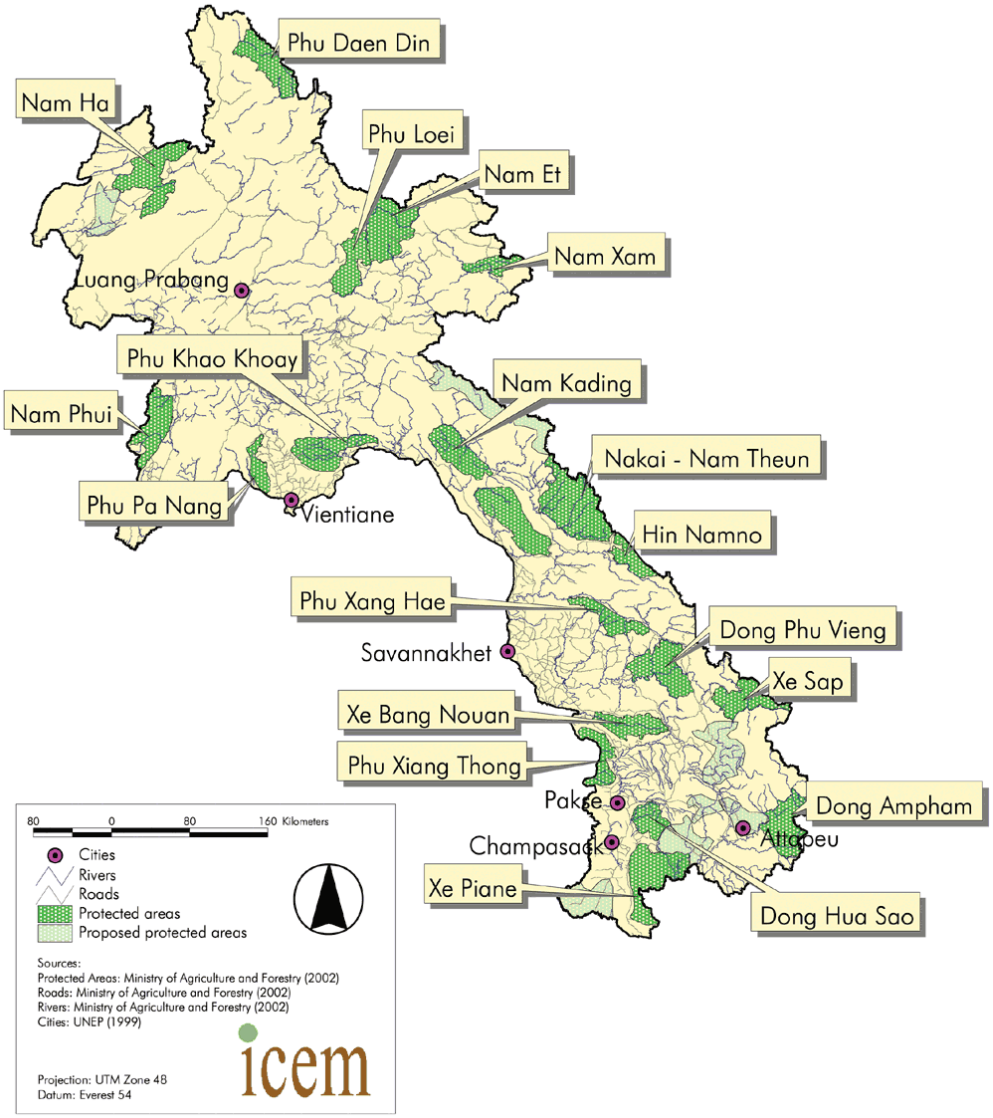


Figure 4: Map of Laos with the proposed pilot site at Nam Kading National Park.

Nam Kading's dominant forest type is dry evergreen/semi-evergreen forest, with broadleaf evergreen forest dominating the Nam Kading Valley within the park. Two rare species found in the area are *Lagerstroemia balansae* and *Justicia gendarussa*, which will be the focus species for the pilot site research. The region experiences a wet season from May to September, with an annual average rainfall of 1256mm, and an average temperature around 25°C.

Our local partner, Dr. Daovorn Thongphanh of the National University of Laos, has agreed to obtain and provide all the data and information required based on the pilot site criteria. Sources and access to the data will be discussed and confirmed during the pilot site visit in February 2016.

2.4 China

The pilot site in China will be Yunnan province in its entirety (Figure 5). Yunnan province is located in the Southwest corner of China, bordering Vietnam, Laos, and Myanmar. It covers 39 million ha. The entire province will be used as a study site for model application rather than a single forest reserve within the area.

Figure 5: Yunnan province, China.

The area is variable in its vegetation, weather patterns, and topography, with high elevations in the northwest and low elevations in the southeast. This region is made up of several different forest ecosystems (Table 2), and has the largest diversity of plant life in China. The temperature has a large variance, reaching highs of 25°C from June to August, and lows of 2°C in December and January.

Modeling and research will potentially focus on several different species, including two larch (*Larix gmelinii* and *L. olgensis*) species, Scots pine (*Pinus sylvestris*), Yunnan Pine (*Pinus yunnanensis*), black locust (*Robinia pseudoacacia*), Chinese cork oak (*Quercus variabilis*), aspen (*Populus tremula*), and moso bamboo (*Phyllostachys edulis*). The specific species that will be modeled and analyzed will depend on data availability and the needs of the local partners. However, the modeling and analysis of the entire ecosystem is certain.

Table 2. Forest landscape classification for Yunnan.

Type of Landscape	Dominant Forest Type
Cold Needle-leaf Forest	Spruce-fir and Larch Forests
Temperate Needle-leaf Forest	Alpine pine Forest
Warm Needle-leaf Forest	Yunnan pine Forest
Deciduous Broad-leaved Forest	Birch Forest
Evergreen Broad-leaf Forest	Oak Forest
Coniferous and Broad-leaved Mixed Forest	Includes Mixed deciduous evergreen oak, hard-broad forest (dominated by Camphor Tree and Phoebe Nanmu), and soft-broad forest.

Dr. Jainrong Su of the Research Institute of Resources Insects, Chinese Academy of Forestry is our local partner for pilot site research carried out in Yunnan. Dr. Su agreed to provide the vegetation data for Yunnan Pine that is required for species specific modeling, as well as meteorological and vegetation data required for ecosystem modeling and analysis. Overall, Yunnan fits the data and ecological requirements necessary for a pilot site due largely to the information provided by Dr. Su and his associates.

2.5 Chinese Taipei

The entire island of Chinese Taipei will be used as our pilot site, with an area of 35,883 km^2. The island is divided into two parts: flat, gently rolling plains in the west, and rugged, forest-covered mountains in the east. The climate of Chinese Taipei is influenced by the East Asian Monsoon with an average rainfall of 2600 mm per year. The climate ranges from a humid subtropical climate in the north to a tropical monsoon climate in the south.

Figure 6: Chinese Taipei, China

Natural vegetation in Chinese Taipei ranges from tropical rainforest in the lowlands to temperate

forests, boreal forest and alpine plants with increasing altitude. The mountain forests are very diverse, with several endemic tree species. The species we will model, along with entire ecosystem, are *Cyclobalanopsis longinux* (syn. *Quercus longinux*) and *Lithocarpus megalophyllus*. These species have been selected after discussion with our local partner, Tze-Ting Chen at National Ilan University, for their economic and ecological importance, as well as availability of detailed inventory and species distribution data. Our local partner has agreed to provide us with this data for analysis.