

Methodological Framework for Vulnerability Assessment of Climate Change Impacts on Forest-based Development Sectors

Second Year Annual Report

Prepared by

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Contract: EuropeAid/ENV/2004-81719
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Contents

Executive Summary	4
1. Introduction	5
1.1 Project Status and Current Progress	5
1.2 Methodology Development	6
1.2.1 Vulnerability: Concept and Links to the Definition	6
1.2.2 The Framework for the Methodology	7
1.3 Implementation Activities of the Project	9
1.4 Implementation Strategy for Project Activities	11
1.4.1 Workshops and Meetings	12
1.4.2 Graduate Student Research	13
1.4.3 Consultancy and National Contractors	14
1.4.4 Scientific Steering Committee	16
2. Staff Changes and the Teams	17
3. Communication and Outreach	18
3.1 Website	18
3.2 Flyers, Briefs, and Papers	18
3.3 Participation in Conferences	18
3.4 Mass Media Coverage of TroFCCA	20
3.5 Visibility Action for the European Commission	20
4. Partners and Collaboration with Other Institutions	21
5. Project Activities Planned for Implementation in Year 3	21
6. Regional Reports	22
6.1 West Africa	22
6.1.1 Introduction	22
6.1.2 Activities Undertaken during the Period	23
6.2 Central America	27
6.2.1 Introduction	27
6.2.2 Implementation of Project Activities	27
6.2.3 Activities Planned for Year 3	34
6.3 South East Asia	36
6.3.1 Introduction	36
6.3.2 Development Issues for Research	36
6.3.3 Main Activities	37
6.3.4 Local Partners and Relations	41
6.3.5 Summary of Outcomes of Research Activities	43
7. Output Targets for Phase 2 and the Status in Year 2	44

Executive Summary

This report describes the second year activities of the Tropical Forests and Climate Change Adaptation (TroFCCA) project. The report covers activities from August 2006 to 31 August 2007, highlighting the technical activities undertaken, planned activities for year three and the financial transactions accompanying activities carried out during the period.

To recap, the primary objective of TroFCCA is to contribute to national processes of adaptation to climate change, particularly to streamline adaptation into development processes through the assessment of vulnerability. The project is implemented in three continents across eight countries: Burkina Faso, Ghana, and Mali in West Africa; Costa Rica, Honduras, and Nicaragua in Central America; and Indonesia and the Philippines in South East Asia.

The project is structured into three phases, each having a central activity that guides implementation of the overall project objective. The phases and activities do not directly correspond to an annual year, and overlapping activities of Phases 1 and 2 were undertaken in the second year documented in this report. The main activity for the second phase of the project is the elaboration of methodology for the prioritised sectors of Phase 1, for the assessment of vulnerability of these sectors as a step for recommending adaptation strategies for those sectors. There are also activities across phases such as capacity building programmes through graduate students training programmes, project workshops, field days, etc., as well as a science-policy dialogue process and the consolidation of relations with partners.

Each region is primarily working on the elaboration of methodologies for vulnerability assessment of the selected sectors together with their partners in consultation with national government representatives to ensure that they will become relevant to national adaptation processes. In line with the common TroFCCA approach, however, a methodological workshop was held 19–22 April 2007 in Bogor, Indonesia, to explore ways of harmonisation of the general approach to the methodology especially on cross-cutting issues such as policy. This was further built upon in another TroFCCA workshop on decision making and policy networks for mainstreaming adaptation to climate change into policy, 14–19 May 2007 in Ouagadougou, Burkina Faso.

Bridging communication terminologies of stakeholders with quantifiable assessments and equivalence is crucial for the science-policy dialogue process. For example, policymakers and stakeholders easily relate to sectors rather than ecosystem services that actually drive those sectors and constitute the measurable blocks for the sectors. Furthermore, a sector may be surrounded by more than one ecosystem service, which makes empirical measurement of sectors difficult except through the surrounding ecosystem services. This is a major outcome of Phase 1 and particularly Year 2 of the project in defining the equivalent ecosystem services of each sector considered relevant to national development, for which methodologies are being elaborated for assessment of vulnerability of the various sectors with climate change. Monitoring and evaluation including projections of response trajectories of the various sectors to other climate scenarios will be facilitated by this approach.

1. Introduction

1.1 Project Status and Current Progress

The second annual report describes the activities from August 2006 to August 2007 represented by semesters 2, 3 and part of 4. During that period, the activities included some portion of phases 1 and 2 of the project (Figure 1). This also emphasises the connectivity between the phases with cross-phase activities.

	year 1		year 2		year 3		year 4	
	semester 1	semester 2	Semester 3	semester 4	semester 5	semester 6	semester 7	semester 8
Phase 1								
Phase 2								
Phase 3								

Figure 1. Distribution of the three phases over the four years period of the project

Project phases are characterised by subthemes that steer the activities during that phase towards implementation of the overall project objective. For example, Phase 2 of the project (Figure 2) primarily focuses on vulnerability assessment of sectors by first elaborating methodologies to be used for the assessment of vulnerability of prioritised sectors by regional stakeholders.

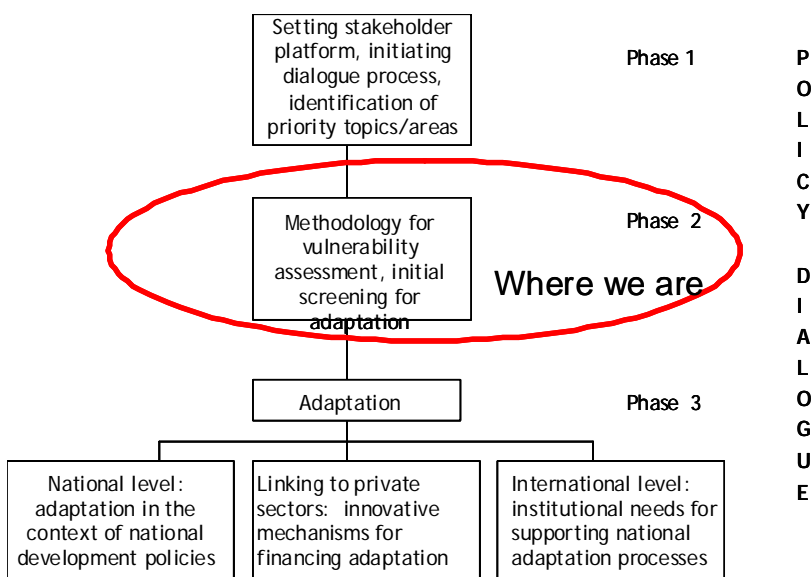


Figure 2. Major themes and activities of the three phases with indication of where we stand

1.2. Methodology Development

The purpose of the methodology is to outline the procedural approach in undertaking vulnerability assessment of the forest ecosystem and the ecosystem goods and services they provide for livelihoods and national development categorised here in sectors, in response to climate impacts. It is important therefore to understand the concept of vulnerability in order to allow for its assessment since its definition has already been dealt with and clearly stated in the working definitions of the project (see Annex 2 of TroFCCA,s first year report).

1.2.1. Vulnerability: Concept and Links to the Definition

Vulnerability assessment differs from traditional approaches of impact assessments in a number of important ways. In essence, impact assessment selects a particular environmental stress of concern (e.g. climate change) and seeks to identify its most important consequences for a variety of social or ecosystem properties. Vulnerability assessment in contrast selects a particular group or unit of concern (e.g. landless farmers, tropical forest ecosystems, coastal communities, development sectors) and seeks to determine the risk of specific adverse outcomes for that unit in the face of a variety of stresses and identifies a range of factors that may reduce response capacity and adaptation to stressors. In principle, the same global change phenomena could be assessed from both perspectives. In practice, impact studies have been most helpful where they have been able to focus on a single stress that dominates system response. It is becoming clear, however, that some of the greatest challenges arising from human–environment interactions entail complex system responses to multiple and interacting stresses originating in both social and environmental realms. Vulnerability assessment offers a maturing strategy to provide guidance in such situations.

Vulnerability is commonly characterised as a function of three defining factors—exposure, sensitivity, and adaptive capacity, which in TroFCCA’s case concerns a coupled human and environmental system. Thus there are three dimensional components that must be integrated in the vulnerability assessment irrespective of the differences that may exist in the levels or intensities of these three components. This therefore requires a framework for selecting indicator criteria that characterise the vulnerability of the coupled human-environment system. Indicators are commonly used to monitor trends on regional and national scales, which should not be confounded with a method that seeks to inform stakeholders of a place-base specific reaction in response to climate change impacts.

In this light it is imperative to elucidate the existing local knowledge base of indigenous adaptation strategies within a community as part of the evaluation of adaptive capacity required by the definition for vulnerability, even if there are evidences of exposure and sensitivity of the coupled system. Furthermore, sensitivity and exposure of human and environment components of the coupled system may differ and will require different indicator criteria which must link the coupled system in order to keep it as an integrated whole system. Stakeholder interests (past, present or future interest) also play important roles in vulnerability assessment. Stakeholders are commonly described as people or organisations with specific interests in the evolution of specific human–environment

systems. This makes it essential that vulnerability assessments inform and facilitate the decision-making process of specific stakeholders of a sector about their options for adapting to the effects of climate change within the scope of their resources. It must be emphasised, however, that these are not static solutions but constantly changing time and place-based options, which makes vulnerability assessment highly linked to sustainable development where there are measurable outcomes.

1.2.2. The Framework for the Methodology

The methodological framework of the project explained in TroFCCA Year 1 Annual Report for 2006 (Annex 1), sets out the procedure for the development of specific methodologies for each of the topics selected by the region and for the assessment of carbon (link to mitigation and adaptation). There is the layout of the description of the 12 steps the methodology comprises.

It is important to indicate that the methodology for vulnerability assessment must represent and highlight the coupled environment–human system and the dynamic interaction between these components. TroFCCA’s approach to the methodology therefore recognises those areas linking the human system to the ecosystem, the sectors linked to the ecosystem, the ecosystem services involved in the sector, and the human system benefiting from these ecosystem services.

As the system in question is a coupled human–environment system, assessments of vulnerability require the establishment of matching equivalences in the terminologies frequently used in the two components. For example, stakeholders representing the ‘human’ component of the coupled system describe ecosystem benefits in sectors that easily facilitate planning and communication among multiple stakeholders. From an environmental perspective, however, a sector may be characterised by one or several ecosystem services. Thus, for an effective assessment of a particular sector, the entire ecosystem services built into that sector need to be identified and assessed individually, thereby constituting the building blocks for the assessment of the vulnerability of that sector. Furthermore, TroFCCA’s ecosystem approach to adaptation is possible only by making the connection between livelihood and the forest ecosystem using ecosystem services. This makes it possible to look at a wide range of interrelated issues; for example,

- climate change impacts on forests and how they affect the provisioning of ecosystem services;
- climate change impacts on livelihood and how they affect the use or consumption patterns of ecosystem services;
- the change of corresponding response behaviour or consumption or provision patterns under climate change impacts; and
- resilience of the system in the face of all these.

The developmental focus of TroFCCA therefore requires that the vulnerability of these sectors be evaluated through assessment of the forest ecosystem services connected to these sectors with great emphasis on how climate change impacts on forests may affect these ecosystem services and consequently the identified sectors. This provides the entry

point for the development of policy-related adaptation strategies across different levels (local, national, and regional) and institutions.

The pathway for TroFCCA is through a multistakeholder participatory approach to implementation of planned activities. This requires engaging stakeholders in the processes of setting priorities and designing implementation strategies, which demands a methodical approach to identifying and selecting the relevant stakeholders to be implicated in the project. The setting of research priorities for forests in adaptation to climate change (as described in TroFCCA,s first year report and recapped in Table 1. The forest-based sectors were prioritised following three connected criteria of livelihood, national development importance and stakeholders’ perceptions of vulnerability to climate change impacts. This set the stage for differential emphasis in the methodologies elaborated by the three regions that also falls along a continuum of regional priorities in ecosystem services following stakeholders’ preferences and national priorities for adaptation.

Under this framework, the sectors listed in Table 1 are emphasised in the methodologies of the three regions. The TroFCCA approach demonstrates the similarities in outcomes of the regional sectors with urgent need for adaptation through stakeholders’ perception, and the state of degradation of the corresponding ecosystem services following a scientific approach of the Millennium Ecosystem Assessment (MEA 2005).

