

Developing Adaptation Strategies to Climate Change Impacts on Tropical Forest Systems

Third Year Annual Report

Prepared by

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Heru Santoso
Javier Saborio

Contract: EuropeAid/ENV/2004-81719

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EXECUTIVE SUMMARY

The annual report describes the third year activities of the ‘Tropical Forests and Climate Change Adaptation’ (TroFCCA) project. The report, which covers the period from August 2007 to 31 August 2008, highlights the activities undertaken in accordance with the plans for year 3 and the financial transactions accompanying those activities.

The primary objective of TroFCCA is to contribute to national processes of adaptation to climate change, particularly by streamlining adaptation into national development processes through the assessment of vulnerability and the identification of adaptation strategies for the prioritised forest-based development sectors in the different regions. The project is implemented in eight countries across three continents: 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 comprises three phases, each with a central theme guiding the implementation of the overall project objective. The phases are surrounded by activities that stretch over more than one year; thus there are overlapping activities in phases 1 and 2 and also in phases 2 and 3. The third year report covers activities of phases 2 and 3. Other cross-phases activities also covered in this report are capacity building, development of climate scenarios, visibility and outreach actions, network and policy analysis, a science–policy dialogue process, and the consolidation of relations with partners etc. The main activity of the third year was the selection of pilot sites for testing the methodologies for vulnerability assessment, including identification and screening of adaptation strategies.

The report provides highlights of project status and current progress and gives a summary of the actual realisation versus the planned activities for the period. The progress made in each of the 12 steps of the methodology guiding the implementation of the project is also documented in the report. There is a discussion on the approach to the development of adaptation strategies that constitutes the central theme of phase 3, the last phase of the project following pilot studies in participatory testing of the methodologies for vulnerability assessment of the prioritised development sectors linked to the forest. Changes in the composition of the various teams are also described including communications and visibility actions. There were significant contributions from the project to scientific meetings, the Thirteenth Session of the Conference of Parties to the United Nations Framework Convention on Climate Change, etc including the organisation of special sessions at two international meetings on tropical forests and climate change adaptation. Activities with partners and collaborations with other institutions brought a high measure of success during this period and they are discussed. In continuation of phase 3, project activities planned for year 4 are shown.

Included is a section on each region, highlighting the activities implemented and their contributions to each output target. The great achievement in capacity building through graduate students research programmes are covered in the regional reports. As an indication of the status and realisations of the project, there is a summary table of the progress made so far for each of the output targets. Finally, there is a financial report summarising the expenditures in year 3 and the budget requirements for year 4.

1. INTRODUCTION

The third year of the project comprises semesters 5 and 6 (Figure 1) and corresponds to phases 2 and 3. The emphasis during this period was on the completion of phase 2, which primarily focused on the development and testing of the methodology for vulnerability assessment of the development sectors identified and prioritised by stakeholders during the kick-off meetings in the various regions. Phase 2 also involved the initial screening of adaptation options which were eventually consolidated in phase 3 as adaptation strategies that correspond to the three categories (Figure 2) as follows:

- 1) National level: adaptation within the context of national development
- 2) Linking to private sector: innovative mechanism for financing adaptation
- 3) International level: institutional needs for supporting national level adaptation processes.

The third annual report describes the activities during the period of August 2007 to 31 August 2008. The report covers the continuation of a sequence of interconnected activities undertaken during this period, following the methodological framework of the project described in the first annual report.

	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								

Figure1. Distribution of the three phases over the four years period of the project

Following the distribution of the various phases across the duration of the project, there are subthemes that characterise each phase, guiding the sequential flow in activities implementation. This is also related to the 12 steps that constitute the methodology, which will be discussed later on.

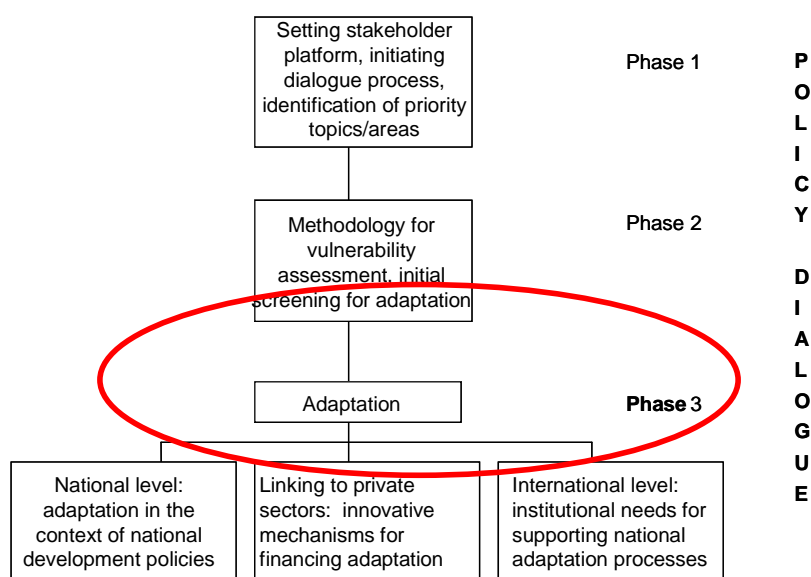


Figure 2. Major themes and activities of each phase (red oval indicates phase covered in this report).

1.1 Structure of the Report

The report, which consists of 10 sections, commences with the introduction of the corresponding project phases and their objectives and describes where they fit into the general framework of the project. Progress and status of the implementation activities are discussed in Section 2, changes in staff composition during this period in Section 3. Outreach and visibility actions are chronicled in Section 4, while activities related to partnerships and collaboration with other institutions are covered in Section 5. Project activities planned for year 4 are listed in Section 6. Reports of the different regions are shown in Section 7, followed by a summary of project output targets and their status of realisation in Section 8. Finally, the financial management of year 3 and action plans for year 4 are covered in Sections 9 and 10, respectively. There is an Annex with relevant documents mentioned in the text, to provide further information.

2. PROJECT STATUS AND CURRENT PROGRESS

2.1 Summary of Products for Year 3

In line with the work plan, the project list of activities to be completed in the third year (corresponding with parts of phases 2 and 3) included the following:

- Completion and testing of the methodologies for vulnerability assessments of the prioritised development sectors in each region. All the regions are expected to complete field trials of the methodologies.

- Documentation of local coping and adaptation strategies and the indigenous knowledge of coping and adaptive strategies. Commissioned studies are on the way in all the West African project countries and Indonesia.
- Screening of these local coping strategies to determine local adaptive capacity and developing 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', Umeå, 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 comprising a collection of methodologies for the assessment of vulnerability to climate change for adaptation planning in forest-based sectors. Earthscan has approached us to become the publisher of such a volume.
- Contribution to the United Nations Framework Convention on Climate Change (UNFCCC) expert meeting on methods and tools, and on data observations, under the Nairobi work programme on impacts of and vulnerability and adaptation to climate change under FCC/SBSTA/2007/MISC.13.
- Working 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.
- Regional workshops and meetings to advance the mainstreaming of project activities.

Find below a summary of the realisation of planned products for year 3 in the same order as above.

- The methodologies have been completed and are being tested in field trials with partners in the various regions. The framework for criteria and indicators has also been developed. It integrates various spatial scales of vulnerability assessment. Activities for the harmonisation of criteria and indicators across the various regions are ongoing.
- Preliminary activities for the documentation of local coping and adaptation strategies have been completed in Burkina Faso (see summary in Annex 1). A finely detailed study matching local coping and adaptation strategies with different climate zones in Burkina Faso for the identification of corresponding adaptation strategies and also to facilitate sharing and transfer of knowledge will soon start as commissioned study.
- Screening of local coping strategies is ongoing in the transition zone of Ghana. This is also one aspect of the commissioned study mentioned above.

- A special session on ‘Tropical Forest Management and Climate Change Adaptation’ was successfully organised during the international conference on ‘Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health: A Review of Science, Policies and Practices’, Umeå, Sweden (see section 2.4.1 of this report).
- Plans for the publication of a special edition of project presentations at the conference are still pending, since approval is required.
- Various areas of the methodologies for the assessment of vulnerability have been prepared and submitted for review as CIFOR Occasional Papers (find details in sections 7.1 and 7.3). A book on adaptation titled *Facing an Uncertain Future: How Forests and People Can Adapt to Climate Change* was launched during UNFCCC Fourteenth Session of the Conference of Parties (CoP14) in Poznan, Poland (see online link at section 4.4 of this report).
- Action pledges through research on tropical forests and climate change adaptation have been made to the UNFCCC Nairobi work programme on impacts of and vulnerability and adaptation to climate change following an invitation from the UNFCCC Secretariat (see Annex 2 and also at the URL <http://unfccc.int/3996.php>).
- Vulnerability risks maps have been developed using changes in forest cover as proxy for changes in the supply of forest goods and services, for livelihood in Ghana (see Section 2.4.4).
- Review of literature and data collection for the development of adaptation strategies are continuing with individual case studies.
- There was a project meeting organised in Costa Rica (see section 2.4.1) and also regional workshops (see sections 7.1–7.3).
- Other products linked to the 12 steps of the methodology for implementation of products are discussed in section 2.3.

2.2 Development of Adaptation Strategies

Climate change is affecting every aspect of human and natural systems, although they may differ in sensitivity and adaptive capacities to cope with the severity of the impacts. The pattern and determinants of climate change vulnerability and the effects on the coupled human system are constantly changing and generating inequality in the impacts on people and their natural resource base.

Ecosystems are capital assets which under proper stewardship yield the flow of multiple goods and services shared by many for their wellbeing and national development. Ecosystems are also undergoing large-scale changes through expanding human population and livelihood activities, economic growth and changes in consumption patterns affecting both their integrity and resilience to climate impacts. Dealing with changes in systems is challenging most especially for dynamic and complex systems surrounded by social and economic ramifications. A methodical approach, thus, becomes essential in balancing the different fluxes in the system.

Smart planning is therefore essential, whereby attention is paid to the most vulnerable systems and people in the process of balancing the needs of multiple stakeholders under climate crisis. Development of an adaptation strategy that addresses the socio-economic complexity of activities and the corresponding bio-physical alterations in forest ecosystems would require a consensual approach to balancing the multiple interests of stakeholders who may have intrinsic differences. Development of practical strategies for implementation therefore requires setting practical priorities that are hinged to sustainable national and regional development goals.

In line with the latest developments in the science of adaptation and vulnerability, TroFCCA focuses its activities on the **development issues¹ of regional or national priority** for which forests play a substantial role. These topics were chosen in consultation with national governments as part of a policy dialogue that is being implemented through regular stakeholders meetings. The relevance of the project therefore is in the scope of its analysis, so that it would directly tackle vulnerability in the context of development policies.

2.2.1 TroFCCA Approach to Adaptation

The project uses an ecosystem approach to adaptation by planning and developing adaptation strategies using ecosystem services. The philosophy behind this is that through ecosystem management it is possible to respond to climate change impacts through the development of adaptation strategies. This will likely allow for climate proofing of these ecosystem services as livelihood portfolios for adaptation. It also provides a robust approach to adaptation that has general applicability and implications for poverty, food security, and rural energy security within the framework of sustainable development. Furthermore the approach allows regional planning for the adaptation of transboundary ecosystems shared by several nations such as forests, river catchments, and watersheds.

The ecosystem approach to adaptation also places forests within the contextual framework of household livelihood and national development such that the developed adaptation strategies primarily focus on the socio-economic sectors or areas or topics that were mutually prioritised by national experts and other stakeholders through a participatory approach. This enables the underscoring of how climate change impacts on the forest may hinder development in those sectors, areas, or topics and be reflected in the vulnerability of households and national development.

The participatory approach used in setting the agenda and planning the implementation of activities interactively with all stakeholders set up in phase 1 of the project, which guided the process of identifying and prioritising the sectors or areas of regional interest, continues to serve in testing the adaptation strategies. With engagement of stakeholders from the onset, their participation in future policy dialogue could be assured particularly

¹ Development issues may include national development objectives, policies, or broader interests linked to the process of development in a country. They may include processes for, or threats to, development on sectors or goals for which forest goods and services play a significant role.

at a time when discussions of development strategies in developing countries is geared towards development pathways that involve national adaptation plans.

Identification and prioritisation of development sectors for adaptation, which occurred at both the regional and national levels of project activities (Table 1), and was ratified by all workshop participants as national and regional priorities, is the first important step for forest-based adaptation. The discourse in defining the livelihood and development sectors for adaptation within the framework of forest resource management is important in aligning livelihood strategies and natural resource management along new trajectories of climate risks and livelihood needs for adaptation as defined through a participatory approach. This consensus among the multiple stakeholders involves voluntary trade-offs of their unilateral interests and positions for a common interest with the aim of achieving adaptation for all. This is an important milestone achievement that can be supported by scientific research and policies at both national and regional levels. Sharing of the responsibilities and the burden of climate change prioritisation allows for the redistribution of risks across different social and economic groups such that climate impacts are not too severe on the most vulnerable since their unique situation is captured by the prioritisation process.

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

Regions	Prioritised Sector	Ecosystem Services	Type of Services	Status (MEA 2005)
West Africa	Water	Fresh water	Provisioning	▼
	Wood fuel	Fiber (wood fuel)	Provisioning	▼
	NTFPs			
	- Foods - Medicinal	Foods Biochemicals, natural medicines, pharmaceuticals	Provisioning Provisioning	▼ ▼
Central America	Water			
	- Potable water - Hydroelectricity	Fresh water Fresh water	Provisioning Provisioning	▼ ▼
South East Asia	Landslide	Natural hazard regulation	Regulating	▼
	Wildfire	Natural hazard regulation	Regulating	▼

▼ Degradation

2.2.2 Approach to Selection of Adaptation Options

The selection of adaptation options is built on the specific methodologies developed for the assessment of vulnerability for each of the topics selected by a region (Table 1). Testing of the methodologies paves the way for identification and screening of adaptation options across various development sectors. The assessment of vulnerability involves criteria and indicators that characterise all aspects of the coupled human–environment

system. This is important because TroFCCA's ecosystem approach to adaptation is only possible by emphasising the linkages between livelihood and the forest ecosystem using ecosystem services to enable the development of policy-related adaptation strategies across different levels (local, national, and regional) and institutions. That also makes it possible to approach the planning of adaptation from a wide range of interrelated issues such as

- impact of climate change on forests and the effects on the provisioning of ecosystem services;
- impact of climate change on livelihood and the effects on the use or consumption patterns of ecosystem services;
- change in behaviour, consumption, or provision patterns in response to climate change impacts; and
- resilience of the system in the face of all these factors.

The processes of testing the methodology, identifying and screening the adaptation options are undertaken through the multi-stakeholders participatory approach following the standard approach of TroFCCA, for implementation of the planned activities. Under this framework the screening of adaptation options is therefore based on the prioritised sectors (Table 1) of the three regions. Besides the outcomes of vulnerability assessments, the state of corresponding ecosystem services of the regional sectors are shown to be degraded by Millennium Ecosystem Assessment (MEA 2005), further emphasising the urgency for adaptation strategies in these sectors.

2.3 Achieving Planned Activities—Phase 3: Adaptation

The implementation of project activities is discussed with great emphasis on activities planned for this period of reporting. Following the project document, phase 3 is supposed to be guided by the following objective: To plan adaptation strategies for the needs and priorities identified in the previous phases. By this objective, the focus of the last year of the project will be on the planning of adaptation. During this phase, identified priorities from the previous phase are assessed in the context of development policies, with a view of incorporating adaptation into the activities of national public institutions. Similarly, contacts with the private sector need to be pursued in an effort to identify innovative sources of financing adaptive forest management. At the end, a project guide for the implementation of adaptation will be elaborated.

As mentioned earlier, the specific activities of each of the three project phases are inter-linked with one another for the realisation of specific objectives as well as the overall project objective. Activities implemented in year 3 represented a completion of phase 2 and the commencement of phase 3 of the project. Thus, prior to discussing the activities of phase 3, below is a summary of the activities of phases 1 and 2 following the project document.

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.

Activity 3 (phases 1 and 2): Develop and test criteria and indicators for adaptive management.

As mentioned previously, the project activities during this reporting period included part of phases 2 and 3 on testing the methodologies for vulnerability assessment of the prioritised sector(s) or topic(s) (Table 1) and screening options for adaptation, all of which are guided by the 12 steps of the methodology with measurable outputs for each step listed in the project document. Only steps linked to the activities of phases 2 and 3 will be emphasised in this annual report. As a guide to the overall implementation of the project, however, there is a summary of the status and progress of each of the steps in this report. Details of past activities can be found in previous annual reports. This is important for a full comprehension of the progress of the project.

The discussion on the 12 steps of the methodology includes implementation activities, expected versus actual outputs so far, and measures put in place for realisation of the expected output for cases still in progress, as follows.

Step 1: Definition of the area *or* topic from the national development policies. The **main output of step 1** was to have a clear definition of the topic(s) *and* 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 *included* contacts with governments, regional kick-off meetings, and literature review. This particular output was accomplished following the recommended channels. The regional development topic(s) *and* area(s) are listed in Table 1.

Step 2: Specification of the goods and services and the environmental services that support *or* relate to the topic(s) *or* area(s) selected. The **main output of step 2** is a description of the goods and services from forests that relate to the topic(s) *or* area(s) selected. The corresponding ecosystem services have all been identified and listed in

Table 1. This *effort* was taken one step further in highlighting the state of degradation of these underlying ecosystem services following this global assessment (Table 1). Results show that all the goods and services that support *or* relate *to* the topic(s) *or* area(s) prioritised by the regions are degraded. A peer reviewed scientific paper has been published that addresses both steps 1 and 2 (see copy at: Online link: <http://www.icrisat.org/Journal/SpecialProject/sp17.pdf>).

Step 3: 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 the provision of the goods and services described in step 2, 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 using literature reviews of all the topic(s) and area(s). The selection of indicators is still continuing to link functioning and provisioning of these goods and services.

Step 4: Assessment of the biophysical processes and parameters that control the functions identified in the previous step. 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 the other regional sectors. Furthermore a scientific paper matching ecosystem functions of different states of tropical forests with the corresponding goods and services surrounding the prioritised development sectors is under review for a scientific journal.

Step 5: Assessment and analysis of the climatic variables and parameters than can have a direct effect on the parameters assessed in the previous step. **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 connection between forest ecology and vulnerability to climate change has been assessed especially in Central America through an analysis of how changes in climate, and climate variability in particular (temperature, rainfall, and extreme events), affect the ecological parameters that control ecosystem functions underlying goods and services. Activities in West Africa and Indonesia addressing this particular output are still ongoing. They will provide criteria and indicators linking climatic variables to biophysical parameters.

Step 6: Selection of case studies. The **main output of step 6** is the selection of case studies for each country or region on the basis of their relevance to the topic(s) and area(s) for which information is available. Following the elaboration of the methodologies for the assessment of vulnerability, case study sites have been selected jointly with national partners and institutions. In South East Asia, there are ongoing pilot

studies in Indonesia in collaboration with the World Wide Fund for Nature (WWF) in testing the methodology. Similarly, there are pilot studies in the Philippines in collaboration between TroFCCA and the International Council for Research in Agroforestry (ICRAF) on testing strategies of mainstreaming adaptation into policy and practices at the provincial levels. In West Africa, the methodology for vulnerability assessment is currently being tested in the transition zones of Ghana.

Step 7: Development of climate scenarios. **The main outputs of step 7** 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 the 'Providing REgional Climates for Impacts Studies' (PRECIS) model in South East Asia and in West Africa, in collaboration with the UK Met Office Hadley Centre. This activity is still ongoing in all three regions. One staff from each of the project regions participated in a workshop organised by the UK Met Office in the UK. There was also a project team constituted during the project annual meeting in April 2008 in Costa Rica and charged with the preparation of a document guiding selection and use of climate scenarios.

Step 8: Identification of current and future biophysical impacts. **The main output of step 8** is an assessment of the possible impacts of the current and expected climate variability and extreme events over the biophysical parameters and ecosystem function for the selected case studies. This activity is ongoing in combination with the development of climate change scenarios and the downscaling activities using PRECIS described in step 7.

Step 9: Assessment of derived impacts. **The main output of step 9** is 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 on payment for environmental services as well as quantifying the implications on society of the potential costs of the climate change impacts on the provision of ecosystem goods and services. Similar activities are on the way in West Africa and South East Asia through commissioned studies.

Step 10: Vulnerability assessment. **The main output of step 10** is an assessment of vulnerability of the specific topic(s) and 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 policy analyses at both the macro level (regional and national) and the micro level directly involving communities. Some of these activities involve network analysis to identify main actors and their relationships so as to facilitate mainstreaming into policy.

Step 11: Vulnerability mapping. After having assessed the vulnerability of a specific case study and whenever data permit, the project will extrapolate the case study results to the country or regional level. The objective of the step is to gain a big picture overview of the

vulnerability. This step is supposed to make use of social scenarios whereby the results of the previous step are superimposed on social and climate scenarios. The **main output of step 11** includes a map of the vulnerability related to the topic(s) and area(s) at the country level. The tools and means for this step include social and climate scenarios, and geographic information systems. Step 11 constituted a major activity of project year 3. Through a commissioned study, there has been the completion of the vulnerability mapping of Ghana following changes in forest cover as indication of resource degradation. There are plans to scale up this effort to the entire region through replication of the process in Burkina Faso and Mali, where social scenarios and climatic conditions are vastly different. (See Annex 3 for a synopsis of the report.)

Step 12: Adaptation pre-screening. While step 11 is the formal initiation of the work on adaptation and the last step of the methodology, step 12 ushers in the screening of adaptation options. There is a policy dialogue process that started with the objective of assessing the priorities and national interests for reducing vulnerability. The results of the application of the previous steps, especially those leading to the methodology for the assessment of vulnerability, have been presented to several actors including government agencies and the private sectors. The substeps include

- identification of relevant actors,
- definition of possible response options with experts of concerned sectors,
- analysis of the interest of society to respond to the identified vulnerability and to use the proposed options, and
- analyses of the costs and benefits of the response options the concerned sectors have selected.

The results of the application of the methodology are supposed to be the main input to the work on adaptation. Planning adaptation will be undertaken directly with the governments and other actors through one or two workshops per region. The specific work will be elaborated at a later stage. These activities have started in South East Asia and West Africa. They will constitute the main focus in year 4 of the project.

Some of the details of the 12 step implementation plans, especially those germane to the period of this report, are highlighted in the various regional report sections of this document.

2.4 Project Implementation Strategies

The standard approaches recommended for implementation of project activities as outlined in the project document were followed in year 3. These include

- national teams,
- scientific panel meeting,
- national contractors,
- doctoral and master students,
- centralised activities performed by the teams of Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) and CIFOR depending on their expertise,

- meetings and workshops,
- contacts with national governments and partners, and
- policy dialogue.

Only those that were used during the reporting period are discussed. Following the structure of the report, only global level activities are covered below. Activities implemented in the various regions are reported in the respective sections.

2.4.1 Project Meetings and Workshops

As part of enhancing project activity through review of past activities and planning new activities, annual global meetings for project staff are organised. Similarly, in line with scientific and outreach programmes, the project also engages in scientific meetings and workshops. Meetings organised by the project at the global level included the following.

1) Tropical Forests and Climate Change Adaptation Project meeting, CATIE Turrialba, Costa Rica, 17–18 April 2008

In its third year the TroFCCA project was at the eve of completion. This important point in the project lifetime is surrounded by two important phases, after which there will be a detailed project report to the European Commission marking the end of the project. As part of the project work plan, there was an annual staff meeting primarily to review the previous year's activities and the planned activities for the year as outlined in the log frame and project document. The meeting also allowed for the preparation of visibility activities like events in scientific meetings e.g. special sessions, UNFCCC annual conference of parties (CoP) etc. The objectives of the project meeting were to review 2007 activities and events (CoP13, Subsidiary Body for Scientific and Technological Advice/Nairobi Work Programme (SBSTA/NWP), external review reports, and CIFOR-Mid Term Plan) and to plan project activities for 2008. (See meeting at the project web site http://www.cifor.cgiar.org/trofcca_ref/home/products.htm).

2) Organisation of a session on 'Tropical Forests Management and Climate Change Adaptation' at the conference Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health: A Review of Science, Policies and Practices, Umeå, Sweden, 25–28 August 2008.

The session was the only one to cover tropical forests during this conference, which leaned heavily towards temperate forest management. Instead of a pure emphasis of climate change impacts on forest health, the session provided the opportunity to draw attention to the coupled human–environment system especially on livelihood implications of climate change impacts on tropical forests, which cater for a majority of the needs of the populations in tropical regions. There were 17 presentations from the project, which drew a lot of interest and attention and subsequent requests for presented papers from organisations including the European Union. The abstracts are available at http://www.cifor.cgiar.org/trofcca/attachment/umea/book_of_abstracts.pdf

3) Organisation of a session on ‘Forests and Climate Change Response: Can we balance adaptation and mitigation in climate change response programmes?’ at Sustainable Forest Management in Africa: African Solutions to African Problems in Natural Forest Management, Stellenbosch, South Africa, 3–7 November 2008.

Climate change scenarios suggest that Africa and its forest ecosystems will face new challenges with great implications for the forests, household livelihoods, and national and economic development. A significant percentage of the population depends directly on forests for livelihood resources. Forests are important for planning climate change response strategies especially through policies at both national and regional levels in transboundary situations. It is therefore important to promote technical and scientific exchanges on both the implications and applications of sustainable forest management for adaptation to climate change without compromising forest ecosystem resilience and their critical mitigation activities. During this session chaired by TroFCCA project manager there were one keynote speech and eight scientific presentations, six of which were from the TroFCCA project. The full papers of the presentations are being peer reviewed for production of a scientific proceeding of the meeting. The abstracts are available at <http://www.cifor.cgiar.org/trofcca/ref/home/products.htm>

4) Side event ‘Linking Climate Change Adaptation, Tropical Forests and Biodiversity’ during Forest Day 2 organised by Stockholm Environment Institute and TroFCCA, CoP14, Poznan, Poland, 6 December 2008.

The aim of the side event was to highlight the role of tropical forests for climate change adaptation including the co-benefits and lessons learned as they relate to managing forests and biodiversity. There were contributions from activities that provide examples of the multiple ways forests serve for adaptation to climate impacts. To achieve this, we proposed to use the speakers’ corner approach to encourage interactive learning and personal networking. Posters were used in this process. This was followed by a general discussion whereby questions were directed to each presenter to analyse the poster in more detail.

2.4.2 Graduate Student Research

The graduate training programme remains an integral part of the project that cuts across capacity development and scientific activities for project implementation. Graduate students are instrumental in project implementation at global, regional, and national levels. Global level supervision of graduate students and their activities included the following.