Table 1. Region prioritised sectors and their corresponding ecosystem services and the level of degradation according to the Millennium Ecosystem Assessment (MEA 2005)

Region	Prioritised Sector	Ecosystem Services	Type of Services	Status (MEA 2005)
West Africa	a. Water	Fresh water	Provisioning	▼
	b. Wood fuel	Fibre (wood fuel)	Provisioning	▼
	c. NTFP			
	—Foods	Foods	Provisioning	▼
	—Medicinal	Biochemicals, natural medicines and pharmaceuticals	Provisioning	▼
Central America	Water			
	—Potable water	Fresh water	Provisioning	▼
	—Hydroelectricity	Fresh water	Provisioning	▼
Southeast Asia	Landslide	Natural hazard regulation	Regulating	▼
	Wildfire	Natural hazard regulation	Regulating	▼

Note: ▼ Degradation

1.3 Implementation Activities of the Project

The activities implemented in the second year represented a continuation of Phase 1 and the commencement of Phase 2 of the project as mentioned earlier. A summary of the planned activities of phases 1 and 2 as exactly stated in the project document follows.

Activity 1 (Phase 1): Develop methodologies to assess the vulnerability of the specified development topics due to impacts of climate change on forest ecosystems. Compilation of toolkits applied to the methodology.

- Select development topics.
- Undertake a literature review for the various steps of the methodology.
- Compile available tools and information on impacts of climate change over forests.
- Assemble and test methodologies.

Activity 2 (Phase 2): Implement the methodology to assess vulnerability of the development topics biodiversity and carbon.

- Select case study areas.
- Assess goods and services from forests in relation to climate change and climate variability.
- Develop climate scenarios.
- Apply the methodology: assessment of vulnerability for the study areas.
- Elaborate vulnerability maps and extrapolate results.

The activities implemented therefore included a continuation in the elaboration of the methodologies for vulnerability assessment of the prioritised sector(s)/topic(s) (Table 1). The process is guided by the 12 steps and measured by the corresponding outputs for each of the steps listed in the project document. The steps are discussed below together with the implementation activities, and the extent of realisation of expected output from each step during this period of project activity is evaluated.

The **main output of step 1** was to have a clear definition of the topic(s)/areas(s) of the development policy in which forests play a significant role and where impacts of climate change may hinder development. The means and tools to accomplish this output were contacts with governments, regional kick-off meetings, and literature review. This particular output was accomplished following the recommended channels and the regional development topic(s)/area(s) are listed in Table 1 above.

Once the topic(s)/area(s) of research emphasis have been identified, the next step will be the specification of the goods and services that support/relate to the topic(s)/area(s) identified. According to the project document, the **main output of step 2** is a description of the goods and services from forests that relate to the topic(s)/area(s) selected. The corresponding ecosystem services have all been identified and listed in Table 1 above using the Millennium Ecosystem Assessment (MEA 2005). This was taken one step further by highlighting the state of degradation of these underlying ecosystem services

following the global assessment (Table 1). The results show that all the goods and services that support/relate to the topic(s)/area(s) prioritised by the regions are degraded.

The third step of the methodology is the assessment of the ecosystem functions underlying the goods and services identified in the previous step. **The main output of step 3** is a detailed description of the ecosystem functions that support provision of the goods and services described in step 2 as well as indicators to link ecosystem functions to the provision of specific goods and services and, to the extent possible, the type of relation. This output has been partially accomplished. There are descriptions of the role of forests in the provision of goods and services gleaned from literature reviews of all the topic(s)/area(s). The selection of indicators is still continuing to link functioning and provisioning of these goods and services.

Step 4 comprises identification and analysis of the biophysical processes and parameters that determine ecosystem functions specified in step 3. **The output of step 4** is a detailed description of the biophysical processes and parameters that support the ecosystem functions, including indicators to link biophysical parameters to ecosystem functions and also the type of relation where possible. Research activities in Central America have fully demonstrated the relationship between changes in forest cover and the hydrological cycle and the implications on flow rates and hydroelectrical power generation in the region. Similar activities are still continuing in other regional sectors.

In step 5, the connection between forest ecology and vulnerability to climate change will be assessed through an analysis of how changes in climate, and climate variability in particular (temperature, rainfall, and extreme events), will affect the ecological parameters that control ecosystem functions underlying goods and services. **The main output of step 5** will be a detailed description of how climatic variables like rain and temperature can affect the biophysical parameters identified in the previous step. This will include indicators to link climatic to biophysical parameters and, to the extent possible, the type of relation. The activities linked to this particular output are still on the way although there are literature reviews that addresses some of the connections between climate variables like temperatures and rainfall and their implications to biophysical parameters of ecosystems.

Step 6 of the methodology process involves the selection of case studies in each of the regions. **The main output of step 6** will be the selection of regional or country case studies that are relevant to the topic(s)/area(s) development priorities. Commissioned activities are on the way to fully accomplish this particular output and provide complete information for vulnerability assessment using the project definition that consider three critical aspects—exposure, sensitivity, and adaptive capacity. There are already selected pilot studies in all three project countries in Central America on the provision of hydroelectricity. In South East Asia, there are pilot studies in the Philippines in collaboration of TroFCCA and ICRAF. In West Africa and in Indonesia there are commissioned studies that will provide outputs linked to this step (see section 1.4.3 on Consultancy and National Contractors).

Step 7 is based on the development of scenarios. The **main output** are climate scenarios that are applicable to the case studies, regions, and countries. In line with the realisation of this particular output, there are ongoing runs of climate simulations with PRECIS in South East Asia and in West Africa, in collaboration with the UK Met Office Hadley Centre. Two desktop computers with the right capacity and specification to run the software were purchased for each of the regions. In West Africa, an expert consultant from the African Centre for Applied Meteorology and Development (ACMAD) based in Niamey was brought over for a hands-on training of project staff jointly with staff of the national meteorological department of Burkina Faso. A PhD student has been recruited specifically to run the simulations and analyse the data. There is also a staff responsible for the runs in Indonesia cumulatively with other responsibilities.

Step 8 involves the identification of current and future biophysical impacts. **The main output of step 8** is an assessment of the possible impacts of current and expected climate variability and extreme events over the biophysical parameters and ecosystem function for the selected case studies. This step has not yet commenced since it is dependent on steps 5 and 7.

Step 9 is an assessment of the derived impacts, the main output comprising an assessment of the implications on the provision of goods and services in measurable terms (i.e. through criteria and indicators). There are ongoing activities in Central America and similar activities are on the way in West Africa and South East Asia.

Finally, step 10 focuses on vulnerability assessment. **The main output of step 10** is an assessment of vulnerability of the specific topic(s)/area(s) including the possible costs to society arising from impacts of climate change on forests. This would include other processes and pressures such as deforestation and identify priority areas that can be addressed through policy instruments and through the participation of the private sector and other relevant actors. There are ongoing policy research activities across the three regions directly related to the main output of step 10. These activities involve both macrolevel (regional and national levels) policy analyses as well as microlevel activities directly involving communities. Some of these involve network analysis in identifying main actors and their relationships to facilitate mainstreaming into policy.

1.4 Implementation Strategy for Project Activities

The project document recommends a number of ways to undertake project implementation activities. These include:

- National teams
- Establishment of a scientific panel
- National contractors
- Doctoral and master students
- Centralised activities performed by the teams of Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) and Center for International Forestry Research (CIFOR) depending on their expertise
- Meetings and workshops

- Contact with national governments and partners
- Policy dialogue

All these options are continuously being employed by the project. Below, however, emphasis is placed on those that were instituted during the period covered in this report and on targeted activities undertaken during this period.

1.4.1. Workshops and Meetings

With the multidisciplinary project team spread over multiple global locations, the need arises for workshops for the project team and members of the scientific steering committee, and sometimes with external members, to discuss research activities taking place across the different regions as part of the implementation strategy. Meetings organised under the project at the global level included the following.

1) Methodology Workshop of the ‘Tropical Forests and Climate Change Adaptation’ (TroFCCA) Project, 24–27 April 2007, Bogor, Indonesia

The elaboration of a methodological framework for vulnerability assessment of the forest ecosystem and the goods and services forests provide (through the selected sectors) constitutes a major theme of Phase 2 activities. As the project spans three global regions, there are certainly site-specific differences including the prioritised sectors that need to be highlighted in the methodology. Furthermore, since the forest represents TroFCCA’s principal ecosystem, that requires the standardisation or calibration of some areas of the methodology to maintain similar structural approaches and also allow for regional comparisons.

Development of a methodological approach constitutes a crucial output for TroFCCA in contribution to the knowledge-base and science of vulnerability assessment especially for the forest ecosystem, which is currently lagging other ecosystems. It was therefore important to establish a unifying platform for the methodology that reflects the common facets and objectives of TroFCCA.

In the mid-term of TroFCCA’s activities, it was also important to have a strategy for outreach and dissemination activities using current outcomes and recommendations. Although these have been an ongoing process, the 13th Conference of the Parties (CoP13) in Bali, Indonesia, in December 2007, would provide a thematic platform and represent an important opportunity with a high-profile forum of interdisciplinary stakeholders engaged in discussions and negotiations under the United Nations Framework for Climate Change Convention (UNFCCC). It was important to plan for TroFCCA’s participation in CoP13, including setting timeframes for the realisation of some outputs for presentation.

The goal of the workshop was to review the approaches, methods, and tools in the methodologies elaborated by each region for vulnerability assessments of the selected sectors during their stakeholders’ regional kick-off meetings and to ascertain they were fully met. The workshop also provided the opportunity to plan for CoP13 and explored ways of increasing or improving current activities and visibility of the project. Participants also undertook a rapid internal appraisal of TroFCCA by responding to a

series of questions. A classification of the responses yielded interesting results and provided a platform for reflection and discussion on new orientations, building on our strengths and addressing gaps and weaknesses. Several social events in the evenings provided for personal interactions.

2) Establishing Steps of Policy Network Analysis for Mainstreaming Adaptation to Climate Change in TroFCCA, Ouagadougou, Burkina Faso, 14–19 May 2007

The workshop was designed to open the discussion on tools relevant for policy analysis within the context of the TroFCCA project. The specific focus was on the methodology for mainstreaming adaptation to climate change into priority sector policies. Given the contextual differences in project regions, it was important to focus on conceptual frameworks, methods, and methodological phases rather than on specific regional characteristics or needs. Regional research teams are expected to adapt the general framework and methods discussed and developed during the workshop to their respective regional situations. Workshop results should enable selection of a methodological toolbox for the identification of forest- and sector-relevant adaptation strategies to climate change impacts and the mainstreaming of these strategies into policy across regions. The workshop was organised mainly as an internal discussion of project researchers on policy network analysis. When considered feasible and appropriate, additional resource persons will be invited to participate and to contribute to specific methodological and conceptual issues.

1.4.2. Graduate Student Research

Graduate students are instrumental to project implementation at global, regional, and national levels. Doctoral students involved in global level project activities include Moussa Kone and Matieu Henry.

Moussa Kone, PhD candidate, Department of Geography, University of Illinois, Urbana-Champaign, USA: joint supervision with University of Illinois under the 2007 Norman E. Borlaug International Agricultural Science and Technology Fellows Program in Leadership Enhancement in Agriculture Program (LEAP).

Project title: Up in Smoke: Biomass Burning, Land Cover Change, and Atmospheric Emissions: A Comparative Study of the Guinean and Sudanian Savannas of Côte d'Ivoire.

This dissertation research investigates biomass burning in the light of social, economic, political, and biophysical processes at the local and regional scales in Côte d'Ivoire. Fire is an important management tool in the farming and pastoral systems of West Africa. Environmental researchers and policymakers consider biomass burning an important source of greenhouse gases and aerosols such as sulphur, nitrous oxide, methane, and carbon dioxide. Africa dominates the geographical distribution of fire events globally with about 40 percent of all fires and is believed to account for 30 percent of the biomass burning emissions worldwide. The objectives of this study are threefold. The first is to examine trends in savanna burning in terms of timing, frequency, and efficiency. The researcher hypothesises that burning regimes have changed due to new farming and herding practices. The second objective is to examine the nature and direction of land cover change over the period 1975 to 2008. The researcher hypothesises that land cover

is becoming more wooded in the Sudanian zone due to the shift in burning from the middle and late dry season to the early dry season. The third objective is to assess the West African contribution to global greenhouse gas production. The researcher hypothesises that this contribution is not as high as believed because of changing burning regimes and land cover changes that result in fewer greenhouse gas emissions. This research will enhance TroFCCA's activities in the region by highlighting the dynamics of fire as a management tool, and the possible constraints and opportunities for adaptation as well as the potential contribution to overall carbon emissions. The research will also assist in the assessment of the contribution of fire to the vulnerability and adaptation of various land uses in the region under present and past climate change trends, and in predicting possible responses using future climate change scenarios. This research is of much interest to the Consultative Group on International Agricultural Research (CGIAR)–CIFOR centre whose research programme examines 'the role of landscape heterogeneity in providing many environmental goods and services as well as the role of a variety of stakeholders at multiple scales in managing them' (<http://www.cifor.cgiar.org/trofcca>).