1) Moussa Kone: PhD candidate, Department of Geography, University of Illinois, Urbana Champagne, 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.

Although part of the research is still continuing, the funding, which was meant for two years, came to an end. The case study in the Katiali region used a political-ecological approach to expand the understanding of burning regimes and to present a more accurate assessment of land use and land cover change in the Sudanian savannas. The study concluded that local resource users increasingly use fire early in the dry season as a management tool. Farmers set fire to protect their cashew and mango orchards while herders burn for new grasses that are more palatable to cattle. Early dry season burning is less intense and less efficient, and over the years favours the expansion of woody vegetation in the Sudanian savanna. Less intense burning also produces lower gas and aerosol emissions. The resulting increase in vegetation cover could potentially sequester more carbon dioxide than is presently attributed to the system. (See Annex 4 for full report.)

2) Matieu Henry: PhD candidate, University of Tuscia, Italy, under the CarboAfrica project; a member of TroFCCA, 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 the 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. This project is still ongoing and Henry gave a presentation on his research activities and results so far during the CarboAfrica conference in Ghana, 25–27 November 2008. All the presentations are being prepared as papers for a conference proceeding.

3) Henri-Noël Bouda: PhD candidate, Copenhagen University, Denmark, working on the adaptive properties to drought stress of *Parkia Biglobosa* and *Adansonia Digitata*. These are important tree species in West Africa with differential tolerance and adaptive capacities to drought and other stresses. The baobab (*Adansonia Digitata*), for example, thrives in a wide range of ecological zones with annual precipitation between 250 mm and as much as 1500 mm. The main goal of the study is to evaluate adaptation to climate change by the two species within their distribution areas by looking at the relationship between ecophysiological and morphological parameters, and also growth and phenological parameters in their contributions to adaptation to drought stress in Burkina Faso.

4) Denboy Kudejira: Graduate candidate, Master of Arts in Sustainable International Development, Heller School for Social Policy and Management, Brandeis University, USA. Kudejira worked for six months with the CIFOR-West Africa Regional Office as a TroFCCA intern conducting an in-depth study to understand how the role of Forest Ecosystem Goods and Services (FECS) has been integrated in the National Adaptation

Plans of Action (NAPAs) of Burkina Faso and Mali. During this period he reviewed the National Adaptation Programmes of Action (NAPA) and their priority projects that implicate forest ecosystem goods and services in Burkina Faso and Mali. The study will help increase awareness on strategies that governments in developing countries can employ to enhance effective implementation of prioritized NAPA projects.

2.4.3 Supporting National Governments and Partners

The project's objective of mainstreaming adaptation into national policies involves continuously engaging national and regional policy makers in promoting the role of forest for adaptation and for the integration of climate change adaptation into development planning. The high points of progress in this regard include the fact that the project has been engaged by national governments and regional organisations in Africa to contribute to the elaboration of policy related documents. For example:

National level

- 1) The government of Burkina Faso, through its Secrétariat Permanent du Conseil National pour l'Environnement et le Développement Durable (SP-CONEDD), invited TroFCCA to contribute to its national environmental document on issues of adaptation.

Sub-regional level

- 2) L'Union Economique et Monetaire Ouest Africaine (UEMOA) requested a contribution to its Environment and Natural Resource Management document.
- 3) The Economic Commission of West African States (ECOWAS) requested a contribution on forests and climate change adaptation to the ECOWAS Forestry Policy.

Regional

- 4) Invitation to contribute to the 'Scoping Paper for Expert Group Meeting on Climate Change Adaptation' presented to the African Ministerial Conference on the Environment (AMCE), 7–9 June 2008, Johannesburg, South Africa.
- 5) Invited contribution to the African Group preparatory meeting prior to the 3rd Session of the Ad Hoc Working Group on Long Term Cooperation Actions under the UNFCCC, 18 August 2008, Ghana.
- 6) TroFCCA-CIFOR was recently selected as one of the host institutions for the African Climate Change Adaptation Fellowship programme coordinated by the global change SysTem for Analysis, Research and Training (START) and the African Academy of Science.

These cases are indications of the recognition and acceptability of the project's message in the region constituting important steps of mainstreaming and effecting policy change.

2.4.4 Consultancy/National Contractors

There are commissioned studies—some already completed, others still being undertaken—through consultancies to support and provide information relevant to project outputs. These include the following.

1) The development of forest-based information and materials for contribution to the second national communications of TroFCCA project countries to emphasise the roles of forest in national climate change response

Background

The multiple goods and services of tropical forests are highly integrated in the social, cultural, economic, and national development of most tropical countries. Tropical forests also have major roles to play globally and locally in climate change responses, roles that often are not fully reflected and captured in the national communications to the UNFCCC of most tropical forest countries. Using TroFCCA's research activities and outputs in three tropical forests regions of Central America, South East Asia and West Africa involving eight countries, there are opportunities for recommending materials and information for their national communications. The objective of the consultancy is to use TroFCCA research findings and different inputs to develop information and materials that could 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.

Activities

- 1) Review the national communications of TroFCCA participating countries in highlighting the gaps, limitations, lost opportunities etc in the use of forests.
- 2) Following the outline provided for the second national communication, identify areas that could be supported by forest information.
- 3) Develop relevant information from case 2, on a country basis, using information from the project and from other sources where appropriate.

The study has been completed and a report has been prepared. There are separate sections highlighting individual country situations, needs, and forest potentials for climate change response (mitigation and adaptation) and how to integrate that information into the second national communication. This particular activity is linked to the project's output on contribution to the development of the second national communications, which is due for submission to the UNFCCC in 2008 – 2009. (See Summary in Appendix 5)

2) Indigenous knowledge and adaptive capacity of communities in West Africa

This activity has now been awarded to a consultant after long delays in administrative procedures. Because of the scale of the activity, consultant will conduct the activity alongside the project team. This activity is also of interest to the 'Environmental Development Action – Third World' (ENDA-TW) and the 'Capacity Development for Adaptation to Climate Change' (C3D) collaborative project. The evaluation of indigenous knowledge is a crucial activity of step 12 on adaptation screening of the project implementation plan. See the second year project annual report for a detailed implementation plan of the activities.

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 Ghana

The vulnerability map for Ghana has been completed setting an example and demonstrating potentials in the preparation and use of these maps. This represents an output of step 11 on vulnerability mapping.

4) Development of communication strategy for the project

In order to effectively achieve the project goal of mainstreaming into policy, there is the need for planning communications with the various stakeholders at the different levels especially in targeting policies. This activity is ongoing and the report will become available later on.

2.4.5 Scientific Steering Committee

A scientific steering committee was scheduled during UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) in June 2008 in Bonn, Germany. Not all the members were able to be present. There are two representatives who bring in global and integrative outlooks to the project. Dr Max Campos of San Jose, Costa Rica, representing Central America, participated in the project meeting in Costa Rica.

2.4.6 External Reviews

The following persons conducted external reviews of project activities:

- 1) Mr Stephen Devenish: Output Verification Inspection (August 2007);
- 2) Mr Geraldo Carstens: CGIAR Internal Auditing Unit for auditing CIFOR EC-funded projects with focus of the audit on the large TroFCCA project (September 2007); and
- 3) Drs Marc J. Metzger and Max Campos: mid-term review of TroFCCA in Central America (October 2007).

3. STAFF CHANGES AND THE TEAMS

During the period under review some changes took places in staff arrangement through recruitment, non-renewal of contract, and end of contractual period of funding of the Dutch Associate Professional Program (APO). All these movements of staff affected the composition of both the global and regional teams and the undertaking of project activities. It follows a list of those who left the project.

- 1) Dr Carlos Perez (regional project coordinator for Central America), whose contract was not renewed.
- 2) Dr Lucio Pedroni (director of Grupo de Cambio Global) resigned from CATIE.
- 3) Mrs Elke Verbeeten (research fellow in West Africa), who came to the end of her APO-funded contract.
- 4) Mrs Patricia Ann J. Sanchez (research assistant in the Philippines) resigned from the project for a PhD fellowship programme in Japan.

Dr Javier Saborio joined the project as regional coordinator for Central America (in replacement of Dr Carlos Perez).

Mrs Delfino, Rafaela Jane joined the project as research assistant in the Philippines (in replacement of Patricia Sanchez)

Following these changes, here is the current team composition.

Global

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

- Programme Director: Markku Kanninen (Finland)
- Project Manager: Johnson Nkem (Cameroon)
- Principal scientist (1): Bruno Locatelli (France) (transferred from CATIE)
- PhD research fellow: Moussa Kone (Ivory Coast)
- PhD research fellow: Matieu Henry (France)
- Mr Denboy Kudejira (Zimbabwe)
- Secretary: Rosita Go (Indonesia)
- Project Secretary: Popi Astriani (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. The team is composed of:

- Regional coordinator (until August 2008): Johnson Nkem (Cameroon)
- Principal scientist: Monica Idinoba (Nigeria) (Regional Coordinator -August 2008)
- Post doctoral fellow: Maria Brockhaus (funded by the government of Germany)
- Research Assistant: Yacouba Noël Coulibaly (Burkina Faso)
- APO: 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 CATIE in Turrialba, Costa Rica. The team comprises the following members:

- Regional coordinator: Javier Saborio (Costa Rica)
- Principal scientist (2): Raffaele Vignola (Italy)

This team is supported by Grupo de Cambio Global, which includes Marcos Tito (Brazil), Pablo Imbach (Argentina), and Patricia Ramirez (Costa Rica).

South East Asia

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

- Regional coordinator: Heru Santoso (Indonesia)
- Principal scientist: Daniel Murdiyarto (Indonesia)
- Research Assistant: Hety Herawati (Indonesia)
- Research Assistant: Yulia Siagian (Indonesia)

In the Philippines TroFCCA is in partnership with ICRAF and the team is comprised of the following:

- Coordinator: Rodel D. Lasco (Philippines)

- Scientist: Florencia Pulhin (Philippines) (half time)
- Research Assistant: Delfino, Rafaela Jane (Philippines)

4. COMMUNICATION AND OUTREACH

Communication and visibility are part of the project activities in connecting with the public and with policy. As a pathway to mainstreaming adaptation, the project was involved in various forms of visibility activities, some of them by fortuitous invitation. At the same time, traditional outreach and visibility outlets like the project webpage, flyers etc were maintained and updated

4.1 Website

A webmaster periodically updates the website at http://www.cifor.cgiar.org/trofcca/_ref/home/index.htm with a wide range of new information including news items such as announcements on research fellowships, meetings, meeting reports, etc. The link to the website is.

4.2 Flyers

The project maintains two categories of flyers, the overall project flyer printed in three languages (English, French, and Spanish) and the bilingual regional flyers highlighting regional issues. These flyers were updated in 2007 prior to CoP13 in Bali, in order to integrate the implementation activities of the project and some outputs and outcomes so far. UNFCCC CoP13 in Bali and SBSTA in June 2008 in Bonn provided unique opportunities for their distribution. Copies are available at this URL http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm

4.3 Briefs (Information and Policy)

Other forms of communication and outreach include policy briefs and scientific papers including proceedings of conferences and meetings. Five briefs on various subjects (info, policy, research) were produced by the project during this reporting period. Furthermore, Moussa Kone, a doctoral student on the project, published one research brief under the Norman Borlaug LEAP fellowship programme. (See copies of the briefs in Annex 6).

4.4 Book(s)

A book was published from the project during this period titled 'Facing an uncertain future: how forests and people can adapt', and launched during the fourteenth Conference of the Parties (CoP14) in Poznan, Poland with extensive media coverage. An electronic copy of the book is available at:

http://www.cifor.cgiar.org/publications/pdf_files/media/CIFOR_adaptation.pdf

A second book addressing 'Frequently Asked Questions' (FAQ) on climate scenarios that aims at policymakers, new adaptation scientists or adaptation managers have been prepared and submitted for publication as CIFOR Publication. The book tries to shed light on the roles of climate scenarios in adaptation assessment and some technical problems in handling them. It elaborates on topics such as: do we need climate scenarios;

how to create, obtain or use climate scenarios; how to handle the differences among datasets such as spatial and temporal resolutions (e.g. downscaling); which emission scenarios and which GCM to choose, and how to treat uncertainties.

4.5 Invited Participation and Scientific Contributions

4.5.1 Invited Contributions

1. Contributions to various chapters of the International Union of Forest Research Organizations (IUFRO) book on *Adaptation of Forests to Climate Change* as an expert panel organised by IUFRO for the development of forest-related intergovernmental processes by assessing available scientific information on adaptation of forests to climate change.
2. Invited contribution to the Environment and Natural Resource Management document of UEMOA.
3. Invited contribution on forests and climate change adaptation to the regional Forestry Policy of the Economic Commission of West African States (ECOWAS)
4. Contribution to 'Climate change adaptation in Africa', a scoping paper for expert group meeting on climate change adaptation for the African Ministerial Conference on Environment, 7–9 June 2008, Johannesburg, South Africa. United Nations Environment Programme (UNEP), Nairobi.

4.5.2 Invited Participation

1. Special Workshop on Climate Change and Variability in Africa: The African Forestry Sector Response. The African Forestry Forum, 23–25 September 2008, Nairobi, Kenya.
2. Invited Paper for the African Group Meeting prior to the 3rd Session of the Ad Hoc Working Group on Long Term Cooperative Actions under the Convention and the first part of the Sixth Session of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol, 18–19 August 2008, Accra, Ghana.
3. Potential Drivers of Land Use Change in the Tropics: Impacts of Bioenergy and Avoided Deforestation, Annual Conference, International Society of Tropical Resource Institute, Yale School of Forestry and Environmental Studies, 27–29 March 2008.
4. UNFCCC expert meeting on methods and tools and on data and observations under the Nairobi work programme on impacts, vulnerability and adaptation to climate change, 4–7 March 2008, Mexico City, Mexico.
5. Sixteenth Session of the African Forestry and Wildlife Commission, Food and

Agriculture Organisation of the United Nations, 18–21 February 2008, Khartoum, Sudan.

6. Pre-Fellowship Planning Workshop: Africa Climate Change Fellowship Programme, organised by Institute of Resource Assessment of the University of Dar-es-Salaam, the International START and the African Academy of Sciences, 8–10 January 2008, Nairobi, Kenya.
7. UNEP Ecosystem Management Programme: Expert Group Brainstorming Nairobi Safari Club Hotel, 4–5 October 2007, Nairobi, Kenya.

4.6 Participation in Conferences

The project encourages scientific contribution to the knowledge base on adaptation, sharing experiences, learning and acquiring new information and skills. Project staff are actively participating in seminars, workshops, and conferences across the world, making presentations of research results from the activities, including reviews as well as 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, and also for European Union (EU) support to knowledge building activities, through the acknowledgement of EU support and the inclusion of the EU logo in all the presentations (both oral and poster). Some of these meetings included:

- Forest Day, 8 December 2007, during CoP13 in Bali, Indonesia
- International conference on Adaptation of Forests and Forest Management to Changing Climate with emphasis on Forest Health: A Review of Science, Policies and Practices, 25–28 August 2008, Umeå, Sweden
- International Conference on Sustainable Forest Management in Africa: African Solutions to African Problems in Natural Forest Management, 3–7 November 2008, Stellenbosch, South Africa
- CarboAfrica Open Science Conference on Africa and Carbon Cycle, 25–27 November 2008, Accra, Ghana
- UNFCCC CoP14, 1–12 December 2008, Poznan, Poland.

4.7 Visibility Actions 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 the disclaimer) in all documents on the website, 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.

5. PARTNERS AND COLLABORATION WITH OTHER INSTITUTIONS

While there was continuous collaboration and strengthening of relationships with existing partners, there was also the establishment of new partnerships and collaborations. This is crucial for a project with a small staff and which believes in a collective approach to seeking solutions to climate change in establishing stakeholders' ownership of the process. Working through these networks also facilitates the achievement of global project goals and contributes to the global process. Only new partnership and collaboration arrangements are highlighted here since previous ones were comprehensively documented in the first year annual report.

- TroFCCA is a participating project in the C3D+ Project on 'Capacity Development for Adaptation to Climate Change & GHG Mitigation in Non Annex I Countries' recently funded by the EU and coordinated by United Nations Institute for Training and Research.
- Collaboration with the International Institute for Sustainable Development (IISD) for the development of 'Community-based Risk Screening Tool' (CRiSTAL)—Forest under the C3D+ Project. CRiSTAL is a rapid appraisal tool for planning adaptation in agricultural systems. Through collaborative activities between IISD and TroFCCA, this rapid appraisal tool will be adapted to forest conditions as CRiSTAL-Forest.
- Collaboration with the Africa Climate Change Fellowship Programme, as a host institution for fellows, under the coordination of START International, Institute of Resource Assessment of the University of Dar-es-Salaam, and the African Academy of Sciences.
- UNFCCC Nairobi Work Programme on adaptation. An action pledge was submitted in 2008. You can view all action pledges at <http://unfccc.int/3996.php>. The CIFOR action pledge is linked to from this page and also available directly at <http://unfccc.int/4584.php>.
- Collaboration with the Stockholm Environment Institute (SEI) in the organisation of a side event during Forest Day 2 at CoP14, Poznan, Poland, 6 December 2008. TroFCCA-West Africa was also invited to contribute to the 'Scoping Paper for Expert Group Meeting on Climate Change Adaptation' presented to AMCE, 7–9 June 2008, Johannesburg, South Africa, coordinated by SEI and UNEP.
- Collaboration with IUFRO through the Expert Panel on Adaptation of Forest to Climate Change for elaboration of the book on *Adaptation of Forests to Climate Change*.
- University of Illinois, Urbana-Champaign, under LEAP of the Norman E. Borlaug International Agricultural Science and Technology Fellows Program.

6. PROJECT ACTIVITIES PLANNED FOR IMPLEMENTATION IN YEAR 4

Project activities in year 4 will primarily focus on completing ongoing activities, preparing project outputs and the final report. Thus the activities will involve the following:

- Development of adaptation strategies within the context of national policies
- Completion of the documentation of local coping and adaptation strategies and the indigenous knowledge of coping and adaptive strategies that started in year 3 with commissioned studies
- Completion of the screening of these local coping strategies to determine local adaptive capacity and develop adaptation strategies
- Completion of the following products, which are currently in progress:
 - A document on climate scenario
 - Identification of response options
 - A document on criteria and indicators for vulnerability assessment
- Organisation of a writing workshop to assist project team in preparing peer reviewed papers and synthesis papers of the project's global activities
- Preparation of final project report for submission to EU
- Contribution to the action pledges to the UNFCCC Nairobi work programme
- Work with the recently constituted Project Steering Committee
- Organisation of a Project Meeting.

7. REGIONAL REPORTS

7.1 West Africa

7.1.1 Introduction

The period of September 2007 to August 2008 was very busy but exciting with success stories in capacity building by TroFCCA West Africa. The first batch of eight recipients of the TroFCCA graduate fellowship awards at MSc/MPhil level successfully completed their programmes in their various universities with excellent grades, serving as pioneers of climate change research in some national universities. This is an important milestone in regional capacity building for climate change and is likely to have great impacts on the broader community and academic institutions over a long period. There are also additional gains in motivating other students to undertake climate change research. Collaboration and partnerships at local, national, and regional levels also increased facilitating the harnessing of inputs for the methodology for vulnerability assessment, policy analysis, and the establishment of exchange platforms at the local level to connect actors implicated in decision making for the management of forest goods and services (FEGS) linking local and national levels.

The great collaboration and partnership enabled knowledge exchange and the collection of scientific and policy data crucial for analyses of key areas of project objectives. Project visibility through these participatory activities resulted in frequent requests for information by national and regional partners seeking advice for the development of new adaptation projects and activities. There were also great efforts by both staff and students in preparing scientific publications using their research findings, with staff members investing time and dedication to help students with both their theses and scientific writings.

The project was privileged to receive a high profile visitor from the EU headquarters in Brussels. Mr Michel Van Dan Bossche of EuropeAid Co-Operation Office, EU, took the opportunity of his visit to the region to assess the project, pay courtesy calls to national partners, observe the field challenges, and also visit local communities involved in the project. His visit presented a unique opportunity to bring all TroFCCA students, interns, consultants, and staff together to showcase their work, take questions, and interact with team members from the other countries.

7.1.2 Implementation of Project Activities

In an effort to accomplish the activities planned for year 3, several studies were undertaken by staff, students, and consultants in spite of the challenges. Below are completed and ongoing studies with their connections to the outlined activities in the log frame for realising the project output targets.

Activity 1: Decentralisation—A window of opportunity for successful adaptation to climate change

This is an analysis of first results of a case study on forests, climate change, and aspects of adaptive capacity under a changing institutional landscape. Comparative research focusing on governance, forests, and adaptation was undertaken in two municipalities in the southwest of Burkina Faso. In-depth interviews were conducted with actors from decentralised and deconcentrated structures and development projects involved in the region. The interviews covered role of forests for livelihoods; perception of, experience with, and scenarios for climate change; needed individual, organisational, and political responses; roles and responsibilities for adaptation of the different actors in the arena, including their networks of information and influence regarding the topic.

To examine the opportunities and barriers for successful adaptation to climate change and variability in the context of an ongoing decentralisation process in Burkina Faso, the relatively understudied relationship between adaptive capacity and features of governance is analysed. Adaptive capacity is understood as a function of governance features such as institutional governance structures and the understanding of the individual actors involved in decision making processes related to FEGS. Resource dependency on FEGS serves as a further variable. The combination of FEGS, structures, and actors should allow for an in-depth analysis of what shapes the space for successful adaptation. Key findings of this research are the importance of knowledge to overcome resource dependency and of two key features of governance essential for technical and societal adaptation to climate change: (1) individual understandings and (2) institutional

flexibility ensured by short distances to local realities. The study is related to activity 4.4 of the project log frame.

A paper from the study was presented at Tyndall conference, London, Royal Geographic Society, in February 2008, and will be published by Cambridge University Press as a book chapter in 2009. (See the URL <http://www.cambridge.org/catalogue/catalogue.asp?isbn=9780521764858>).

Activity 2: Local governance: Opportunities and limits for successful adaptation in the arena of climate change and forest ecosystem goods and services

The individual interviews as well as two workshops at village level in the region in 2007 were followed by a workshop in June 2008 with participants from decentralised and administrative structures as well as by development projects and civil society representatives. Overall aim of this workshop was to support mainstreaming of FECS and adaptation into development policies by the establishment of a 'plateforme d'échange' at local level to link actors involved in decision making around FECS management from the local to the national level. Another objective was to deepen the analysis of decentralisation as a window of opportunity for adaptation by an identification of opportunities and limits for successful adaptation in the context of ongoing decentralisation in Burkina Faso.

The results confirmed what was said above about the roles of (1) individual understandings and (2) institutional flexibility ensured by short distances to local realities and deepened the understanding of the obstacles and opportunities related to the three TroFCCA topics.

Partners involved in this workshop besides the institutions and organisations at local level were SP-CONEDD and Réseau Marp from the national level.

Outlook: the actor from SP-CONEDD (cellule focal point UNFCCC) proposed a repetition of these types of 'exchange platforms' in all regions in Burkina Faso. Discussions about this possibility are ongoing.

The workshop report is available on the TroFCCA webpage: Gouvernance Locale: Des opportunités et des limites à une adaptation effective dans le domaine du changement climatique et des biens et services de l'écosystème forestier. The study is related to activity 4.4 of the project log frame.

Activity 3: Payments for environmental services as innovative financing mechanism for adaptation to climate change: Opportunities and limits: The example of Ghana with respect to forest ecosystem services

The aim of the study is the assessment of potentials and barriers for the use of payments for environmental services (PES) as innovative mechanism to finance adaptation to climate change. The specific focus is on forest ecosystem goods and services to minimise the risk of increasing vulnerability of the population in Ghana. The methods for the

assessment of PES potentials will be tested and serve as guidelines for a pre-module 'scoping' for the implementation of PES. The study was conducted from July 2008 to October 2008 by Seminar für ländliche Entwicklung, Berlin, on behalf of TroFCCA and Gesellschaft für Technische Zusammenarbeit (The German technical development organisation). Other partners in Ghana included Forest Research Institute of Ghana (FORIG) and the University of Kumasi. Three students from the University of Kumasi (supported by TroFCCA grants) undertook the study together with a student team from Berlin, Germany. Preliminary results were expected in December 2008. The study is related to activity 4.6 of the project log frame.

Activity 4: Methodology for vulnerability assessment

This item is linked to activity 1.2 of the project log frame for the development of a methodology for vulnerability assessment. The approach here describes the vulnerability elements using their exposure, sensitivity, and adaptive capacity expressed by principles, criteria, and indicators for the assessment. The methodology framework was finalised through a brainstorming workshop in Burkina Faso and Ghana with partners from the Forestry Research Institute of Ghana, Kwame Nkrumah University of Science and Technology, Département Production Forestière/Institut de l' Environnement et de Reserche Agricole. Regional experts from Plant Resources of Tropical Africa, University of Ouagadougou, University of Bamako and Cheikh Anta Diop University, Dakar Fann, Senegal, peer reviewed the document (see Annex 7 for meeting report). This set the stage for the initial testing at local level using students' research projects. This strategic approach was necessary, knowing that response to climate change is a pro poor agenda that needs to involve all stakeholders. In view of having a generic method for all TroFCCA regions, the methodology (Annex 8) was further re-addressed to reflect the three principles agreed upon by the TroFCCA team while maintaining the broad definition of the vulnerability concept. A pamphlet that provides a step-by-step guide for vulnerability assessment of forest ecosystems in providing goods (non-timber forest products) and services (water resources) has been prepared to easy field application. In addition, different sections of the methodology have been presented in two scientific meetings, the most recent being the international conference on Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health: A Review of Science, Policies and Practice, 25–28 August, Umeå, Sweden.

Activity 5: Testing methodology and vulnerability assessment

To give broader scope and coverage of the vulnerability assessment methodology developed jointly with stakeholders and graduate student studies, it was necessary to test it across various scales. This was first done at local and district levels on a particular ecological zone in Ghana identified by partners to be vulnerable but which constitutes an important economic zone for the country. The study included the set of criteria and indicators identified and used by the students in order to evaluate their appropriateness for assessing vulnerability of the selected forest sector and to determine the appropriate spatial and temporal scale for effective utilisation. The study is still ongoing in collaboration with the Forestry Research Institute of Ghana. The outcome of this research

is planned to be presented at CoP15. Related to this activity and in justification of activity 1.1 are case studies from student work summarised in Annex 9, which also generated information to feed into activities 1.3, 1.4, 2.1, 2.2, 2.4, 4.1, 4.2 and 4.3 of the project log frame.