Matieu Henry, PhD candidate, University of Tuscia, Italy, under the CarboAfrica project. TroFCCA member Bruno Locatelli is a member of the supervisory team.

Project title: Potentials for Reducing Emissions from Deforestation in Sub Saharan Africa.

The aims of the study are (1) to estimate greenhouse gas emissions from land use change particularly deforestation and forest degradation, (2) to predict future emissions, (3) to estimate the cost of emission reductions, and (4) to estimate potential for avoided deforestation in sub-Saharan Africa. The shared interest in this research project falls with the broader collaborative framework of CarboAfrica and TroFCCA, which involves assessment of the carbon stock in several countries in Africa. While CarboAfrica is interested in the carbon balance alone, TroFCCA is more interested in the connection between changes in future carbon balances and the risk of vulnerability or opportunities for adaptation.

1.4.3. Consultancy and National Contractors

National contractors have undertaken some commissioned studies, which support and add information to address some of the expected outputs for Phase 2. These include the following.

1) Indigenous Knowledge in Relation to Climate Change: Focus on Land and Forest Fires in Kalimantan and Sumatra, Indonesia

Project Rationale

Climate change is creating conditions that have increased land fires and forest fires. The livelihood of local communities living around forested areas is heavily affected. Forest communities are developing local coping strategies and methods to deal with the fires. Community response to land fires and forest fires can inform national policy level. The project goals are (1) to determine community response to prevention, management, and

coping with land fires and forest fires in Kalimantan and Sumatra; and (2) to use knowledge of community practices to influence policy level. The research questions are:

1. How are forest communities adapting to, preventing, or mitigating damage from land and forest fires?
2. What are the sources of the community response to a fire?
3. What are the traditional methods of forest protection applied in a contemporary context of climate change?
4. How can best practices learned in one community be transferred to a neighbouring community?
5. How can traditional forest protection practices be scaled up to policy level (or institutionalised), and what roles arise for different actors?

The study sites are Sokola in Sumatra (<http://www.sokola.org/eng/>) and Tanjung Puting National Park in Kalimantan.

2) Indigenous Coping Mechanisms, Knowledge and Adaptive Capacity of Communities in West Africa

This research will provide answers to the following questions:

1. How have local communities survived in the face of gradual or sharp changes in the flow of ecosystems resources (being specific on the resources)?
2. How do they recognise change in order to act or draw on a coping mechanism?
3. What guides their decision in the appropriateness of a particular coping mechanism and what happens if it turns out to be inappropriate for that particular situation?
4. Is it likely that local communities have already developed ways to solving these problems?
5. Are these traditional management strategies or solutions to these problems or are they transferred knowledge?
6. If yes or no, what exactly have they done to lessen, partially overcome, or remove the burden caused by reduced flow of forest ecosystem resources?
7. For how long have these methods or measures been around? What is the extent of their use, efficiency, success rate and/or value?
8. What factors determine their success rate and feasibility of application at individual or communal level?
9. Are they transferable measures? If yes, what will be needed in terms of human or institutional capacity to transfer them within and outside the community?
10. What does the community see as important socio-economic constraints or opportunities for their use?

3) Development of Vulnerability Maps Using Changes in Forest Cover as Proxy for Changes in the Supply of Forest Goods and Services for Livelihood in Burkina Faso, Ghana, and Mali

Rationale

Historical changes in vegetation cover and land use change are linked to climatic and human activities, which over the years have changed exponentially in rate and intensity. The direction of change and the underlying drivers of change are often difficult to isolate because they are usually confounded by other factors, which complicates their use for

policy interventions without hurting other sectors and activities. In order to develop policy interventions and reforms, it is important to understand the spatial pattern of risk distribution with the classification of hotspots, highly vulnerable groups, and most likely risks under projected scenarios of climate and social changes and their implications for household and national development.

The objective of this commissioned study therefore is to develop visual and spatial presentations of the historical and current trends of land cover and land use changes as indicators of vegetation dynamics, and the probable risks this may pose for the provision of forest goods and services in order to identify highly vulnerable places with high risks and to project the vulnerability of other communities under different climate, social, and policy scenarios. To achieve this, the following maps will need to be established:

1. Land cover and land use change maps over different time segments using current rate of change under ‘business as usual’ scenario, and the alternative with interventions.
2. Interpolate the maps with time series climate and population change maps etc. to pick out hotspots of change and characterise the associated risks.
3. Overlay changes due to current rates of deforestation.
4. Project new situations with different climate change scenarios such as increase in temperature and variable precipitation (increase or decrease) patterns.

Potential outcomes of the study include:

1. A detailed report and analysis to illustrate hotspots or high risks areas for each of the development sectors to advise policy
2. Selection of sites to test methodology and establish specific case studies
3. An important tool for strategising responses for adaptation
4. Groundwork for more targeted studies on vulnerability
5. Selection of the main drivers of forest resource degradation on a spatial scale and elaboration of the risks they pose under new climate scenarios
6. Elaboration of relationship with poverty distribution maps within the country

1.4.4. Scientific Steering Committee

A scientific steering committee has been established, each region nominating one member who is able to articulate regional issues and emphasise regional perspective and outlook of the project. There are also two representatives who bring in global and integrative outlooks to the project. The members of the committee are:

- Dr Carmenza Robledo, Leader of the Climate Change Group, Intercooperation, Swiss Foundation for Development and International Cooperation
- Dr Habiba Gitay, Capacity Development for Climate Change Adaptation, World Bank Institute
- Dr Max Campos, Executive Secretary, Regional Committee on Hydraulic Resources/Central America Integration System, San José, Costa Rica
- Dr Nur Masripatin, Ministry of Forestry, Indonesia
- Prof Isabelle Niang-Diop, University of Cheikh Anta Diop, and ENDA, Dakar, Senegal.

All the members have participated in project meetings. Dr Robledo participated in the methodology workshop held in April 2007 together with Dr David Brown of Overseas

Development Institute. Some of the members, like Dr Robledo, have been providing scientific reviews of project documents prior to sending them for publication.

2. Staff Changes and the Teams

The project experienced staff changes through resignation, and end of contractual period of funding. This affected the composition of both the global and regional teams. Those who left the project included Claudio Forner, project coordinator, who resigned from the project, and Dr Enrique Ibarra, postdoctoral fellow, of the South East Asian team, who came to the end of his funding contract. Following these changes, the current team composition is as follows.

Global

TroFCCA is being coordinated from CIFOR's headquarters in Bogor, Indonesia. The global team comprises the following members:

- Programme coordinator: Markku Kanninen (Finland)
- Project coordinator: Johnson Nkem (Cameroon)
- PhD research fellow: Mousa Kone (Ivory Coast)
- PhD research fellow: Matieu Henry (France)
- Secretary: Rosita Go (Indonesia)
- Project secretary: Astriani Popi (Indonesia)
- Accountant: Rina (Indonesia)
- Webmaster: Isnan Franseda (Indonesia)

West Africa

TroFCCA in West Africa is coordinated from CIFOR's regional office in Ouagadougou, Burkina Faso, centrally located between Mali and Ghana. The team is composed of:

- Regional coordinator: Johnson Nkem (until August 2007) (Cameroon)
- Principal scientist: Monica Idinoba (Nigeria)
- Postdoctoral fellow: Maria Brockhaus (funded by the government of Germany)
- Research fellow: Elke Verbeeten (funded by the government of the Netherlands)
- Research assistant: Yacouba Noël Coulibaly (Burkina Faso)
- Associate Professional Officer: Fobissie Kalame (funded by the government of the Netherlands)

Central America

TroFCCA's activities in Central America are managed by the global change group of CATIE¹ in Turrialba, Costa Rica. The team comprises the following members:

- Regional coordinator: Carlos Perez (Nicaragua)
- Principal scientist (1): Bruno Locatelli (France)
- Principal scientist (2): Raffaele Vignola (Italy)

¹ <http://www.catie.ac.cr/>

This team is supported by ‘Grupo de cambio global’, which includes Pablo Imbach (Argentina), Lucio Pedroni (Switzerland), Patricia Ramirez (Costa Rica), and Marcos Tito (Brazil).

South East Asia

TroFCCA in South East Asia is coordinated from CIFOR’s headquarters in Bogor, Indonesia. The team is composed of the following members:

- Regional coordinator: Heru Santoso (Indonesia)
- Principal scientist: Daniel Murdiyarso (Indonesia)
- Research assistant: Hety Herawati (Indonesia)

In the Philippines TroFCCA is in partnership with the International Center for Research in Agroforestry. The team comprises the following persons:

- Coordinator: Rodel D. Lasco (Philippines)
- Research assistant: Patricia Ann J. Sanchez (Philippines)

3. Communication and Outreach

The project is resolute and committed to communication and outreach activities using a range of strategies aimed at reaching out to a wide array of stakeholders and public institutions. The project webpage remains the primary electronic presence, and there are audiovisual and audio presences, especially radio interviews. These efforts are primarily aimed at increasing policy and public awareness of the roles of forest in TroFCCA’s activities on tropical forests and adaptation, as well as the visibility of the implementing institutions CIFOR and CATIE and the funding agency (European Commission).

3.1 Website

A webmaster is responsible for regularly updating the website with a wide range of new information, which includes news items such as announcements of research fellowships, meetings, meeting reports, etc. The web address is:

http://www.cifor.cgiar.org/trofcca/_ref/home/index.htm.

3.2 Flyers, Briefs, and Papers

There are two categories of flyers, the overall project flyer (printed in English, French, and Spanish) and the regional flyers highlighting regional issues and emphases. All of the flyers have recently been updated to reflect the current outputs and outcomes of the project. Other forms of communication and outreach include policy briefs and scientific papers including proceedings of conferences and meetings.

3.3 Participation in Conferences

The project encourages scientific contribution to the knowledge-base on adaptation, sharing of experiences, learning of new information, and acquisition of new skills. Project staffs are actively participating in seminars, workshops, and conferences across the world, making presentations of research results from the activities, including reviews and analytical and conceptual issues in contribution to the development of the science of

adaptation. Some of these meetings provide opportunities for visibility of TroFCCA scientific activities. European Union support to knowledge building activities is acknowledged through the inclusion of the EU logo in all the presentations (both oral and poster). Some of these meetings included:

- African Regional S&T Meeting on Women in Science for Food and Nutrition Security in Africa, Entebbe, Uganda, 3–7 July 2006.
- Policy Workshop on Linking AIACC (Assessments of Impacts and Adaptations to Climate Change), an Integrated Assessment of Climate Change, Results to the 2nd National Communication, organised by University of the Philippines Los Baños, Manila, Philippines, 26 August 2006.
- The 16th Asia-Pacific Seminar on Climate Change, Climate Change and Development, jointly organised by Ministry of Environment, Japan; Australian Greenhouse Office; Ministry of Environment, Republic of Indonesia; and the Overseas Environmental Cooperation Center, Japan. Jakarta, Indonesia, 5–8 September 2006.
- Managing Drought and Water Scarcity in Vulnerable Environments, September 2006.
- Twelfth session of the Conference of the Parties to the UNFCCC, Nairobi, Kenya, November 2006.
- EC-AIDCO workshop just after CoP12 to the UNFCCC in Nairobi, Kenya, November 2006, to identify and discuss possible synergies for elaboration of a common project, referred to as ‘The Nairobi Initiative’.
- National Workshop on Adaptation to Climate Change, organised by the Ministry of Environment Republic of Indonesia, Jakarta, Indonesia, 22 December 2006.
- International Conference on the Reduction of Vulnerability to Climate Change of Natural, Economic and Social Systems in West Africa, Ouagadougou, Burkina Faso, 24–27 January 2007, organised by the United Nations Economic Commission for Africa.
- International Forum on Water Governance in Asia, Technologies and Institutional Systems for Water Environmental Governance, Bangkok, Thailand, 14–15 March 2007.
- Research Days at Costa Rica National University, Heredia, 9 May 2007.
- International Union of Biological Sciences in Washington, DC, 8–13 May 2007.
- International Day for Biodiversity Conservation, University of the Philippines, Diliman, Quezon City, Philippines, 23 May 2007.
- Workshop on Tropical Forests & Climate Change, organised by the Group on Forest Ecosystems of Public Interest within the School of Forestry in Montpellier, France, 19–27 May 2007.
- National conference on climate change adaptation, Legaspi, Allay, Philippines, October 2007.

- Community vulnerability and resilience in confronting global climate change: international conference of the Society of Human Ecology, Rio de Janeiro, Brazil, 4–7 October 2007.
- Planning meeting for making a video on climate change in the Philippines, Klima, Ateneo de Manila, Diliman, Quezon City, October 2007.
- International Conference on the Future of Forests in Asia and the Pacific: Outlook for 2020, organised by the Asia-Pacific Forestry Commission, Chiang Mai, Thailand, 16–18 October 2007.
- Community-based Fire Management Workshop organised by The Nature Conservancy, Balikpapan, Indonesia, 28 October–4 November 2007.
- 13th Conference of the Parties to the UNFCCC in Bali, Indonesia, 3–15 December 2007.
- Forest Day, 8 December 2007, during COP13 in Bali, Indonesia.

3.4. Mass Media Coverage of TroFCCA

- Climate change and forestry, WREN media interview. Radio interview recorded in Burkina Faso and used by SABC Channel Africa in its weekly programme, can be accessed online at <http://www.channelafrica.org/portal/site/menuitem.dc0d628006630b67cdf628431fa4324c/>. Channel Africa broadcast across much of sub-Saharan Africa. The interview can also be accessed on the OneWorld radio portal site at <http://radio.oneworld.net/mediamanager/view/6474> in February 2007.
- News article ‘Agriculture Sector Gets Hurt Most’, *Daily Kompas*, 23 June 2007. Original article is in Indonesian and available in <http://www.kompas.com>, and can also be found at http://www.cifor.cgiar.org/trofcca/_ref/news/asia/Agriculture%20Sector%20gets%20hurt.htm
- News article ‘Adaptation to Climatic Changes Is Imperative’, *The Jakarta Post*, 24 April 2007. Original article is available on-line at <http://www.thejakartapost.com>, and can also be found at http://www.cifor.cgiar.org/trofcca/_ref/news/asia/Adaptation%20to%20climatic%20changes%20is%20imperative.htm.
- EU-commissioned film of project activities on climate change adaptation in Africa was screened during the European Development Day in Lisbon, 7–9 November 2007 under the theme ‘Will Climate Change Development?’ The part on TroFCCA is entitled ‘Adaptation to Climate Change in Burkina Faso’. http://ec.europa.eu/europeaid/multimedia/videos/index_en.htm.

3.5 Visibility Action for the European Commission

Visibility of the European Commission through its support of the project is integrated in the project’s public activities through the following channels:

- Inclusion of EU logo (and disclaimer) in all documents on the website, in flyers and all publications;
- Acknowledgement of EC funding during all presentations and conference proceedings; and
- Display of EU logo in all meeting announcements organised by the project.

4. Partners and Collaboration with Other Institutions

The project continues to foster collaboration with existing partners while establishing new partnerships and collaborations. This is crucial since the project believes in a collective approach to seeking solutions to climate change, and also in working through these networks to achieve the global objective of the project.

Collective efforts and the sharing of information and experiences are crucial for the endeavour of achieving adaptation to climate change. In this framework, TroFCCA is constantly interacting and forming new alliances with other partners, collaborators, and institutions in developing new ideas and consolidating existing activities especially where we share the same geographical space or similar research themes, and in exploring synergies e.g. with International Institute for Sustainable Development, International Development Research Centre-Climate Change Adaptation in Africa, CARE International, and Advancing Capacity for Climate Change Adaptation (ACCCA). Only new partnership and collaboration arrangements are highlighted here since previous ones were comprehensively covered in the first year annual report.

- TroFCCA is one of four participating projects working on adaptation and mitigation to climate change in developing countries funded by the thematic budget line EC-AIDCO, involved in the synergy project referred to as ‘The Nairobi Initiative’ titled ‘Capacity Development for Adaptation to Climate Change & GHG Mitigation in Non Annex I Countries’ and coordinated by the United Nations Institute for Training and Research.
- Collaboration with the ACCCA project. Presently, ACCCA have 14 pilot actions in Africa and Asia where we share the same geographical locations. A cardinal aspect of this collaboration is the ACCCA induction workshop that TroFCCA West Africa helped organise and for which it acted as the local host in January 2007.
- University of Illinois, Urbana-Champaign under the Leadership Enhancement in Agriculture Program of the Norman E. Borlaug International Agricultural Science and Technology Fellows Program.
- TroFCCA ecosystem approach to adaptation is being replicated in two other global regions: the Congo basin forests through funding from International Development Research Centre, Canada, involving three countries from the Central African region; and the Andean mountain region of South America in a Mitigation and Adaptation (MIA) project funded by the Spanish government.

5. Project Activities Planned for Implementation in Year 3

The project will follow the timeline characterised by the three phases. As indicated earlier, the third year of the project falls between phases 2 and 3 and will therefore involve activities to complete Phase 2 and those of Phase 3 on adaptation. Thus, the activities will involve the following:

- Completion and testing of methodologies for vulnerability assessments of the prioritised development sectors in each of the regions. All the regions are expected to complete field trials of the methodologies for assessing vulnerability of the prioritised sectors.
- Documentation of local coping and adaptation strategies and of the indigenous knowledge of coping and adaptive strategies. There are commissioned studies on the way in West Africa and Indonesia.
- Screening of these local coping strategies to determine local adaptive capacity and to develop adaptation strategies.
- Organisation of a special session on ‘Tropical Forest Management and Climate Change Adaptation’ during the international conference on ‘Adaptation of Forests and Forest Management to Climate Change with Emphasis on Forest Health: A Review of Science, Policies, and Practices’, Umea, Sweden, August 25–28, 2008.
- Publication of a Special Edition Journal on ‘Tropical Forest Management and Climate Change Adaptation’ following the above conference.
- Publication of a methodological handbook containing a collection of methodologies for the assessment of vulnerability to climate change for adaptation planning in forest-based sectors. Earthscan has approached us to be the publisher of such a volume.
- Contribution to the UNFCCC expert meeting on methods and tools, and on data observations, under the Nairobi work programme on impacts, vulnerability and adaptation to climate change under FCCC/SBSTA/2007/MISC.13.
- Work with the recently constituted project steering committee.
- Organisation of a project meeting.
- Development of vulnerability risk maps.
- Continuation of literature reviews and compilation of data needed for the development of adaptation strategies.
- Participation in regional workshops and meetings to advance project activities on mainstreaming.

6. Regional Reports

6.1 West Africa

6.1.1 Introduction

The period between August 2006 and August 2007 witnessed tremendous accomplishments for TroFCCA West Africa. Within this period staff were invited to several meetings both in the region and internationally. It was an opportunity to further create awareness of the project and the continuation of mainstreaming of forest and adaptation into development programmes, policies, and operational activities. As a result we received many invitations for collaboration and contribution to regional studies, and also to provide inputs to national documents for decision making processes on climate change adaptation. For example, the Commission de l’Union Economique et Monetaire Ouest Africaine requested the project to comment on and provide inputs to the draft

document on ‘grandes orientations de la Politique Commune d’Amélioration de l’Environnement (PCAÉ)’, which is an ongoing process to formulate a common West African Regional body for sustainable forest management similar to Commission des Forêts d’Afrique Centrale. There have been many requests from universities abroad for student internship with TroFCCA. Intakes have been constrained, however, by inadequate logistics and staffing to cope with a larger number.

Students developed and partly used methodologies for vulnerability assessment of sectors in their field work. Policy analyses for the sectors were also undertaken in the three countries and there is a policy brief resulting from this study.

Within the period of this report TroFCCA West Africa saw three of the sponsored regional students graduated with excellent grades for Master of Science degrees. The students were encouraged to participate in regional and international meetings and made scientific presentations of their work. Through this collaboration, climate change is being introduced in the academic curriculum of some universities as a result of their involvement with TroFCCA West Africa.

6.1.2 Activities Undertaken during the Period

Local Partners and Contacts with Governments

During the reported period, many more contacts were established with local partners in Burkina Faso, Ghana, and Mali. This is a continuous process as TroFCCA progresses with its activities on policy dialogue in the region.

The relationships with partners are being maintained, with a continuous sharing of information with these partners: Institut d’Etudes et de Recherches Agricoles (INERA), Environmental development action in the Third World (ENDA), International Research Institute for Climate and Society (IRI), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), African Centre of Meteorological Application for Development (ACMAD), United Nations Economic Commission for Africa (ECA), Comité permanent Inter-états de Lutte contre la Sécheresse dans le Sahel (CILSS), CARE International, International Institute for Sustainable Development (IISD), International Development Research Centre (IDRC), Burkina Faso’s Department of Forestry and Meteorological Department, Union Economique et Monétaire Ouest Africaine (UEMOA), Economic Community for West African States (ECOWAS), Institut International de l’Eau et de l’Environnement 2IE, Botany Department at University of Ghana, Directorate of Conservation of Nature in Mali, and the Forest, Energy and Water commissions of Ghana. There was also collaborative research grant application development with the partners for funding to cover gaps identified in the region that are outside TroFCCA’s scope of current activities. For example, INERA IDRC sponsored a proposal on ‘Promotion de techniques de conservation des eaux et des sols et agroforesterie (CES-AGF) pour une agriculture durable en zone périurbaine de Ouagadougou’.

In January 2007 TroFCCA West Africa hosted the first inception workshop of the Advancing Capacity for Climate Change Adaptation (ACCCA) project, a global project

funded by EC-Aidco. Through this workshop, which brought together participants from over 15 countries, more collaborative relationships were established with ACCCA projects, especially where both projects operate in the same countries such as in Ghana, Mali and even in the Philippines.

Elaboration of Methodology

A draft methodology was elaborated for the selected development sectors, namely, water, bioenergy (particularly fuelwood and charcoal), and non-timber forest products of food (human and livestock) and for health care purposes. The draft was presented at the TroFCCA workshop on methodologies in April 2007 in Bogor, Indonesia. Stakeholders in Burkina Faso and Ghana have been engaged in the review of the draft methodology. Students in TroFCCA graduate award programme are also testing some aspect of the methodologies. The assessment will include biophysical and socio-economic measurements and there are plans to engage partners associated with National Adaptation Programmes of Action (NAPA) processes in testing of the methodology on a bigger scale as a way of hands-on utilisation of the research results in the NAPA process.

Screening for Adaptation

A rapid assessment study was conducted to get an overview of the situation on the ground in terms of local community knowledge regarding adaptation to climate impacts. Study and analysis of indigenous practices to adapt to climate change in the region will follow. There is also the development of indicators and criteria for adaptive management and identification of possible response options in collaboration with experts of the development sectors. This will also include an analysis of the anxiety in society to respond to vulnerability and to use the proposed options.

Mainstreaming Adaptation into Policy

Two project scientists particularly work on policy. Their activities cover analysis of existing policies at regional, national and local levels; network analysis of actors and stakeholders; mapping pathways of policy influence; and elucidating and developing strategies and mechanisms for science-policy dialogue aimed at assisting policy formulation, implementation and enforcement.

Regional Climate Scenarios

In June 2007 TroFCCA organised a national training workshop to enhance scientific and technical capacity in Burkina Faso for use of PRECIS climate modelling as a follow up to a training programme organised in 2006 by the UK Meteorological Office to build national capacity for integrated assessment of climate change impact. A PC-based Regional Climate Model (RCM–PRECIS) developed by the UK Meteorological Office was installed and used for climate change trial experiments. A desktop computer was purchased for this purpose following the specifications. The RCM uses boundary conditions from the reanalysis of observations or General Circulation Model simulations of present or future climate to generate regional climate projections for climate impact assessment. The workshop provided an opportunity for focused training on the installation and use of regional climate models at national level. An expert consultant from the African Centre of Meteorology for Development office in Niamey guided the training.

So far the PRECIS validation run (1948–1998) has been completed. The validation run is necessary to set the platform for adjusting future projections, to enable comparison of observed meteorological data and PRECIS predicted data, and to see the degree of biases between the two. The next stage of PRECIS will involve the 2071–2100 projection runs using the Addjd and HadAM3P story lines or the new PRECIS version, which covers the period of 1949–2099 and takes care of past, present and future climate change scenarios. It is also adjusted to account for the uncertainties associated with former versions.