Activity 6: Developing climate scenarios

To achieve activity 2.3 of the project log frame, the PRECIS validation run (1948–1998) was started in October 2007 and completed in January 2008. The validation run was necessary to set the stage for adjustments for future projections; this involved comparison of observed meteorological data with PRECIS predicted data to spot the degree of biases between the two. The subsequent months after the run involved visualisation of the results, extraction of output data from the model, collection of historical data from meteorological departments in Burkina Faso, Ghana, and Mali, and statistical analyses. This facilitated the development of a climate database not just for the three project countries, but also for some other countries. It also gave students and CIFOR staff easy access to climatic data in a region where access to such data is a challenge. In May 2008, the project had a monitoring meeting with UK meteorological office liaison and training manager. Preliminary results were presented and further guidelines on the analysis of the validation run were provided. Following the outcome of this meeting, TroFCCA West Africa was invited to participate in the training workshop for the recently released new PRECIS model, which covers the period 1949–2099 and incorporates past, present, and future climate change scenarios. The training included configuring, running, and learning how to make the best use of the PRECIS output. The next stage of PRECIS will be to start the 2071–2100 projection runs using the Addjd and HadAM3P story lines, and the organisation of a regional stakeholders' workshop including the different meteorological departments. Preliminary results were presented as a poster during the annual meeting of CIFOR. This activity is undertaken in partnership with the meteorological departments in Burkina Faso, Ghana, and Mali and the UK Met Office Hadley Centre for climate prediction and research.

Activity 7: Analyses of policies on forest, water, and fuel wood in Burkina Faso, Ghana and Mali

The objective is to analyse present policies, institutions and their practices in relation to how they can help or obstruct adaptation actions and processes. This is linked to the project activities of developing policy-oriented adaptation strategies that are relevant for mainstreaming into development policies and programmes of national governments. The methods employed include literature review, intermittent consultation of resource persons and experts, and community field visits in Burkina Faso and Ghana. The partners in Burkina Faso are Conseil National pour l'Environnement et le Développement Durable (CONEDD), Ministère de l'Environnement et du Cadre de Vie (MECV), Direction Générale de la Conservation de la Nature (DGCN), Centre National de Semences Forestières (CNSF), Fédération Nationale des Unions de Groupements de Gestion des Forêts (FENUGGF), Union de Groupements de Gestion des Forêts (UGGF), Comité permanent Inter-états de Lutte contre la Sécheresse et la désertification au Sahel (CILSS),

Ministère de l'Agriculture de l'Hydraulique et des Ressources Halieutiques (MAHRH), Communities at Sapouy, Bougnounou; in Ghana, Environmental Protection Agency (EPA), Forest, Energy and Water Commissions, Forest Research Institute of Ghana (FORIG), Kwame Nkrumah University of Sciences and Technology (KNUST), University of Ghana, communities at Abofor, Adaa, Akwerikrom; and in Mali, Secrétariat Technique Permanent du Cadre Institutionnel de la Gestion des Questions Environnementales (ST-CIGQE), Ministère de l'Équipement, de l'Aménagement du Territoire et de l'Urbanisme (MEATEU), Direction Générale de la Conservation de la Nature (DGCN), Agence Malienne pour le Développement de l'Énergie Rurale (AMADER), Centre National de Recherche Scientifique et Technique (CNRST). The outcome/product of the activity will include a document on the policy analysis of forest ecosystem-linked sectors and climate change adaptation in West Africa: current status of policies.

Activity 8: Scoping for planned adaptation strategies by government to climate hazards

The objective of this activity is to investigate and recommend possible adaptation strategies planned by governments to limit climate hazards on FECS. The link to TroFCCA activity lies in the development of policy-oriented adaptation strategies that are relevant for mainstreaming into development policies and programmes of national governments. The method includes interviews of stakeholders (group and focus group), specialised studies by consultants, utilisation of TroFCCA research outcomes, and small workshops. Partners in Burkina Faso include CONEDD, MECV, DGCN, CNSF, FENUGGF, UGGF, CILSS, MAHRH, Communities at Sapouy, Bougnounou; in Ghana, EPA, Forest, Energy and Water Commissions, FORIG, KNUST, University of Ghana, communities at Abofor, Adaa, Akwerikrom; and in Mali, CIGQE, MEATEU, DGCN, AMADER, CNRST, and communities. The activity is still at the initial stage (started June 2008) and will continue till the end of the next reporting period.

Activity 9: Vulnerability risk map for Burkina Faso, Ghana, and Mali was commissioned to partners at the EPA Ghana

This study contributes to activity 2.6 on vulnerability mapping. A spatial model was used to simulate forest degradation vulnerability maps. Risks were assigned to each grid factor that contributes to forests and woodland degradation in the three major ecological zones of Ghana—high forest, forest-savanna transitional, and savanna. Data used in the simulation were derived from elevation, forest policy, population density, poverty levels, soil productivity and wildfires, for the period of 1972–2000. Time series dynamics of land use and land cover (LULC) and amount of rainfall by 2050 were also included to generate composite forest vulnerability maps for each ecological zone as basis for decision making in adaptation planning.

The analysis from LULC change in 1972, 1985, and 2000 using satellite images indicated that high demand for forestland for cocoa plantations has reduced closed forest in the high forest area from 2,736 km² to 1,623 km² at an annual rate of 2.7%, leaving mainly protected forest reserves in 2000. In the forest-savanna transition, open forest and closed savanna woodlands have degraded by 85% and 36%, respectively, while the woodland

vegetation in the savanna zone has declined drastically from 1,195 km² to 340 km² at an annual rate of 3.0% and 1.3%, respectively, 2.6% of which was due mainly to extensive agriculture and wildfires. Scenarios of predictive maps in the studied zones show that projected degradation of forests under business as usual would lead to a total loss of 95% of the forest-savanna transition zone, 81% of the savanna zone, and 77% of the high forest zone by 2050.

Simulated forest vulnerability maps projected for 2050 show 20%, 33% and 45%, respectively, of highly vulnerable forest and woodland areas in the high forest, forest-savanna transition, and savanna zones. High vulnerability to forest degradation were associated with basins of rivers and streams, low lying areas of ≤ 250 masl, and communities with population density of $\geq 5,000$ inhabitants per square kilometre resulting from a combination of forest degradation risk factors. Low vulnerability areas were associated with statutory forest reserves.

The study made available environmental data and information at ecological levels. Forests cover dynamic now and in 2050, together with temporal rate of change, direction of change, vulnerability of forest degradation and characteristics of hotspots, were provided as essential data sets required to address problems associated with degradation of FEGS as well as climate change impacts at local level. There are plans to expand the study to Burkina Faso and Mali in 2009, if possible.

Activity 10: Vulnerability and adaptive capacity at the interface of FEGS and livestock production systems in Mali

This study conducted in Mali started in July 2008 and will continue in 2009. The objective of the study is the assessment of vulnerability of livestock producers using FEGS with a focus on adaptive capacity. The assessment involves testing of different participatory tools and their suitability to the specific context of FEGS, pastoral livelihoods, and climate change adaptation. The specific objectives of the study include:

1. Role of FEGS (among other fodder) for livelihoods of pastoral communities (mobile, sedentary) and the temporal and spatial importance of FEGS
2. Assessment of local perception of changes in the availability (quantity, quality, access) with a specific focus on climate change, and local knowledge about changes
3. Identification of vulnerability indicators
4. Identification and assessment of response options and adaptation strategies; measures/strategies and future needs under specific scenarios of climate change [technical and social (governance) adaptation].

Following the activities of the first phase (together with a consultant, Houria Djoudi-Niederhaeser), the second phase will analyse the reflection of results from the local level in the ongoing National Adaptation Programme of Action (NAPA) process in Mali (focus on proposed activities/projects, e.g. projects as mentioned in the Mali NAPA).

5. Stakeholder analysis to assess the role of networks to explain policy outcomes (NAPA) by analysing information and influence structures in the arena of FEGS (fodder), climate change, and adaptation.

Partners at macro level are CNRST, METEO, and STP; at the local level are the administrative (Prefect) and decentralised structures (Conseille de Cercle de Goundam). Technical support is given by ICRAF and Veterinaire sans Frontier.

Outputs (report and journal article) can be expected in 2009. The study is related to project activities 2, 3 and 4, and focuses specifically on 2.1, 2.2, 2.4; 3.1, 3.2; 4.3, 4.4, 4.5; 5.1–4 of the log frame.

7.1.3 Communication and Outreach

A major boost to public awareness in the region was obtained through contributing to the production of the EU sponsored film on climate change adaptation in Burkina Faso that was projected during the European Union Day in Lisbon. Staff and students also participated in several meetings to present their research results in relevant national, regional, and international meetings and conferences that further raised awareness on FECS for adaptation. Such participation in meetings especially with national governments also contributes to mainstreaming adaptation into development plans, policies, and activities using TroFCCA research outputs. Output, products, and outcomes include abstracts, posters, and reports produced (see project website <http://www.cifor.cgiar.org/trofcca/africa/docs/>).

Participation in Conferences and Workshops

1. European Congress of Policy Research – ECPR, Pisa, Italy, 6–9 September 2007. See full paper at <http://www.essex.ac.uk/ecpr/events/generalconference/pisa/papers/PP1043.pdf>.
2. Climate Change: Science, Politics and the Management of Uncertainty workshop organised by 21st Century Trust, funded by Foreign & Commonwealth Office, Deutsche Forschungsgemeinschaft, und Stifterverband, Oxford, Merton College, 17–23 September 2007.
3. UNFCCC CoP13, Bali, December 2007.
4. Atelier formation continue sur ‘Utilisation des jeux de rôles dans les concertations entre acteurs’ organisée par le CIRAD et le CIFOR, Bamako, Mali, 19–26 January 2008.
5. Conference on ‘Living with climate change: are there limits to adaptation?’ Tyndall Conference at Royal Geographic Society, London, 7–8 February 2008. Presentation of a paper in Theme 3: ‘Governance, Knowledge and Technologies for Adaptation: Decentralisation: Window of Opportunity for Successful Adaptation? A Case Study from Burkina Faso’. A book chapter in N. W. Adger, I. Lorenzoni, and K. O’Brien (eds.), ‘Adapting to Climate Change: Thresholds, Values, Governance’, Cambridge University Press, Cambridge.
6. Expert Panel on Adaptation of Forest to Climate Change organised by IUFRO at the UN headquarters, New York, 11–12 February 2008. To prepare a report for use by the United Nations Forum on Forests, and also by the UNFCCC and the Convention on Biological Diversity. The assessment report shall present the state of information relevant to understanding the impacts of climate change on forest ecosystems and the forest sector, their vulnerability and their capacity to adapt. During this first

meeting the 15 participants prepared a draft work plan to prepare the report until the end of 2008.

7. Marie Curie 2008 Training Course on the Human Dimension of Global Environmental Change: Participation in Earth System Governance organised by Environmental Policy Research Centre of the Freie Universität Berlin, 18–27 February 2008.
8. Long-Term Policies: Governing Social-Ecological Change 2008 Berlin Conference on the Human Dimensions of Global Environmental Change International Conference of the Social-Ecological Research Programme, Berlin, 22–23 February 2008. Presentation of a paper, ‘Climate Change, Governance, and the Role of Science and Research: The TroFCCA Project Approach’, in the panel Knowledge–Science–Policy Interfaces.
9. IUFRO Expert Panel Meeting in Rome, Italy, 14–17 May 2008.
10. Organisation of a workshop on local governance with actors from macro, meso, and micro levels in Gaoua, Burkina Faso, 7 June 2008. See full report at http://www.cifor.cgiar.org/trofcca/africa/docs/De_Gaoua_FINAL.pdf.
11. Organisation of a workshop at meso level in Goundam, on vulnerability indicators and adaptation strategies at the interface with use and management of forest for animal production systems, Mali, 9 August 2008.
12. National Conference on Science, Policy and the Environment, Climate Change: Science and Solutions organised by USA National Council for Science and the Environment, Washington DC, 16–18 January 2008. The conference created a platform for dialogue with leading scientists, policy makers, industry leaders, educators, and many others to develop comprehensive strategies for protecting people and planet from the threat of climate change. A poster was presented during this conference.
13. Burkina Faso: Development futures in the light of climate change (Les perspective du développement face aux changement climatique au Burkina Faso) organised by Tyndall Centre for Climate Change Research and Christian Aid, Ouagadougou, Burkina Faso, 10–11 April 2008. The workshop projected future development scenarios under present and future climate change impacts by national government officials, NGOs and researchers. The Meteorological Office, CIFOR, Christian Aid, and the Ministry of Economy and finance gave one presentation each. A presentation was made from the project on the state of policy on forest ecosystem sectors and climate change adaptation. See full report at http://www.tyndall-podcasts.com/workshops2008/burkina_faso/kalame_english.pdf
14. West African regional workshop on adaptation to climate change organised by International Institute for Environment and Development and capacity strengthening in least developed countries on Adaptation to Climate Change programme, Dakar, Senegal, 13–15 April 2008. The conference aimed at identifying and facilitating networking of key individuals from civil society on the issue of adaptation in West Africa, and also to brainstorm, network, and plan a route map to promote adaptation in West African countries.
15. Workshop on the promotion of dialogue on the formation of a common body for sustainable forest management in West Africa, Conakry, Guinea, 12–23 November

2007. The workshop aimed at contributing to the ongoing regional discussion on the formation of a regional body for the sustainable management of forest resources.
16. Workshop on ‘Vulnerability, Adaptation and Livelihoods: Enhancing Capacity to Mainstream Climate Change’, organised by CARE International and IISD, Accra, Ghana, 26–29 November 2007. The work aimed at enhancing capacity to integrate climate change into various development activities.
 17. Workshop on forest law compliance, governance and trade in West Africa, organised by Food and Agriculture Organisation and International Tropical Timber Organization, Accra, Ghana, 15–17 July 2008. The workshop aimed at improving forest law compliance and governance in tropical West Africa, which was seen as an important entry point for adaptation to climate change at sub regional level.
 18. Gender and climate change adaptation training workshop, organised by the IDRC, Dakar, Senegal, 17–24 February 2008. The overall objective was to provide participants with an understanding of how to mainstream gender in climate change adaptation projects.
 19. Forum on Readiness for REDD Workshop, organised by the Wood Holes Institute, Accra, Ghana, 19–20, August 2008. The objective of this meeting was to discuss steps needed to move the reducing emissions from deforestation and degradation readiness process forwards on a global scale.
 20. African group preparatory meeting prior to the 3rd Session of the ad hoc working group on long-term cooperation actions under the UNFCCC, 18 August 2008.
 21. PRECIS workshop, Reading University, UK 11–15 August 2008.