Consultative Workshop on Setting Priorities for Climate Change Response

The workshop on setting priorities for climate change response held on 23–24 July 2007 in Yaoundé, Cameroon, brought together 20 key representatives whose activities were directly related to climate change and forest policy processes, with at least two from each of the five countries spanning the Congo Basin Forests (Cameroon, Central African Republic, Congo, D. R. Congo, and Gabon). Participants also included representatives of subregional organisations like the Commission des Forêts d’Afrique Centrale, Central African Regional Programme for the Environment, all the five countries’ UNFCCC national focal points, national forest-related research institutions, nongovernmental organisations (NGOs), universities, community groups, etc., including an expert in the region who is a member of the Intergovernmental Panel on Climate Change.

Outreach Activities

TroFCCA West Africa staff organised and participated in several regional and international conferences, workshops and seminars, some of which are listed below. A book of abstracts of all presentations during the reported period was printed and distributed during CoP13. Other presentations at meetings included:

- An Earth System Science Partnership Global Environmental Change Open Science Conference, 9–12 November 2006. TroFCCA presented four posters on each of the sectors selected by stakeholders. The meeting provided an opportunity for global awareness of TroFCCA activities and also served the exchange of information and ideas with other researchers in the domain of climate change adaptation studies.
- ACCCA Project Inception Workshop, Ouagadougou, Burkina Faso, 17–20 January 2007. TroFCCA hosted and participated in this workshop, which provided opportunities for shared learning, the identification of key challenges and sharing of the understanding of climate change adaptation (http://www.acccaproject.org/rubrique.php3?id_rubrique=1&lang=en).
- Recherche Interdisciplinaire et Participative sur les Interactions entre les Ecosystemes, Le Climat et les Societes d’Afrique de l’Ouest, RIPIECSA. Atelier Fondateur, 5–7 Mars 2007, Bamako, Mali (<http://www.ird.fr/rapiecsa>).
- TroFCCA’s participation at the international training on forest certification and forest sustainable management in Sweden, 4–29 May 2007, was to see what kinds of opportunities the forest certification process might provide for adaptation (<http://www.ssc-forestry.com/>).

- 2007 International Union of Biological Sciences, 8–13 May 2007, Washington, D.C.
- Conférence Régionale sur les changements climatiques et les phénomènes extrêmes en Afrique sub-Saharienne: Impact sur les ressources naturelles, enjeux pour la recherche et la décision, 6–9 June 2007, Cotonou, Bénin. The objective of the conference was to identify ways to involve politicians in climate change adaptation in the region. The conference provided a regional platform for TroFCCA to learn and contribute to the processes, and also to increase TroFCCA's visibility in the region.
- PRECIS National Training workshop, 11–17 July 2007, organised by TroFCCA West Africa in collaboration with the meteorological offices of Burkina Faso and the United Kingdom as well as ACMAD. The overall objective of the workshop was to follow up on the PRECIS training workshop held in Ghana in 2006 to build national capacity for integrated assessment of climate change and variability impact for Burkina Faso.
- Third International Conference on Climate and Water, Helsinki, Finland, 3–6 September 2007. Project staff and one student participated in this meeting aimed at exchanging ideas, research results and concerns on impacts, adaptation and mitigation in the water sector. TroFCCA presented student research results in the water sector in Ghana.
- Tropentag 2007, 9–11 October 2007, Witzenhausen, Germany. Utilisation of diversity in land use systems: sustainable and organic approaches to meeting human needs. TroFCCA's elaborated methodology on the different sectors selected by stakeholders was presented at this conference to gain wider contribution on the methodology (<http://www.tropentag.de/conference/general.php?menu=2>).

Student Research

Within the framework of regional capacity building TroFCCA put out its first announcement for graduate fellowship awards in June 2006. There were 33 applications received, out of which three M.Sc. and one M.Phil. graduate students were selected for the 2006–07 academic year. The same procedure was repeated in June 2007 for awards for the 2007–08 academic year. This time, over 26 applications were received and four students were selected. On each occasion, the fellowship announcement required that the student research proposal be related to the central theme of the project phase. In addition, the research projects of the students were distributed across the four principal sectors identified during the kick-off meeting, and they also integrated biophysical and socio-economic dimensions of these sectors. So far three students have successfully defended their theses with good grades.

6.2 Central America

6.2.1 Introduction

This section reports activities and progress achieved by TroFCCA in Central America during the period from August 2006 to August 2007. In Central America, climate change and climate variability are expected to have an impact in several socio-economic sectors. Water resources will not escape the effects of these impacts. The vulnerability of populations and sectors that depend on water sources for their sustainability will be a function of the sensibility of the water resources and the adaptive capacity of the population or sectors. Forest ecosystems and other land uses provide different ecosystem goods and services to water users. Determining the location and extent of different land uses and their provision of ecosystem services is relevant for designing adaptation policies and strategies. TroFCCA Central America decided to conduct investigations on the relevance of forest ecosystems as providers of goods and ecosystems services through a meta-analysis and studies at the national level on two key socio-economic sectors (drinking water and hydroelectric power). These sectors were selected during the regional kick-off meeting in April 2006.

The strategy followed by the project to conduct the studies included the invitation to graduate students to conduct the studies under the supervision of scientific advisors working in CATIE and other institutions of higher education. Consultants were also hired for specific studies in highly specialised subjects (i.e., the energy sector in Central America). In the case of Nicaragua, two MSc graduate students from CATIE were in charge of conducting studies to identify tropical forests providing ecosystem services to hydropower and drinking water sectors. A similar approach was used in Honduras, where a single MSc from the National Autonomous University conducted research under a collaboration agreement between TroFCCA and that education center.

The products generated by TroFCCA Central America during this period include completed theses, consultancy reports, and journal articles. When appropriate, these products have been uploaded to the TroFCCA project website. A summary of other activities and collaborations during this period have been provided.

6.2.2. Implementation of Project Activities

Collaboration with Partners

a) Collaboration between TroFCCA and the International Union for Conservation of Nature (IUCN) to improve payment for ecosystem services in Costa Rica in the hydroenergy sector. Almost 80 percent of energy produced in Costa Rica relies on hydropower. This type of energy production depends strongly on the hydrological dynamics in the watersheds. The most relevant environmental pressures occurring upstream are climate and land use. Climate change impacts in the region include increasing occurrence of precipitation extremes and the amount of rainfall per event. The hydrological system together with land use change and land management practices in upstream landscapes determines the level of current land degradation. TroFCCA, in

collaboration with the National Institute for Hydroelectricity, identified a case study in the Reventazon watershed, where 30 percent of hydroelectric power for Costa Rica is generated. This case study has been co-financed by the Fund for Environmental Policy of IUCN Mesoamerica. The goal is to contribute to local and national discussion on a payment for ecosystem services scheme that would benefit both demand (e.g., from downstream hydropower plants) and supply (upstream land users and forest owners) of hydrological services. The project is exploring the utility function of supply and demand of hydrological services to design a sustainable financing scheme for erosion and sediment transport control. This action entails a series of activities that include the systematisation of existing information from the watershed, understanding technology adoption and current land management practices, and several policy dialogue meetings with stakeholders. Although activities have started during the first semester, most of the results will be coming out during the second semester of 2007 and first trimester 2008. TroFCCA assigned the coordination of this study to Raffaele Vignola.

b) Collaboration between TroFCCA and Both ENDS for community based adaptation documentation. In February 2007 TroFCCA C.A. and Both ENDS joined efforts to systematise a local experience of community based adaptation to climate variability and change in agriculture and water resources in the dry tropics of Nicaragua. This experience emphasises the importance of forest ecosystem restoration for improving resilience in agriculture and water resources. The case refers to the municipality of San Pedro del Norte in northern Nicaragua, located in the dry tropics of Central America. The study included a revision of the information available from key documents in the municipality of San Pedro del Norte and documents and references published elsewhere. Three workshops were organised, one with farmers acting as suppliers of ecosystem services, another with water users as part of the demand for those services, and the third with local authorities. Questionnaires distributed at the three meetings were oriented towards fact finding on the subject of past, present and future climate related risks and natural resources management. A joint analysis was performed of local and national policies influencing local adaptive capacity.

In San Pedro del Norte several climate extreme events, such as Hurricane Mitch and various episodes of droughts, have caused major socio-economic damages. Droughts are recurrent climate events that have affected agricultural production and water availability, particularly for the urban population. Upon the drought of 2001, authorities decided to implement a pilot project on payment for ecosystem services to restore vegetation in a microwatershed. Since 2003, negotiations with upstream farmers have induced natural forest regeneration on 13 ha, and the introduction of other soil and water conservation practices such as stone ditches and stone rows. Additionally, there has been a horizontal (farmer to farmer) discussion on the importance of not practicing slash-and-burn for land clearing before planting food crops. A new Municipal Environmental Ordinance was approved in August 2006, with special consideration of forest fire avoidance and the acquisition of slash-and-burn permits by farmers. The reduction of land degradation and ecosystem restoration is at the top of a list of measures to ensure water resources conservation and management.

The local scheme of payment for ecosystem services has strengthened local organisational capacity, and other inter-institutional links that are favorable towards increasing social capital. Overall, resilience to climate variability is improving but resources (financial and human) are still short compared to the investments stated in the Municipal Development Plan. Inter-institutional coordination will be highly important to have better chances for generating policy changes at the national level, to call the attention of national institutions to the need for increased investment in the area to enhance infrastructure and technical assistance, and to improve the current policy for transferring funds from the national treasury to municipalities. Climate change scenarios officially reported suggest that the area will become drier and hotter, increasing the risks to food security and water availability. Climate variability and climate change should be integrated into local and national policies, prioritising areas like San Pedro del Norte that are located in the Pacific Basin and have similar projections of climate change and climate variability. A major challenge will be to access funds at the international level to invest in improving resistance and resilience to climate related risks. Locally payment for ecosystem services has proven to be an effective way of promoting forest regeneration. Additionally, hillside farmers are planting trees for forage and seeds as food source. Both ENDS is considering this and nine other local experiences to contribute to the international dialogue on adaptation policies.

Workshops/Meetings

- RIOCC: The project participated in the third annual meeting of the Ibero-American Network of Offices of Climate Change (RIOCC), organised by the Spanish Ministry of the Environment in Santa Cruz de la Sierra, Bolivia, 4–6 October 2006. This event was attended by representatives from the climate change offices and programmes from most Latin American countries. RIOCC is considered a platform that allows the exchange of experiences, dissemination of information concerning current projects and programmes in any of the countries, and the formulation of position documents that are eventually brought to the Convention of the Parties. TroFCCA was presented in plenary session and was welcomed by the audience.
- CentroAmerica y Europa para Ambiente y Energia (AEA): TroFCCA Central America (C.A). gave a presentation on the ‘Importance of forest ecosystem services for the hydroelectric power sector’ during the Meeting of the European Union and Latin-America on Renewable Energy organised by the Central America Alliance on Energy and Environment in Panama City, Panama, 9– 11 October 2006. Several leaders of the Central and South American energy sector attended the meeting. During the course of the event it was observed that interest in biofuels is strong and that in Central America there is strong interest to increase the generation potential of renewable energy, mainly hydropower, followed by geothermal and wind power. It was concluded that selection of the hydropower sector as an area of research for TroFCCA in the region was appropriate, given the strategic significance of this sector and its connection with forest ecosystem services. Additionally, the strong interest in biofuels (ethanol, biodiesel) may become stressful for forest ecosystems in the region if the areas planted to sugar cane, oil palm, or other crops are expanded. Planning will

be critical to avoid effects on food crops and forest ecosystems providing ecosystem services to society.

- Raffaele Vignola represented TroFCCA C.A. during the 2nd International Latin-American Congress on Forestry and Policies, organised by the group of International Union of Forest Research Organizations (IUFRO) / Instituto Forestal de Chile (INFOR) / Food and Agriculture Organization of the United Nations (FAO) in La Serena, Chile, 18–25 October 2006. The aim of TroFCCA's participation was to acquire background information on elements that are critical to mainstreaming adaptive forest management into the climate change adaptation policies. TroFCCA's research on forests and climate change should be socialised at different stages of the research and not wait until the end. Identifying appropriate hubs or platforms for delivery of the scientific information is critical to making the linkage between science and policy design. This conference was key to strengthening the decision of TroFCCA C.A. to go into policy network analysis as an essential component of the research agenda.
- CoP12: TroFCCA C.A. participated more actively during the side event 'Development and Adaptation Days' organised by the International Institute for Development Economics, which took place 11–12 November 2006. The presentation by TroFCCA C.A. was entitled 'Importance of tropical forest ecosystems for climate change adaptation in two socio-economic sectors: drinking water and hydroelectric power generation'. The International Institute for Sustainable Development (IISD) reported in its Development and Adaptation Days Bulletin Vol. 99, No. 3 of 14 November 2006 and on its website at <http://www.iisd.ca/climate/cop12/DAD/> the following:

Carlos Perez, Tropical Agricultural Research and Higher Education Center (CATIE), Costa Rica, presented a project on tropical forests and adaptation taking place in Asia, Central America and West Africa. He stressed the increasing importance of hydroelectric power generation given the high cost of oil, adding that hydroelectricity potential in Central America is relatively high, therefore making it critical to manage water sources. He said that ecosystem services, such as regulation of water flows and soil erosion reduction, and identification of relevant forest ecosystems are crucial for adaptation. In conclusion, he stressed: the increasing importance of hydroelectric power generation; the importance of forest ecosystems services; reduced water availability resulting from climate change; the need for adaptive management and financial mechanisms for implementation (of adaptive management); and forests as key to carbon sinks and adaptation.
- Workshop on Adaptation to Climate Change in the Hydroelectric, Water and Agricultural Sectors was organised in Nicaragua on 30 November 2006. Participants of this workshop represented the National Office for Clean Development Mechanism and Climate Change (ONDL) and the National Energy Commission (NEC). The TroFCCA project gave three presentations and a representative of ONDL added another: i) Identification of forest ecosystems relevant for climate change adaptation

of the hydroelectric power sector of Nicaragua; ii) Identification of forest ecosystems relevant for climate change adaptation of the drinking water sector of Nicaragua; iii) A methodological proposal to evaluate farmer's adaptation to climate variability, mainly drought, in watersheds of Central America; and iv) The preparation and content of the II National Communication to the UNFCCC by Dr. Freddy Picado from ONDL. For TroFCCA it was highly important to hear the comments from the representatives of ONDL and NEC. Comments regarding the work conducted by Efrain Leguia were immensely positive and of great value for a socio-economic sector that is being highly prioritised by the Nicaraguan government. The conclusion was that the work on identification of forest ecosystems relevant to the hydroelectric sector could become part of the adaptation strategy of the sector, and should become part of the 2nd National Communication. For the NEC representative it was clear that the management plans of the upper watersheds were highly important, and the representative added that every hydroelectric project, actual or future, should integrate the importance of forest landscapes ecosystem services and implement the ecosystem's management plans. The work performed by Cliserio González was also of high interest for the 2nd National Communication because drinking water is a strategic sector and is linked to the Millennium Development Goals. For the ONDL representatives this work is innovative in Central America and should be integrated into the II National Communication to the UNFCCC before March 2008 when the document is due.

- Workshop on Adaptation to Climate Change, organised jointly by TroFCCA C.A. and the National Meteorological Institute (NMI), was held on 13 December 2006 in San José, Costa Rica. Participants of the workshop, invited by NMI, represented the National Fund for Forest Financing (FONAFIFO), the Costa Rican Electricity Institute (ICE), the Institute for Biodiversity Conservation, and NMI. Two presentations were given by the TroFCCA project: i) Identification of forest ecosystems relevant for climate change adaptation of the hydroelectric power sector of Nicaragua; and ii) Identification of forest ecosystems relevant for climate change adaptation of the drinking water sector of Nicaragua. The study on identification of forest ecosystems relevant for the provision of ecosystem services to the hydroelectric sector is highly relevant and could eventually become an important tool for ICE. In Costa Rica, 80 percent or more of the electric power is generated by hydroelectric plants and upper watersheds need to be managed adequately to enhance or maintain the provision of ecosystem services. For the work to be done in Costa Rica, ICE could provide information it had already available and hence could facilitate the work that TroFCCA will perform in the country. The representatives from ICE requested a presentation for ICE's personnel of TroFCCA's work in January 2007. For the representatives of FONAFIFO, the studies presented, particularly the methodology, are quite relevant because the institution will be in charge of assigning financial resources for forest ecosystem management under a payment for ecosystem services scheme. The water tax in Costa Rica will soon be implemented and a study like the one presented by TroFCCA is quite relevant. FONAFIFO is willing to provide TroFCCA with information for the work to be executed and concluded during the first trimester 2007 in this country.

- Workshop jointly organised by TroFCCA and the National Program on Climate Change of the Ministry of Natural Resources and the Environment in Tegucigalpa, Honduras, 27–28 February 2007. The main objective of this workshop was to present TroFCCA’s results from Honduras and to perform an analysis of the relevance of the findings with participants. Two presentations were given by TroFCCA: i) an overview of TroFCCA and the research being conducted in Honduras and other countries, and ii) the results of the study on ‘Identification of forest ecosystems providing services to hydroelectric and drinking water sectors in Honduras’ (see above). Attendants at this event were representing the Ministry of Natural Resources and the Environment (SERNA), the National Service on Drinking Water and Sanitation, the National Forestry Corporation (COHDEFOR), and the National Electricity Enterprise. Participants welcomed the results of the work performed by TroFCCA and there was consensus that both sectors are dependent on ecosystem services provided by forests. It also became apparent, however, that the information on forest cover and land use was not up-to-date. This discussion was relevant because the representatives from COHDEFOR took note of the relevance of performing an inventory of forest cover and land use at least every five years. It was also important that representative from SERNA and the National Program on Climate Change agreed to integrate these results into the II National Communication to the UNFCCC, which is in preparation and should be delivered in 2008. Another important partner in Honduras is the National Autonomous University, particularly the Latin American Program for Social Studies.
- TroFCCA Central America staff members Pablo Imbach and Bruno Locatelli represented the project at the workshop Tropical Forests & Climate Change organised by the Group on Forest Ecosystems of Public Interest within the School of Forestry in Montpellier, France, 19–27 May 2007. Subjects covered of great relevance for TroFCCA’s activities included (but were not limited to) water cycle and carbon; remote sensing techniques for ecosystem studies; current knowledge on past, present and future climate scenarios for tropical forests in Latin America and the Caribbean and Africa; and several aspects of tropical forest management. Attendance of this workshop was relevant to a better design of the methodology TroFCCA C.A. will use for research on forest ecosystems and hydrological services under climate change. Contacts were made with scientists from the forest sector of France and the possibility arose of organising a workshop like this in Central America under collaborative efforts between TroFCCA C.A. and Ecofor. This remains to be decided.
- Developing strong links with higher education centres from Switzerland and Netherlands. Over all, TroFCCA’s research on policy network analysis for mainstreaming adaptation to climate change has required in-depth capacity building and discussions. Besides the participation of R. Vignola in the II International Latin-American Congress of Forestry and Policies (see above), additional actions on capacity building within the subject required participation in meetings at the Institute for Environmental Decision-Making at Eidgenössische Technische Hochschule

Zürich in Switzerland, 20–23 June 2007, and at the Conference on Earth System Governance: Theories and Strategies for Sustainability held at the University of Amsterdam, the Netherlands, 24–26 May 2007. TroFCCA's participation in these two higher education centres has allowed development of instruments for surveys in the upper watershed of the Reventazon watershed in Costa Rica, where the project, in collaboration with IUCN, is conducting research for the improvement of a payment for ecosystem services system. One relevant outcome of the above participation is the participation of at least three professors from Eidgenössische Technische Hochschule Zürich in the policy network research in the Reventazon watershed for hydroelectric power generation with application of innovative payment for ecosystem services.

- The VI Inter-American Dialogue on Water Management was held in Guatemala City, Guatemala, 12–17 August 2007. Participants at this event came from almost every country in Latin America and the Caribbean. Subjects covered included people and water; water, environment and climate change; water, economy and commerce; sustainable use of water; infrastructure, technology and services related to water. TroFCCA was invited to make a presentation on tropical forests and water.
- Meeting with ICE in San José, Costa Rica, on 18 January 2008, at the request of ICE during the workshop at NMI (see above). The meeting had two main objectives: i) to inform ICE staff of TroFCCA research activities on tropical forests and climate change adaptation and the relevance of forest ecosystem services for the hydroelectric sector in Central America; and ii) upon sharing the work of TroFCCA in Nicaragua, in return to obtain ICE's support to gather relevant and reliable data for the study in Costa Rica that would be conducted during the first semester of 2007. One of the most important aspects of demonstration of interest was the letter sent by Vice President of ICE Carlos Obregon Quezada, which welcomed TroFCCA's work and pledged the support of the institution whenever requested. Following the above meetings, the NMI has invited TroFCCA to three meetings on adaptation to climate change in the water resources sector.

Research Activities and Progress

During the period, TroFCCA devoted efforts to conducting research to achieve a better understanding of the relationship between forest and water through an in-depth analysis of the existing literature on the relationship between forest and hydrological ecosystem services through a methodological approach leading to a meta-analysis. Another study was conducted through consultancy to better understand the electric sector, with an emphasis on hydroelectric power generation and the opportunities for TroFCCA. A position article was also written in order to gain a better understanding of the vulnerability of forests to climate change and potential adaptive management.

Research was undertaken to identify forest ecosystems that are important for the drinking water and hydroelectric power sectors. Similarly, studies for determining the vulnerability of forest ecosystems to climate change focused on the areas of i) understanding potential ecological shifts that may affect competitiveness of the timber

industry and ii) studying the dynamics of insect pest outbreaks and forest fires under varying climate parameters and host conditions.

A third line of action by TroFCCA C.A. aimed at strengthening participation of society in adaptation through a series of studies to better understand the underlying mechanisms of involving society into adaptation activities. The strategy TroFCCA is implementing includes research in territories by selecting case studies, in-depth policy network analysis in selected socioeconomic sectors and an analysis of current mechanisms of payment for ecosystems services as valuable tools to enhance adaptive forest ecosystem management from the perspective of society.

6.2.3. Activities Planned for Year 3

In Central America, TroFCCA's research programme and validation of methodologies will be consolidated during the third year, because several results and products will be achieved during the period running from July 2007 through 31 August 2008. Additionally, the collaboration with national partners to integrate results into the national communications to the UNFCCC and other policies will intensify. It is also expected that TroFCCA will contribute to knowledge sharing on the science of adaptation to climate change through articles, conferences, seminars and workshops at various levels: national, regional and international. The following are initiatives that either have started during Year 2 of TroFCCA and will continue or begin being enacted during Year 3.

- A study on impact of climate change on forest plantations of commercial interest will be conducted at the regional level from May to December 2007. This study will produce maps of suitable areas for selected forest species for future planning of plantations and adaptation measures. The methodology will comprise the use of climate change scenarios for the region, soil and climate requirements for optimal growth of selected forest species, and ecological conditions on the ground. At the end, it is expected that current optimal areas will change due to global warming.
- Climate change and outbreaks of the southern pine bark beetle *Dendroctonus frontalis* (Coleoptera: Scolytidae) in Nicaragua and Honduras. The products of this study are expected to be available during the first trimester of 2008.
- The study on the dynamics of forest fires in Mesoamerica under climate change scenarios will begin in July 2007. Results are expected during the first trimester of 2008. A methodology will be designed and validated to develop a forest fires risk index considering climate change scenarios. This initiative will combine data on human factors, classification of fuel types, and climate parameters associated with forest fires.
- Evaluation of the impacts of climate change on ecosystem functions providing hydrological services in the Mesoamerican region by modelling actual and future distributions of functions and services. This effort started in January 2007 and is expected to go until the first trimester of 2009.