Graduate Student Research

During the reporting period, five recipients of TroFCCA graduate fellowships graduated with good grades. One student from the 2006/2007 award continued to an MPhil degree, while three more students are currently on TroFCCA award for the 2007/2008 academic year. Table 2 shows the fellowship recipients for 2006/2007 and 2007/2008 by sectors and affiliated universities. The project also hosted four students as interns. (See Annex 9 for summaries of the research).

Table 2. Students under the TroFCCA West Africa graduate fellowship programme

Name	Country	Academic Year	Programme Institution	Thesis Title
Kabore Pauline	Burkina Faso	2006–2007	MSc University of Ouagadougou	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)
Medah Moise	Burkina Faso	2006–2007	MSc University of Ouagadougou	Impact de la gestion forestiere par les organisations locales sur la dynamique de la vegetation ligneuse dans le contexte des changements climatiques: Cas du chantier d'aménagement forestier de Bongnounou au Burkina Faso
Sidiki Boire	Mali	2006–2007	MSc University of Bamako	Vulnérabilité des ressources en eau aux impacts des changements climatiques dans le bassin versant du Bani à Doun
Chantal Sessi Vivena	Benin	2006–2007	MSc University Abomey-Calavi, Benin	Dynamique de l'occupation du sol, vulnérabilité des formations forestières ligneuses et changement climatiques au Burkina Faso
Benjamin Gyampoh	Ghana	2006–2008	MPhil Nkwame Krumah University of Science & Technology	The effects of climate change and variability on freshwater and livelihoods from the Owabi watershed in Ghana
Stephen Lartey	Ghana	2007–2008	MSc Nkwame Krumah University of Science & Technology	Vulnerability assessment of climate change impacts on the production and utilisation of fuel wood in Ghana
Sawadogo Boukary	Burkina Faso	2007–2008	MSc University of Ouagadougou	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)
Kologo Oumarou	Burkina Faso	2007–2008	MSc University of Ouagadougou	Le Karité (<i>Vittelaria Paradoxa</i> Gaertn.) et sécurité alimentaire: vulnérabilité face au changement climatique dans la Bougouriba au Burkina Faso

7.1.4 Partners and Collaboration with Other Institutions

TroFCCA in West Africa is involved in collaborations at the local, national, and regional levels with various institutions, NGOs etc. These include the following.

Regional Initiatives

- ECOWAS is developing a climate change adaptation policy for the region, which will soon be ratified by the conference of head of states. This organisation has the mandate to develop water policy as well as to facilitate and enforce compliance. Water and water-catchment management are important for climate change adaptation and food security, especially in a region that experiences extreme climate variability.
- Comité permanent Inter Etats de Lutte contre la Secheresse dans le Sahel (CILSS) is a regional institution that assists countries in the Sahel in the adaptation to, and combat of, drought and desertification. It directly deals with policy, but has established Centre Regional de Formation et d'Application en Agrométéorologie et Hydrologie Opérationnelle (AGRHYMET) as its research arm. CILSS and TroFCCA plan to explore synergy between the ongoing CILSS activities of combating drought and desertification under the United Nations Convention to Combat Desertification and TroFCCA's climate change adaptation activities.

In addition to the above, a wide range of organisations from different levels will provide specific inputs for the research. These include the following.

National Institutions

- Ghana EPA
- Forestry Research Institute of Ghana
- Kwame Nkrumah University of Science, Kumasi, Ghana
- Université de Ouagadougou, department de sociologie, Burkina Faso
- Centre Nationale de la Reserche Scientifique et Tecnologie, Ouagadougou, Burkina Faso
- SP-CONEDD, Ougadougou, Burkina Faso
- Conseil National pour l'Environnement et le Développement Durable, Burkina Faso
- Centre Nationale de la Reserche Scientifique et Tecnologie, Bamako, Mali
- Ministre d'Environement, Bamako, Mali
- European Union, Bamako, Mali
- German Technical Assitance (GTZ) Bamako, Mali
- Inter Cooperation, Delegation IC au Sahel, Bamako, Mali
- Secrétaire Technique Permanent (STP/CIGQE), Bamako, Mali
- Direction Nationale De La Conservation De La Nature (DNCN), Mali
- VSF-CICDA : Coordinateur National Mali
- Cercle de Goundam, Président de Conseil de Cercle , Goundam, Mali
- IUCN Bamako Mali, working in climate change adaptation in Mali

Collaborations on climate change projections (PRECIS)

- Institut de l'Environnement et de Recherche Agricole, Burkina Faso
- Meteorological department, Burkina Faso
- Meteorological department, Ghana
- Meteorological department, Mali
- African Centre for Meteorology in Development (ACMAD), Niamey, Niger
- Hadley Centre, UK

7.1.5 Project Activities Planned for Implementation in Year 4

1. Complete the economic analysis of the Modified Taungya System in the transition zone of Ghana. This is linked to project activities on development and recommendation of planned adaptation strategies. The expected outputs are a report on cost-benefit analysis of the Modified Taungya System. Corresponding project output will include recommendation of planned adaptation strategies for mainstreaming.
2. Undertake the study on historical baselines of community perceptions, coping strategies and adaptive capacity to climate change vulnerability, 'Options for Planning Future Adaptation and Enhancing Adaptive Capacity', is linked to project activities 3.1, 3.2 4.1, 4.2 and 4.3 of the log frame. The study objectives are to
 - a. understand changes in the flow cycle of forest ecosystems resources, including past shocks and their driving factors;
 - b. understand and highlight local perceptions on climate change impact on ecosystem resources and their impact on rural livelihoods;
 - c. investigate indigenous coping mechanisms and knowledge base of communities;
 - d. explore innovative opportunities and mechanisms for building resilience and adaptive capacity of communities; and
 - e. involve national partners in Burkina Faso and Mali in testing vulnerability assessment methodologies.
3. Establish baselines for projecting climate scenarios across scales.
4. Elucidate the mechanism for policy formulation, implementation, and enforcement.
5. Simplify scientific information for communication with policy.
6. Synthesise all reports produced in the region.
7. Undertake vulnerability mapping for Burkina Faso and Mali.
8. Plan regional conference on action and knowledge for forest and climate change adaptation in Africa (see Annex).
9. Participatory development and recommendation of planned adaptation strategies by government to climate hazards (continuation of activity 8 of the log frame).
10. Prepare scientific papers and project reports.

7.2 Central America

7.2.1 Introduction

Section 7.2 reports activities and progress made by TroFCCA in Central America during the period from August 2007 to August 2008. In Central America, TroFCCA looks at the relevance of forest ecosystems as providers of goods and ecosystems services through meta-analysis and studies at 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 studies involve Birris hydroelectric watershed in Costa Rica, Guacerique and Grande de San José drinking water watershed, and Apanas and Asturias Lakes hydroelectric watershed.

In Central America, climate change and climate variability are expected to have an impact on several socio-economic sectors. Water resources are not escaping the effects of these impacts. The vulnerability of the population and the dependent sectors on water sources for their sustainability depends on the sensitivity 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 to ecosystem services is relevant for designing adaptation policies and strategies.

The strategy for project implementation in Nicaragua (i.e., hydroelectric sector) included the participation of graduate students in investigations under the supervision of scientific advisors working in CATIE and other institutions of higher education. In Honduras, consultants are hired for specific studies in highly specialised subjects (i.e., drinking water sector). In Costa Rica students, institutes, and consultants undertake the investigations (i.e., hydroelectric sector).

In the case of Nicaragua, three MSc graduate students from CATIE were in charge of conducting studies to identify tropical forests that provide ecosystem services to the hydropower and drinking water sectors, for adaptation policies. A similar approach was used in Honduras, where two consultants conducted research under a collaboration agreement between TroFCCA and the National Service of Drinking Water (SANAA).

The products generated by TroFCCA C.A. during this period are varied. For our purposes, we consider the following products: theses finalised by MSc or PhD students; reports from consultancies; and articles that have been either submitted or accepted in regional or international journals. When appropriate, these products have been uploaded to the TroFCCA website. An effort was made to provide a summary of each of the products available during this reporting period.

7.2.2 Implementation of Project Activities

During the reporting period, TroFCCA conducted research in two ways. First, it is important for the project to achieve better understanding of the relationship between forest and water. Thus an exhaustive analysis of the existing literature on the relationship between forest and hydrological ecosystem services was conducted applying a

methodological approach leading to a meta-analysis. Second, another study was conducted through a consultant to better understand the electric sector with an emphasis on hydroelectric power generation and the opportunities for TroFCCA. An article was authored to provide a better understanding of the vulnerability of forests to climate change and potential adaptive management.

TroFCCA C.A. also made progress in conducting research in the following three lines of action.

- i) Identify forest ecosystems that are important for the drinking water and hydroelectric power sectors, test methodologies for identification of forest ecosystem that provide services to hydroelectric power and drinking water sectors, and contribute to climate change adaptation in the corresponding sectors.
- ii) To determine the vulnerability of forest ecosystems to climate change, the focus was on two areas of research: a) understanding potential ecological shifts that may affect competitiveness of the timber industry; and b) studying the dynamics of insect pest outbreaks and forest fires under varying climate parameters and host conditions.
- iii) The third line of action for TroFCCA C.A. is ‘strengthening participation of society in adaptation’. This aims at performing a series of studies to better understand the underlying mechanisms to involve society into adaptation activities. The strategy TroFCCA uses in implementing research in the region includes selecting case studies, meticulous policy network analysis in selected socio-economic 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.

There are studies being conducted to better understand the vulnerability adaptation of forest to climate change, through either shifts in ecological conditions or disturbances such as forest fires, and to evaluate adaptation options for protecting hydrological services for hydropower production and the threat to hydrological ecosystems services (see summaries of studies in Annex 10).

7.2.3 Communication and Outreach

Participation in Conferences and Workshops

Pablo Imbach, Luis Molina, and Raffaele Vignola participated at the world conference on Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health: A Review of Science, Policies and Practices, 23–29 August 2008, Umeå, Sweden. They made the following presentations of different studies:

1. Session 2: Climate induced changes in forest ecosystems: ‘A Conceptual Model for Studying the Effects of Landscape Connectivity on Ecosystem Adaptation to Climate Change in Central America’ (B. Locatelli and P. Imbach).

2. Session 3: Impacts of altered regimes of extreme abiotics events: ‘The Future of Forest Fires in Central America under Climate Change and Socio-Economic Scenarios’ (B. Locatelli, P. Imbach, L. Molina, E. Palacio).
3. Session 7: Biodiversity, conservation and protective functions of the forest: ‘Impacts of Climate Change on Hydrological Ecosystem Functions in Mesoamerica’ (P. Imbach, B. Locatelli, and L. Molina)
4. Session 11: Tropical forest and climate change adaptation: ‘Present Advances of Policy Research on Adaptation and Tropical Forests’ (R. Vignola).

The conference provided an update of the available scientific information at global level on the subject of forests adaptation. On the subject area of adaptation and ecosystem services, the approach of TroFCCA is properly aligned with other international activities and, in many cases, it surpasses them in the sense that it is better adapted to tropical countries and it goes beyond impact studies.

Saborío and also Vignola and Imbach participated in the First National Congress: Integral Environmental Management ‘Challenges and Opportunities of the Environmental Sustainability in Costa Rica’, 12–14 February 2008, University of Costa Rica, organised by the Institutional Program of Integral Environmental Management. The congress had thematic emphasis on environmental issues associated with the impact of climate change and the ways to sustainably address it in the future. The aim of TroFCCA’s participation was to acquire background information and elements that are critical for mainstreaming adaptive forest management into the climate change adaptation policies.

Vignola participated in the Annual Encounter of the Climate Decision-Making Center of Carnegie Mellon University of Pittsburgh, Pennsylvania, United States of America, 18–23 May 2008. The theme of the event was the development of investigations in energy thematic, the impacts of climate change and the decision-making under uncertainties that characterise those hazards. The event was of particular interest because TroFCCA’s general goal is to integrate climate change adaptation into development policies in the countries of intervention. This goal requires an understanding of the thematic policy to effectively achieve this aim, and also to develop a methodology that could eventually be used for adaptation to climate change in other areas of interest.

Saborío represented TroFCCA C.A. at the VII Pan-American Congress FEPAC-2008, Energy vs Environmental, Santiago, Chile, 19–21 May 2008. The aim of TroFCCA’s participation was to acquire background information and elements that are critical for mainstreaming adaptive energy management into the climate change adaptation policies. This was relevant to the investigation in Honduras related to the hydroelectric sector and climate change and to the introduction of adaptation to the ecosystem forest. The event demonstrated the importance of taking climatic change into account for energy projects with emphasis on renewable energy, and specifically the hydro sector.