- Collaboration between TroFCCA and IUCN to improve payment for ecosystem services in Costa Rica in the hydroenergy sector. This initiative will be consolidated during Year 3 of TroFCCA. It is anticipated that graduate students from Spain and the Netherlands will join this project to contribute in compiling the scientific information needed to achieve results. In particular, collaboration with the Polytechnic University of Madrid will contribute to a better understanding of the contribution of different soil uses to the hydrological services and soil erosion control. This information, linked with the studies on technology adoption, will lead to the design of different scenarios for reduction of sediments that interfere with hydropower generation.
- Response from society to changes in ecosystem services. As stated above, the study entitled ‘Determinants of social decisions for landscape management as an adaptive response to changes in the provision of hydrological ecosystem services in Costa Rica’ has been conducted by TroFCCA C.A. since January 2007. Results are expected by the first trimester of 2008.
- Decision making and policy networks in forestry-dependent development sectors: mainstreaming adaptation to climate change into policy. A methodological approach for this action has already been discussed during the workshop in Burkina Faso in May 2007 (see above). The field phase of this research will begin during the last trimester of 2007.
- During Year 3, site selection for Nicaragua and Honduras will be completed. In Costa Rica the site has already been selected and fieldwork in the Reventazon watershed is underway through collaboration of TroFCCA, ICE, and UICN. The latter was selected due to the strategic importance of this watershed, which produces about 35 percent of the hydroelectric power in the country and drinking water to 600,000 people. In Nicaragua, initial contacts have been made with the National Office for Clean Development Mechanism and Climate Change and with the National Electricity Enterprise to determine if TroFCCA should invest resources in a watershed that is relevant for hydroelectric power generation and agricultural production with different irrigation methods. In the case of Honduras, initial contacts and discussions will be conducted until a decision is reached during the third trimester of 2007. In both cases (Nicaragua and Honduras) studies in specific sites should be designed and started during the fourth trimester in 2007.
- As outreach activities, TroFCCA C.A. will participate in CoP13, to be held in Bali, Indonesia, in December 2007. Other outreach activities will be organised with the offices of climate change in the countries where TroFCCA is working in the region. Additionally, TroFCCA will disseminate results by participating in seminars and conventions organised at national, regional and international levels by different organisations that require the dissemination of knowledge being acquired through the work performed by TroFCCA.
- By the end of Year 3, TroFCCA C.A. will have made significant progress towards a set of methodologies that will contribute to the knowledge base on forest adaptive management from the perspective of society or relevant socio-economic sectors.

6.3 South East Asia

6.3.1. Introduction

TroFCCA in South East Asia is being implemented in Indonesia and the Philippines, and focuses its activities on the countries' development needs and priorities. Forest ecosystems in South East Asia provide environmental goods and services to the people living in the region. Direct benefits to the people living in forest area are goods in the form of timber and non-timber forest products such as rattan, dammar, food and medical plants, etc. Indonesian forests and that of the Philippines are among the top 10 most important of the world in terms of biodiversity. Other important services of the forest ecosystems are regulation of water, which is important for drinking, agriculture and power generation; regulation of local and meso-climate; and as carbon sink.

As climate change and climate variability can affect the provision of these goods and services, forests need to be managed and protected in order to maintain and restore their natural capacities to reduce the impacts of climate change and climate variability. Vulnerability to climate change is linked to biophysical changes in the forest structure and biodiversity, often due to society's dependence on and use of forest goods and services especially in response to climate change and climate variability. Many disasters in the region are driven by climate such as floods, landslides, droughts and forest fires.

6.3.2. Development Issues for Research

During the kick-off meeting on 29–30 May 2006, the TroFCCA in Indonesia stakeholders selected forest fires and landslides to constitute regional research priority. These two topics are actually big issues in the forestry sector of Indonesia. Long-term changes in climatic trends in the region are expected to increase frequency and intensity of fires and landslides in the future. Without efforts to anticipate the loss and adapt to future climate, these two hazards could cause significant economic disruptions and resource loss for national development.

The research topic for TroFCCA in the Philippines is water resources. The country is highly dependent on water resources for domestic and industrial use, irrigation, power generation, animal husbandry, fisheries and recreation activities. The country is becoming more prone and susceptible to water related disasters under weather extremes such as floods, droughts, and typhoons.

Forest fires

There are several reasons for selecting the topic of forest fires. First, forest fires cause significant negative impacts on the environment and socio-economics. Second, forest fires have local, national, regional and global relevance. They cause damage and loss at local and national levels, and cause irritating pollutants that affect the region, while the amount of CO₂ released by forest fires causes a significant increase of the atmospheric greenhouse gas concentration. The third and most important reason is that extent and intensity of forest fires are associated with climate conditions, and therefore are relevant to the issues of climate change. Future climate change scenarios indicate that Indonesia

will be at higher risk of fires resulting from drier conditions in particular during the dry season. Together with exacerbated dry conditions due to interannual climate variability, the risk of fire may increase.

Forest fires in Indonesia cause significant social, economic and environmental impacts. As an example, the total estimated loss caused by fires in 1997–98 was between US\$8.7 billion and US\$9.6 billion and incurred by many sectors: health, livelihood, biodiversity, forest goods and services, agriculture, tourism, CO₂ emissions, buildings and properties, transportation, and fire fighting costs. Losses of this proportion can cause disruption in development.

Landslides

The issue of landslides was raised during a consultative meeting with the National Focal Point at the Ministry of Environment, and incidentally came up again at the kick-off meeting where it was selected as a research topic of focus. Occurrence of landslides on disturbed and undisturbed lands has been increasing in recent years, resulting in the loss of lives and property and damage to infrastructure. On average, landslides cause the loss of 40 lives and US\$4 million in economic losses per year in Indonesia. The figures tend to increase because population pressure requires more land for human activities and forces people to unstable areas.

Land cover and land use play important roles in landslides through plant root anchorage and hydrological properties. Land management is an important aspect in avoiding losses caused by landslides. Future climate scenarios indicate that parts of Indonesia will have increased rain intensity during the rainy season. Extremely high rainfall during La Niña interannual climate variability is expected to increase landslide occurrences.

Water Resources

As susceptibility to water related disasters is increasing with climate change, TroFCCA in the Philippines focuses on water resources as the priority research area. TroFCCA in the Philippines is the continuation of the Assessments of Impacts and Adaptations to Climate Change (AIACC) project which ended in 2006.

6.3.3. Main Activities

Main activities during the second year included the development of methodology for vulnerability assessment of the prioritised sectors. TroFCCA in Indonesia has been involved in the development of national policy and adaptation strategy, raising awareness, and knowledge improvement in line with the commitment to support the national adaptation process. TroFCCA also provided scholarships for research students and organised commissioned studies for the selected development issues. These activities are briefly explained below.

Methodology for Vulnerability Assessment

The methodology for vulnerability assessment is an important step in the research. It will provide the guidance to map the relative degree of vulnerability of a region and to determine appropriate adaptation strategies. The assessment of vulnerability methods is

developed mainly through literature review and participation in international, regional and national workshops and seminars.

National Process on the Development of Policy and Adaptation Strategy

TroFCCA in Indonesia has been involved in the national process on climate change adaptation through Working Group on Adaptation, which is coordinated by the Ministry of Environment. The activities included frequent dialogues in the working group. The group contributed to the National Action Plan in Addressing Climate Change (RAN-PI) planned for launch during the UNFCCC CoP13 in Bali in December 2007.

Awareness Raising

It was revealed during the kick-off meeting in May 2006 that the government has a strong interest in climate change issues even though it was acknowledged that the capacity of government was still low. Capacity and awareness are particularly low at the provincial and local levels. In order to increase awareness and to improve knowledge, TroFCCA in collaboration with WWF–Indonesia organised a training workshop on climate change for journalists. This workshop was part of a capacity building programme for journalists in Indonesia, so that they would be well prepared for CoP13 in Bali and able to deliver climate change related stories appropriately. TroFCCA was also involved in many other knowledge improvement activities for higher degree students, NGOs, and forest communities.

Research Scholarships

TroFCCA in Indonesia provided financial support for two students to conduct research in related development issues.

Specific Research Activities

TroFCCA in Indonesia in partnerships conducted specific research activities to fill the knowledge gaps identified during the kick-off meeting and the First Dialogue Meeting on Climate Change and Landslides in December 2006. These were:

- **Regional climate simulation using PRECIS**
With the help of Hadley Meteorological Office, starting in late 2007, TroFCCA South East Asia runs a climate change scenario simulation for the region using the regional climate model PRECIS in Bogor. This climate simulation station in Bogor is part of the South East Asia PRECIS user network for climate change scenarios data sharing.
- **Development of mathematical correlations between climate variables and fire risk (in partnership with National Institute for Space and Aeronautics)**
The objective of the research is to identify the mathematical correlation between climate parameters, which are normally generated by dynamic regional climate models, and the fire risk parameter or index such as number of hotspots. The finding will be used as a function to spatially map the potential fire risk area based on recent and projected climate data. The research covers the area of Indonesia in three steps based on coverage areas and level of detail, from

countrywide to specific areas for detail studies at provincial level that represent two different characteristics of fire risk zones in Indonesia.

- **Increasing understanding of the link between climate and the land movement mechanism (in partnership with Indonesian Institute of Sciences)**

The research aims at increasing the understanding of the link between climate and landslides, through computer simulation of an area at landscape level, from which landslide risk maps will be produced. The simulation should include necessary geological parameters, slope, and other internal factors that control the landslide mechanism. The research is expected to fill the knowledge gap or enhance understanding of the role of climate (and climate change) in land movement mechanism, and to assess changes in the risk zones as caused by climate change, particularly to identify whether climate change will cause an expansion, shift or reduction of the area at risk to landslides in specific timeframes.

- **Laws and policy studies on forest and land fires, focusing on underlying causes and weak law enforcement (in partnership with Indonesian Center for Environmental Law/ICEL)**

Policies and regulations to reduce forest and land fires are part of adaptation strategies to cope with the future increased risks of fires under a different climatic condition. The output of the research is expected to identify the causes of weak current law enforcement, and solutions to enhance it. The study will also identify legal problems related to the underlying causes of fires, and to provide solutions to enhance the adaptive capacity through policy instruments. The study covers related policies and regulations of forest and land fires from the national to local levels. Representative areas will be selected for detailed studies at the local or community level.

- **Roles of trees in anchoring soil and reducing landslide risk (in partnership with Brawijaya University and World Agroforestry Centre)**

Trees add weight, which may destabilise a slope, but they can also reduce the occurrence of small landslides (at root depth) and control the soil hydrology. The effectiveness of trees and forest in preventing land movement depends on the tree species, root types, and diversity of species growing on the surface. The research addresses the role of vegetation in preventing land movement at a plot scale, and to project their effectiveness on larger scales (subdistrict or landscape level).

- **Improving disaster risk reduction programme in a landslide prone area (in partnership with the Center for Vulcanology and Geological Hazard Mitigation)**

The aim of this research is to increase the adaptive capacity in order to reduce loss caused by land movement. Two approaches are assessed: land management and disaster management. The land management approach includes studies on how to enhance land regulations, land use planning and integrated known biophysical measures and infrastructure development (such as roads, hospitals, warehouses, etc). The disaster management approach concentrates on enhancing or

establishing a community based disaster risk reduction programme through socio-economic and human resource empowerment including policy and institutional arrangement, community understanding and alertness of pre-land movement signs, local knowledge, etc.

Meetings and Seminars

During Year 2 the regional coordinator and staff participated in seminars, workshops and general meetings. These activities have the important purposes of introducing TroFCCA and finding and sharing knowledge for the development of methodology for vulnerability assessment. Several important meetings and workshops were attended.

- *2nd International Workshop on Community Based Adaptation to Climate Change, Dhaka, Bangladesh, 24–28 February 2007*
Workshop objectives included bringing different stakeholders and practitioners together to capture the latest learning on a wide variety of issues concerning community based adaptation practices in the developing world, to integrate these lessons into national and international development programmes, and to compile papers and findings of group discussions for further dissemination worldwide. Results of the workshop were expected to stimulate further work in research and by NGOs in enhancing the adaptive capacity of vulnerable groups in developing countries by improving their livelihoods, to increase the knowledge of key players in the development field on adaptation to climate change, to further influence policy and practice, and to build better networks around climate change and adaptation. Heru Santoso from TroFCCA gave a presentation on the need to link different perspectives of adaptation for mainstreaming into the development agenda, specifically government versus community perspectives.
- *UN Framework Convention on Climate Change Asian Regional Workshop on Adaptation, Beijing, China, 11–13 April 2007*
The workshop aimed to highlight Asian concerns related to climate change adaptation and vulnerability reduction, with a view to identifying specific adaptation needs to be considered under the UNFCCC. Heru Santoso reported on the activities of a TroFCCA project that promotes adaptation to climate change and emphasised the lack of a common understanding and institutional capacity as key gaps in addressing adaptation, and stressed the role of regional workshops attended by all relevant ministries and agencies as forums for information exchange.
- *2007 Amsterdam Conference on the Human Dimensions of Global Environmental Change, Amsterdam, Netherlands, 24–26 May 2007*
This conference, the seventh in the series of annual European Conferences on the Human Dimensions of Global Environmental Change, featured the latest developments on the human dimensions research. It addressed the theme ‘Earth System Governance: Theories and Strategies for Sustainability’ and had the objective to integrate the latest developments on the human dimensions research. Specifically, the conference showcased the latest knowledge and experiences in earth system governance. It also served as a venue for discussion and debate on the future

directions in global change research on governance and institutions. The conference made a significant contribution to directing future research in the field of human dimensions of global environmental change. It successfully identified gaps and emerging issues in presentations given and discussions held.