Vignola participated in a discussion with his project committee, from 31 May to 7 June 2008, in Zurich, Switzerland. The discussion focused on the draft of an article for peer review, which takes into account the objectives of TroFCCA. The article centres on the role of risk perception, social norms and knowledge in decision-making regarding soil management of producers located in the high parts of the watersheds. In those areas,

hydrological services will be affected by climate change. It was also decided to evaluate decisions around the participation in programmes of watershed conservation like adaptive answers to climate change. During that period, Vignola participated in a workshop on the use of the techniques for life-cycle assessment (LCA) and their application to the water sector. Those techniques until now have been used only to identify environmental efficiencies of industrial production. In the workshop, the idea of application to hydrologic resources came up. Nestle, a private company, and the World Business Council for Sustainable Development presented the use of LCA application to water. Some nutritional product distributors in Europe are beginning to be interested in the certification of efficient use of natural resources in countries outside Europe. That could be of particular interest to areas where the efficiency of use of the hydrologic resource agrees with the expected norms that diminish an area's vulnerability to climate change.

Saborío and Vignola participated in an Asociación Regional de Empresas de Petróleo y Gas Natural en Latinoamérica y el Caribe seminar promoted by the Environment and Energy Ministry and the Costa Rican petroleum refiner Recope, 16–17 July 2008, in San José, Costa Rica. The intention was to analyse different governmental strategies by the countries of Latin America in responding to the challenge of climate change.

Imbach participated in the course 'Analysis of Uncertainty in Ecosystem Modeling', 30 June–7 July 2008, in Aberdeen. The course presented diverse techniques and applications for the calibration of models, as well as for the estimation and reduction of uncertainty in the use of ecosystemic models.

Imbach participated in a 'Short Course on Geostatistical Analysis for Environmental Data', 10–16 August 2008, in Gainesville, Florida. The course was particularly useful for climatic variability modelling and prepared the user in techniques of downscaling, to assure better compression from a specific locality.

Graduate Student Research

Several graduate students undertook research with TroFCCA in Central America (Table 3).

Table 3. Students conducting research under the TroFCCA C.A. graduate fellowship programme

Name	Activities during 2007–2008	Comments
MSc Manuel Calderon	Conducted research in Honduras on determinants of socioeconomic aspects of societies' adaptation	MSc degree in CATIE
MSc Angela Díaz	Conducted research in Honduras on determinants of societies' adaptation	MSc degree in CATIE
Tatiana Espinoza	Analysis of the change of soil use and proposed alternatives of adaptation under climate change in the watershed of Apanás, Nicaragua	Exchange student from Polytechnic Madrid University
MSc Alexander Hernández	Conducted research in Honduras to identify forest ecosystem relevance for drinking water sectors	PhD Student of Utah University
Efraín Leguía	Evaluated the impact climate change will have on the potential distribution of teak plantations in Central America	MSc degree student in CATIE; finalised in March 2008
Luisa Madrigal	Conducted research about the hydrologic forest function in framework of adaptation to climate change in Nicaragua	Exchange student from Polytechnic Madrid University finalised the field job. Final report in progress.
Elena Palacios	Forest fires and climate change in Central America	Exchange student from Polytechnic Madrid University, finalised in May 2008
Michel Saini	Resilience and alternatives of adaptation in the socio-ecological system of the hydroelectric plant Center America, Nicaragua	MSc degree student in CATIE, final graduation project in process

7.2.4 Partners and Collaboration with Other Institutions

Collaboration between TroFCCA and IUCN to improve a payment for ecosystem services system in the hydro energy sector of Costa Rica

Hydropower represents almost 80% of Costa Rica's energy source. This type of energy production depends strongly on the hydrological dynamics in the watersheds. In this respect the most relevant environmental pressures occurring upstream are climate change and land use. Indeed, observed and projected climate change in the region identifies increasing occurrence of precipitation extremes and also the amount of rainfall per event.

This hydrological dynamic, combined with land use change and land management practices in upstream landscapes, determines the level of current land degradation. According to this, TroFCCA, in collaboration with the National Institute for Hydroelectricity (ICE), identified a case study of relevance, the Birris sub-watershed in the Reventazon watershed. 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 the demand (e.g., from downstream hydropower plants) and the 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, current land management practices, and several policy dialogue meetings with stakeholders. Although activities have started during the first semester and the first part, Biophysical Studies, was finalised in the first trimester of 2008, most of the results will be coming out during the first trimester of 2009. TroFCCA assigned the coordination of this study to Raffaele Vignola.

Workshop organised jointly by TroFCCA and SANAA, in Tegucigalpa, Honduras, 18–21 February 2008

The main objectives of this workshop were to present TroFCCA's results in Honduras and perform with participants an analysis of the relevance of the findings. The objectives were: i) revision of research of the impact of climate change on the ecosystems of the watershed Guacerique and Rio Grande, hydrological systems that supply potable water to Tegucigalpa; ii) to present TroFCCA research activities in the following areas: a) digital characterisation of the different soils used; b) present and future hydrologic balance considering climate change; c) a laminar erosion analysis that takes in account climate change; d) a model of susceptibility of sliding will be complemented with information of active sliding by SANAA; e) maps of sensitivity of water quality in communities located in different sectors of the river basin; and f) hydrologic modelling to determine sediment transport, with the corresponding measures to reduce sediments.

Workshop on Adaptation to Climate Change in the Hydroelectric, Water and Agricultural Sectors, Nicaragua, 7 April 2008

Participants in this workshop were representing the National Office for Clean Development Mechanism and Climate Change (ONDL), National Institute for Hydroelectricity, National Institute of Territorial Studies (INETER), National Audobon Society, National Institute of Information of Development, and National Commission of Drinking Water and Sanitary Sewage System. Seven presentations related to the proposed investigations for the hydroelectric power and drinking water sectors in Apanás and Lake Asturias watershed, Nicaragua, were made from the TroFCCA project. The presentations were: i) erosion model applying Calsite vis-à-vis climate change (J. Saborío); ii) management of scenarios of climate change (P. Imbach); iii) biophysical and adaptive study: case of Birris, Costa Rica (R. Vignola); iv) potential of soil conservation in watershed related to climate change (L. Madrigal); v) alternatives of adaptation under

climate change (T. Espinoza); vi) evaluation of adaptive capacity of the hydroelectric sector vis-à-vis climate change (M. Saini); and vii) preparation and content of the III National Communication to the UNFCCC by Dr. Freddy Picado from ONDL.

For the TroFCCA project it was important to hear the comments of representatives of ONDL and the different institutions involved. For the work conducted by Espinoza, Madrigal, and Saini comments were positive and of high value for a socio-economic sector highly prioritised by the Nicaraguan government. The conclusion was that the work on identification of forest ecosystems and adaptation strategies is relevant for the hydroelectric sector, could become part of the adaptation strategy of the sector, and should be part of the II National Communication to the UNFCCC before March 2009, when the document is due.

It is relevant to mention that the government of Costa Rica is relatively more advanced in policies towards climate change mitigation and adaptation, which is reflected in the national development plans. National Meteorological Institute (NMI), IUCN, and ICE have become major partners of TroFCCA in this country.

Meeting with ICE, Planta Los Lotes in Tres Ríos, Cartago, Costa Rica, 4 August 2008

This meeting had two major objectives: i) to inform ICE staff of the work TroFCCA is doing on tropical forests and climate change adaptation, and the relevance of ecosystem services provided by forests to the hydroelectric sector in Central America; ii) contribution of TroFCCA to the design of a payment for ecosystem services scheme in Reventazon watershed involving various soil uses and various actors (CATIE, TroFCCA, ICE, and UMCRE); and iii) identification of management of the risks and impacts generated by climate change to obtain adaptation and mitigation of its effects on the hydroelectric power sector.

The work performed by TroFCCA in Costa Rica was welcomed by most participants that work in the hydrology department at ICE, Commission for Management of the Reventazón Watershed, administrative board of the Electric Services of Cartago (JASEC), and Forest Model from National Ministry of Environmental and Energy. For the representatives of ICE and JASEC, the studies presented, particularly the methodology, are quite relevant because the institutions will be in charge of assigning financial resources for forest ecosystem management under a of payment for ecosystem services scheme. A water tax will soon be implemented in Costa Rica and a study like the one presented by TroFCCA is quite relevant.

Second workshop organised jointly by TroFCCA and SANAA, Tegucigalpa, Honduras, 4–6 August 2008

In this workshop, the TroFCCA team presented its research activities on adaptation to climate change. This included the exploration of financial mechanisms to execute the plans of action to implement management of the hydrological ecosystem (stakeholders, institutions, forest, soil, and water). These mechanisms may include schemes for payment for ecosystem services, preparation of a proposal for the Global Environmental Facility

(GEF), and allocation of part of the funds given to the government of Honduras for management and reforestation.

It was also important that the 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 February 2009.

Workshop on climate change organised jointly by TroFCCA C.A., Regional Committee of Hydraulic Resources (CRRH/SICA), National Meteorological Service of Mexico and the Mexican Commission for the Mesoamerican Cooperation, at CATIE, Costa Rica, 1–5 September 2008

CRRH/SICA invited workshop participants representing NMI Costa Rica, CCRH, Geophysical Research Center of the University of Costa Rica, National Meteorological and Vulcanologic Institute from Guatemala, National Meteorological Institute/Ministry of Environmental and Natural Resources of El Salvador, National Office of Climate Change and Meteorological Service National from Honduras, INETER of Nicaragua, Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC), Environmental National Authority (ANAM), Company of Electrical Transmission of Panama, National Meteorological Service, and the National Autonomous University of Mexico. The general objectives were: i) review of developed climatic scenarios in the region; ii) comparative analysis of the results; and iii) fortification of regional and national capacity to apply techniques of reduction of scale in climate change models. The specific objectives were to identify convergences and divergences in the obtained estimations of climate change with different methodologies and to produce an orientation document for the people in charge of development of the National Strategies Regional on climate change. Various participants made several presentations including ones on the generation of regional scenarios of climate change using the climate predictability tool and on dynamic reduction with model MM5 and its application in the generation of climatic scenarios in Central America and other parts.

TroFCCA contributes to mainstreaming climate change adaptation in regional agenda

The Central American Commission on Environment and Development (CCAD) invited CATIE to join the Caribbean Community Climate Change Center and CATHALAC to form an initiative to design and implement a regional strategy for climate change (ERCC in Spanish). The definition of 'ERCC' includes different sectors: academic, institutional, associations, civil societies, enterprises, financial, and the corresponding links between agricultural sector, environment, socio-economic sector, health, and climate change. The proposal must include information compiled from the different sectors, which would be undertaken by the Pan-American Agricultural School, Federation of Municipalities of the Central American Isthmus, Coordinating Indigenous and Farmer Association Community on Agroforestry in Central America, SICA, CCAD, and the business school INCAE. TroFCCA will continue to support this effort and contribute to the design of the ERCC, which will include climate change and climate variability at the highest level in the region.

7.2.5 Project Activities Planned for Implementation in Year 4

In Central America, TroFCCA's research programme and validation of methodologies will be consolidated during the fourth year, because several results and products will be achieved during the period of July 2008 through 31 August 2009. Additionally, the collaboration with national partners to integrate results into the national communications to the UNFCCC and other policies will intensify. TroFCCA is also expected to 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 initiatives have either started in year 3 and continue or will begin during year 4:

- A study of the potential impacts of climate change on drinking water supplies by two watersheds that contribute to the Tegucigalpa-Comayagüela communities, Honduras, Central America. This will involve an assessment of the biophysical roles of hydrological ecosystem services under current and future climate change scenarios for water supply to the Tegucigalpa-Comayagüela communities in the Rio Grande and Rio Guacerique watersheds.
- A socioeconomic analysis of ecosystem management as adaptation strategies to climate change in the Tegucigalpa-Comayagüela watersheds. This study is oriented towards the potential impact of climate change on the drinking water supply by two watersheds that contribute to the Tegucigalpa-Comayagüela communities. The objectives of the study include the economic and financial valuation of climate change; adaptive management alternatives; and to propose a strategy for adaptation to the changes of the hydrologic ecosystem services (SHE in Spanish), in two sub-river basins in the Tegucigalpa-Comayagüela watersheds in Honduras, Central America.
- A study in Nicaragua that includes 'analysis of the erosion and the potential conservation of soil in the river basin of the lake of Apanás. This is to investigate the parameters of land use cover and soils, taking into account the climate change risks. The study will be complemented with an assessment of the biophysical role of hydrological ecosystem services under current and future climate scenarios for energy supply.
- Strategies for adaptation of agricultural producers as response to climate change: economic incentives and handling of risk in the Apanás river basin. This study will analyse the main determinants of land and cover use and value the costs associated with the implementation of soil management practices, with the purpose of increasing the reduction of sediments, an ecosystem service that benefits hydroelectric plants in Central America.
- A study to evaluate the adaptation capacity of the hydroelectric sector in Nicaragua to climate change by looking at the role of hydrological ecosystem services and investigating their value.
- Response by society to changes in ecosystem services. As stated above TroFCCA C.A. has conducted the study entitled 'Determinants of Social Decisions for Landscape Management and Adaptive Response to Changes in the Provision of

Hydrological Ecosystem Services in Costa Rica' since January 2007 in the Birris watershed. Results are expected by the second trimester of 2009.