- *International Conference on the Future of Forests in Asia and the Pacific, Chiang Mai, Thailand, 16–18 October 2007*

This major international conference provided broader perspectives on emerging changes, probable scenarios and their implications for forests and forestry in the Asia-Pacific region. The conference enhanced awareness of long-term changes in society-forest relationships and formulated a better definition of a 21st century vision for forestry in the region, taking onboard likely scenarios for development, and improved understanding of emerging opportunities and challenges for various stakeholders, enabling a more balanced approach to management and utilisation of forest and tree resources appropriate to the overall needs of society. The conference also served as a venue to increase collaboration and partnerships to address problems at global, regional and subregional levels. TroFCCA presented its lessons learned experiences on climate change impacts on tropical forests, vulnerability and the adaptive capacity.

- *Community-Based Fire Management Workshop, Balikpapan, Indonesia, 28 October–4 November 2007*

The workshop put particular emphasis on community based programmes associated with protected natural areas, conservation zones and other types of forests reserves and on programmes associated with general forest and fire management. In particular, it addressed the difference between good and bad fires for the communities. Participants learned about the importance of fires for the community and how to manage fires safely.

- *ICRISAT and CGIAR 35th Anniversary Symposium on Climate-Proofing Innovation for Poverty Reduction and Food Security, Hyderabad, India, 22–24 November 2007*

Climate change could reduce food production. The symposium addressed strategies to tackle issues related to poverty and food security under climate change. The symposium concluded that mainstreaming climate change adaptation into decision-making at various levels is essential to ensure that sensitive agricultural enterprises are resilient to today's and future climates. Climate change research should not be seen as an add-on programme but as an integral part of research, and the CGIAR system should continue to work with national and regional partners in mainstreaming climate change for the benefit of farmers and the poor.

6.3.4. Local Partners and Relations

This section lists the organisations and partners with whom we have established a working relationship. They are classified into three large groups: government organisations dealing with development programmes, policies and regulations; research organisations dealing with scientific services and development of science and technology; others including projects or field practitioners and NGOs.

Government Organisations

- *Ministry of Environment, Government of Indonesia*: This ministry is the office of the national focal point to the UNFCCC, coordinator of the National Communications, and coordinator of National Committee on Climate Change. It has a responsibility to increase awareness on issues of climate change.
- *Ministry of Forestry, Government of Indonesia*: This ministry provides regulations and legal aspects on commercial uses and conservation of forests and has a responsibility in preventing and controlling forest fires. In addition, this ministry has a specific group on clean development mechanisms and other climate change issues in the forestry sector.
- *Ministry of Home Affairs, Government of Indonesia*: This ministry supervises and guides provincial development and facilitates communications on national issues between central government and local government.
- *National Planning Agency (Bappenas)*: This agency is responsible for planning and budgeting national development programmes. However, all programmes should be approved by the national parliaments before they can be implemented.
- *National Agency for Disaster Relief (Bakornas)*: Under a new piece of legislation, this agency has the role of coordinating actions in case of disasters and conducting mitigation plans.

Research Organisations

- *National Institute for Space and Aeronautics (LAPAN)*: This agency processes and archives satellite photos for monitoring land cover change, including forest fires, using remote sensing technology. It also conducts research and modelling on climate science.
- *Indonesian Institute of Sciences (LIPI)*: This agency has a working group on geo-hazards. This working group conducts research on landslides, provides models and data, and conducts public awareness on this hazard.
- *Center for Vulcanology and Geohazard Mitigation (PVMBG)*: This centre monitors and evaluates all geo-hazards in Indonesia. It also provides warning for potential geo-disasters as well as capacity building in disaster mitigations.
- *Brawijaya University*: The Faculty of Agriculture of this university has a research group to study roots and their roles in strengthening the stability of soils. Some of their studies are conducted in partnership with International Council for Research in Agroforestry.

Others (Including Projects or Field Practitioners and NGOs)

- *Indonesian Center of Environmental Laws (ICEL)*: This NGO has done research on the policy and law aspects of forest fires and many other environmental issues.

- *WWF–Indonesia*: This NGO has a division on Climate and Energy. It has done advocacies and capacity building on climate change issues for local and central stakeholders. TroFCCA worked in partnership with this institution in organising a workshop on climate change for Indonesian journalists in May 2007.
- *Pelangi*: This NGO is in collaboration with multinational foreign NGOs under the South South North Adaptation project for conducting research on mainstreaming adaptation with a community base approach. The adaptation stage of the project began in 2006.

6.3.5. Summary of Outcomes of Research Activities

National Process on the Development of Policy and Adaptation Strategy

Submission for the National Action Plan in Addressing Climate Change (RAN-PI), and the document (book) was launched during the UNFCCC CoP13 in Bali, in December 2007. TroFCCA was specifically involved in formulating conceptual strategy for adaptation in general and adaptation in the forestry sector in particular.

Specific Research Activities

All of the specific research activities were initiated in 2007 and would end in the first semester of 2008.

- Regional climate simulation, whole South East Asia region, low emission scenario (B2), period 2070–2100; output expected in May 2008.
- Mathematical correlation of climate variables and fires; final report expected in May 2008.
- Link between climate and landslides; final report expected in May 2008.
- Laws and policy on forest and land fires; final report expected in May 2008.
- Roles of trees in reducing landslides; final report expected in August 2008.
- Improving disaster risk reduction programme; final report expected in May 2008.
- Complete the specific research activities to fill the gaps to support biophysical and institutional vulnerability criteria.
- Complete the development of specific methodologies to assess the vulnerability to forest fires and landslides.
- Continue with literature reviews.
- Undertake policy oriented research that focuses on analysing the current institutional framework of the two sectors, and explore how climate change adaptation could be mainstreamed into policies for fire suppression and policies related to landslides.
- Undertake a comprehensive policy analysis on forests, forest fires and landslides to highlight gaps and opportunities.
- Identify geographical areas for testing methodologies.
- Analyse multilevel climate change adaptation strategies, from national to local levels, in line with the resiliency improvement of the system.
- Supervise students.

7. Output Targets for Phase 2 and the Status in Year 2

Following the project document, the outputs of Phase 2 of the project are supposed to be the following (Table 2). A column has been added to indicate the status of the product during the period of this report.

Table 2. Summary of the products of Phase 2

Product	Comment	Form	Status in Year 2
Criteria and indicators of vulnerability	A set of criteria will result from steps 2, 3 and 4 of the methodology. The criteria will be classified per topic(s)/area(s) and will be presented as a chain of indicators in accordance with the findings of the different literature reviews.	A set of criteria and indicators as a toolbox	A set of criteria have been identified and they are being tested in the field.
Climate scenarios	Climate scenarios relevant for the case studies will be developed for each region or country as needed. These scenarios will be derived from those already elaborated by national governments if available.	Document	Simulation runs with PRECIS are ongoing in West Africa and Indonesia in collaboration with the Hadley Centre.
Vulnerability assessments and mapping	The assessment of vulnerability will be the main product of Phase 2 and the application of the methodology.	Document and publishable articles	In progress in all the regions e.g. in West Africa based on forest cover change.
Tools	The list of tools used in the project (models, data bases and others) will be compiled in a toolbox for future use.	A toolbox	A list of tools is constituted and receives additions as the project progresses.
Identification of priorities	The vulnerability assessment will identify priorities for the work on adaptation.	Document and publishable articles	This has been fully completed.
Identification of response options	In conjunction with the priorities, the team will work on the most appropriate response options at the policy level. The concept of adaptive forest management will be incorporated as the most important response option.	Document and publishable articles	This is ongoing. A policy brief has been published for West Africa with some policy recommendations.
Material for national communications	Findings and different inputs will be incorporated into the national communications of participating countries and shared with international institutions like the Intergovernmental Panel on Climate Change.	Sections on the relevant chapters	Ongoing since most project countries are still preparing their national communications.

Table 3. Summary of TroFCCA graduate students fellowship training on various areas of project research themes across the regions and prioritised sectors of activities.

Name	Year	Region	Title of Thesis	Status
Cliserio González (MSc)	December 2007	Central America (Nicaragua)	Identificación de bosques importantes para la adaptación del sector agua potable en Nicaragua	Available online in CATIE's library
Efraín Leguía (MSc)	December 2007	Central America (Nicaragua)	Identificación de bosques importantes para la adaptación del sector energía hidroeléctrica en Nicaragua	Available online in CATIE's library
Tania Najarro (MSc)	June 2007	Central America (Honduras)	Identificación de bosques importantes para la adaptación del sector hidroeléctrico y agua potable en Honduras	In review
Kabore Pauline (DEA)	2006–07	West Africa (Burkina Faso)	Vulnérabilité socio économique, précarité écologique et gestion des ressources naturelles, impacts des représentations sur l'implication des exploitants de bois des villages de Wayen et de Yagma, province du Ganzourgou (Burkina Faso)	Available in CIFOR regional office
Medah Moise (DEA)	2006–07	West Africa (Burkina Faso)	Impact of local organization on the dynamic of forest resource: case study in Bognounou managed forest in Burkina Faso	Available in CIFOR regional office
Sidiki Boire (DEA)	2006–07	West Africa (Mali)	La vulnérabilité des ressources en eau aux changements climatiques dans le bassin versant du Bani à Douna au Mali climate change impacts in Bani water catchment	Available in CIFOR regional office
Chantal Vivena (DEA)	2006–07	West Africa (Benin)	Dynamique de l'occupation du sol, vulnérabilité des formations forestières ligneuses et changement climatiques au Burkina Faso	Available in CIFOR regional office
Benjamin Gyampoh (MPhil)	2006–07	West Africa (Ghana)	The effects of climate change and variability on freshwater and livelihoods from the Owabi watershed in Ghana	Available in CIFOR regional office
Stephen Lartey (MSc)	2007–08	West Africa (Ghana)	Vulnerability assessment of climate change impacts on the production and utilization of fuelwood in Ghana	Ongoing

Name	Year	Region	Title of Thesis	Status
Sawadogo Boukary (DEA)	2007–08	West Africa (Burkina Faso)	Changements climatiques et vulnérabilité socioéconomique des ressources en eau: impacts et stratégies d'adaptation des populations dans le bassin versant du barrage de Yitenga (province du Kouritenga)	Ongoing
Kologo Oumarou (DEA)	2007–08	West Africa (Burkina Faso)	Le Karité (<i>Vittelaria Paradoxa</i> Gaertn..) et sécurité alimentaire : vulnérabilité face au changement climatique dans la Bougouriba au Burkina Faso	Ongoing
Danan Prasetyo Hadi (MSc)	2007	South East Asia (Indonesia)	A RS/GIS-based multi criteria approaches to forest fire assessment in Indonesia with a case study in West Kutai, East Kalimantan	In review
Arief Darmawan (PhD)	2007–08	South East Asia (Indonesia) (Univ. of Tokyo)	Estimating forest fire risk and vulnerability using multi-criteria decision analysis (MCDA) and Geographic Information System (GIS) in West Kutai, East Kalimantan Indonesia	Ongoing

Other Outputs and Outcomes

- Scientific publications and policy briefs
- Training and capacity building
- Contributions to scientific and policy-related conferences and workshops at global level such as United Nations Framework Convention on Climate Change (UNFCCC) Subsidiary Body for Scientific and Technological Advice (SBSTA)
- Contribution to the Nairobi Work Programme

TroFCCA is contributing to the global push for greater inclusion of adaptation into development through facilitating stakeholders in setting the adaptation agenda and undertaking demand-oriented research in those sectors most relevant to national development.

TroFCCA has initiated a science-policy dialogue in the region on the process of mainstreaming adaptation into national development policy.

Capacity building activities through graduate studies under TroFCCA graduate fellowship research awards. There was the organisation of training workshops such as PRECIS modelling to help national partners simulate and predict climate change scenarios at regional levels.

TroFFCA's research is being published and presented at regional and global conferences and workshops.

Another realisation is the setting up of a steering committee as an advisory body to the project.