- A complementary study on quantifying investment cost of alternative landscapes for adapting to climate change includes identification of costs and benefits of alternative landscapes for adapting to climate change: identify the costs of a) losing soil or b) implementing alternative land use decisions in the Birris watershed, Costa Rica. Results are expected by the second trimester of 2009.
- Analysis of adaptive capacity in national policy networks. The objective of this study is to identify perception and response options in relevant policy actors for designing adaptation strategies to climate change. That includes: a) characterise perceptions of climate change relevant to hydrological ecosystem services; b) characterise perceived weaknesses and obstacles relevant to designing an adaptation strategy; c) identify reputation and information flow in networks; and d) analyse the network structure and relations relevant to designing adaptation strategies.
- Evaluating the impacts of climate change on ecosystem functions of providing hydrological services in the Mesoamerican region by modelling the actual and future distributions of functions and services. This activity started in January 2007 and is expected to continue until the second trimester of 2009.
- A study that investigates the impacts of climate change on biodiversity across scales in Costa Rica. This consists of exploring the impacts of climate change on Costa Rica's biodiversity at the ecosystem at species scale and policy implications thereof. The focus areas are a) developing climatic change scenarios for Costa Rica's Holdridge life zones and current vulnerabilities of the national protected areas system; and b) assessing the impact of climate change on an indicator species, the dung beetles along an altitudinal belt.
- Collaboration between TroFCCA and IUCN to improve the adaptation strategy in climate change for Central America and collaborate with training courses in adaptation and risk analysis associated with climate change.

As outreach activities, TroFCCA C.A. will participate in CoP15 to be organised in Copenhagen, in December 2009; hire a consultant, Dr. Carlos Brenes, to support the climatic strategy of CATIE in union with CCAD or other organisations in the region. Other outreach activities will be organised with the offices of climate change in the countries in which TroFCCA is working in the region. Additionally, TroFCCA will disseminate results by participating in seminars, workshops, and conventions organised at the national, regional, and international levels.

By the end of year 4, TroFCCA C.A. will have reached 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.

7.3 South East Asia

7.3.1 Introduction

In South East Asia TroFCCA is being implemented in Indonesia and the Philippines. It focuses its activities on the countries' development needs and priorities. TroFCCA in Indonesia works on forest and land fires, and landslides. These two topic areas are important development threats to the forest and to people living around the forest in Indonesia. 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, livestock raising, fisheries and recreation, and becoming more susceptible to water related extreme weather disasters such as floods, droughts, and typhoons.

The main activity during the third year of TroFCCA in South East Asia was the development of a methodology for vulnerability assessment. This included

- development of a vulnerability assessment concept,
- development of criteria and indicators of vulnerability for the related development sectors,
- development of a 'tool box' for vulnerability assessment,
- identification of adaptation strategies, and
- development of climate scenarios.

In addition, TroFCCA in South East Asia was involved in activities to mainstream adaptation into the national agenda/policy and in the preparation of the Second National Communication (SNC) for Indonesia.

7.3.2 Implementation of Project Activities

Development of a vulnerability assessment concept. The concept of vulnerability to climate change assessment in the forest sector is to systematically assess the causes of the complex environment-human system vulnerability. The concept, which was developed through review of literature and group discussions, is documented as a section in *Facing an Uncertain Future: How Forests and People Can Adapt*, available at http://www.cifor.cgiar.org/publications/pdf_files/media/CIFOR_adaptation.pdf.

Development of criteria and indicators of vulnerability. Criteria and indicators (C&I) are used to qualitatively or semi-quantitatively assess the vulnerability to climate change (or climate variability) of a development sector. It is part of the project output on the methodology for vulnerability assessment. The conceptual approach for the development of these C&I adapted CIFOR's approach to Sustainable Forest Management, and has been developed for cases of forest and land fires in Indonesia. There are ongoing activities for the development (see section 7.3.3 for application of the developed C&I concept for vulnerability assessment by WWF Indonesia). A poster showing the C&I concept was presented during the CIFOR 2008 annual meeting. The document is available at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

Development of a 'tool box'. The 'tool box' contains sets of tools and methods for vulnerability assessment of TroFCCA development sectors. It is developed by collecting and reviewing tools used for assessing the vulnerability to climate change of each development sector. This work is in progress and is expected to be published in 2009. There is a draft of guidance for generating climate scenarios completed in 2008.

Identification of adaptation strategies. Adaptation strategies are ultimately being developed in response to the results of vulnerability assessments. However, there exist some adaptation strategies based on good practices and good traditional knowledge, which reflect the adaptive capacity of the communities and forest management units. The good practices and local knowledge for the case of land and forest fires in Indonesia are currently being identified through a literature study. Outputs from this activity, including adaptation strategies for the case of landslides, will contribute to a synthesis report on response options to be published in August 2009.

Development of climate scenarios. TroFCCA South East Asia runs a climate change scenario simulation for the region using the regional climate model PRECIS in Bogor. Projected climate scenarios have been produced using the B2 low emission scenario and the boundary data taken from the AOGCM HadCM3 (UK Hadley Meteorological Office). TroFCCA is part of the South East Asia network of PRECIS users. PRECIS data are shared with network members. TroFCCA South East Asia identified potential extreme events in relation to forest and land fires, landslides, and water management. Some of the output data will be made available online through the website in late 2008.

Mainstreaming adaptation into national agenda/policy and Second National Communications (SNCs). TroFCCA South East Asia conducted activities to enable mainstreaming adaptation into the national development agenda or policies through awareness raising in national conferences, workshops, dialogues, and engagements in national adaptation initiatives.

TroFCCA staff in Indonesia are part of the Working Group on Adaptation under the coordination of the Ministry of Environment and also regularly involved in the Working Group on Adaptation coordinated under the newly established National Climate Change Council. TroFCCA staff in Indonesia also contributed to the development of the National Action Plan Addressing Climate Change published by the State Ministry of Environment, the Republic of Indonesia, which was launched during UNFCCC CoP13 in Bali, Indonesia. (See also section 7.3.3.) TroFCCA staff are also part of the team preparing Indonesia's SNC under the coordination of the Ministry of Environment, although currently the process for the preparation of the SNC is stalled.

TroFCCA staff in the Philippines are part of the Technical Working Group of the Philippine Senate Committee on Environment and Natural Resources that is responsible for the refinement of a bill proposing the creation of a national commission and framework programme for climate change adaptation. TroFCCA Philippines staff also contributed to the drafting of the Medium Term Philippine Development Plan and are part of the team preparing the Philippines' SNC.

Consultancy/National Contractors

The following activities have been outsourced through consultancies and student research fellowships.

- i) Climate change and fire risks in Indonesia: the development of mathematical function of correlations between climate variables and fire risks (in partnership with the National Institute of Aeronautics and Space)

The research objective is to identify the mathematical correlation between climate parameters, which are normally generated by dynamic regional climate models, and the fire risk parameter or an index such as number of hotspots. The finding is used as a tool to spatially map the potential fire risk area based on recent and projected climate data, and it contributes to the tool box and the vulnerability assessment (assessment of the link between climate change and related ecosystem goods and services). Important findings are: a) climate is an important determinant of fire occurrence, but there are many other determinants; b) the role of climatic determinant is important at a large scale (countrywide), but less important at a small scale (district or local); c) fire prevention is more important at the local level, for which non-climatic determinants should be considered. A summary of the findings was presented in session 13 of the 2008 International Conference on Adaptation of Forest in Umeå, Sweden (see section 7.3.3). Abstract and summary of the report are provided in the Annex. The report is available at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

- ii) Impact of climate change on landslide susceptibility in West Java Province: case study of Bukit Sentul area, district of Bogor (in partnership with the Research Centre for Geotechnology, Indonesian Institute of Sciences)

The research objective is to increase understanding of the role of climate change in landslide behaviour through a computer simulation of an area at a landscape level, in particular to identify whether climate change will cause an expansion, shift or reduction of the area at risk for landslides in specific time frames. Landslide risk maps are produced at a sub-district or district level (smallest government-coordinated disaster mitigation unit). Important findings are: a) climate change affects the landslide risk zone distribution and the risk levels; b) climate change affects the landslide mechanism to a certain precipitation threshold, and beyond this threshold climate has no effect on landslide behaviour; and c) deep landslides are more sensitive to climate change than shallow ones. These findings were presented in session 7 at the 2008 International Conference on Adaptation of Forest in Umeå, Sweden (see section 7.3.3). Abstract and summary of the report are provided in the Annex. The report is available at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

- iii) Study on Indonesian laws concerning land and forest fires (in partnership with the Indonesian Centre for Environmental Law)

Policies and regulations to prevent and control forest and land fires are part of adaptation strategies to cope with the possibly increased risks of fires under future climatic condition. The research objectives are to identify the causes of weak current law enforcement, and solutions to enhance it; to identify legal problems related to the underlying causes of fires; and to provide solutions to enhance the adaptive capacity through policy instruments. The important findings are:

- The need to re-plan and re-inventory the status of land and forest in Indonesia to prevent the occurrence of deserted (abandoned) land resulting from unclear licensing of land or forest utilisation, especially for peat land, which is often misused.
- The need to tidy up administrative systems such as Environmental Impact Analysis and licensing to bring about a strong control mechanism and supervision in the implementation and utilisation of forest and land.
- The need to revise laws and regulations by using the problem solving method, considering that the current handling of forest and land fires uses the reactive approach and fails to address the problems faced by the public.
- The need to provide incentive and public assistance as soon as possible to stop the community from burning the land.
- The need to reduce the bureaucratic chain of the prevailing law enforcement system, e.g. create a one-roof law enforcement system.

The report is available at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

- iv) The role of trees outside forest in anchoring soil and reducing landslide risk during high rainfall episodes (in partnership with Brawijaya University and World Agroforestry Centre)

Trees add weight, which may destabilise a slope, but trees can also reduce the occurrence of small landslides (at root depth) and control soil hydrology. The research assessed the role of vegetation in preventing land movement at a plot scale, and projected its effectiveness to larger scales (sub-district or landscape levels). Important findings are:

- The ability of trees to increase slope stability depends on the root anchoring and binding capacities, which are measurable through the root anchoring index (IRA) and root binding index (IRB).
- IRA and IRB are dependent on a tree's age, species, and locality.
- Other factors such as precipitation, slope, soil type, structure, and profile may overcome the roots' role.
- Mixed species having high IRA and high IRB may benefit from combined strength and could change dangerous rapid mass-flow type landslides to less dangerous soil creeping type landslides.

A summary of the findings has been presented in session 7 at the 2008 International Conference on Adaptation of Forest in Umeå, Sweden (see section 7.3.3). Abstract

and summary of the report are provided in Annex 11. The report is available at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

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

The objective of this study is to identify areas for increasing the adaptive capacity to reduce loss caused by landslides from both biophysical (hard) approach and disaster management (soft) approach. It is developed through a literature research, lessons learned and experiences, and results of TroFCCA consultancy studies. This contributes to the development of adaptation strategies in line with the outputs in the third phase of the project. The completion of this activity is expected by the end of 2008. (See Annex 11 for summaries of the projects)

7.3.3 Communication and Outreach

Participation in Conferences and Workshops

TroFCCA South East Asia staff participated in various conferences, seminars, workshops, and meetings. These activities provided venues to introduce the TroFCCA project, and also serve as medium for learning and knowledge sharing and for promoting mainstreaming adaptation into the development. Several important meetings are listed below.

- The International Conference on the Future of Forests in Asia and the Pacific: Outlook for 2020, Chiang Mai, Thailand, 16–18 October 2007

This major international conference was organised by the Asia-Pacific Forestry Commission in response to recent, unprecedented economic and social change in the Asia-Pacific region that has significantly altered the way forests are regarded and used. Diverse stakeholders discussed probable scenarios and their implications for forests and forestry in the region. The main objectives of the conference were to analyse social, economic, institutional, and technological changes in the Asia-Pacific region and their impacts on forests, and to identify potential opportunities and challenges for forestry in the face of changing demands for forest goods and services.

At this event, TroFCCA presented the paper ‘Climate Change Impacts on Tropical Forests, Vulnerability and the Adaptive Capacity: Lessons Learned from TroFCCA Experience’ to the session on forests and environment. The presentation material is available at <http://www.fao.org/forestry/foris/ppt/outlook2020/santoso.pdf>.

- First National Conference on Climate Change Adaptation (NCCCA), Albay, Philippines, 22–24 October 2007

Project proponent ICRAF has been actively involved in some initiatives to mainstream climate change adaptation into sustainable development. This is being

undertaken in coordination with the local government unit of Albay. ICRAF co-sponsored the first and pioneering NCCCA held 22–24 October 2007 at Legazpi City, Albay with the theme ‘Think Global Warming, Act Local Adaptation’. The major output of the conference was the Albay Declaration on Climate Change Adaptation. The Center for Research and Initiatives on Climate Change Adaptation—a joint venture of ICRAF, the provincial government of Albay, and the Department of Environment and Natural Resources–Environmental Management Bureau Region 5—has been established to conduct research, development and extension activities in the province of Albay. For more details visit <http://albaycirca.org/>.

- Community-based fire management training workshop, Balikpapan, East Kalimantan, Indonesia, 28 October–4 November 2007

This training workshop was organised by The Nature Conservancy and the Food and Agricultural Organisation of the United Nations for increasing the capability of participants in communicating ‘good fires’ and ‘bad fires’. Good fires are controlled and planned fires for benefit uses of farming and land management. Bad fires are uncontrolled and unplanned fires that may cause disasters. TroFCCA used this opportunity for gaining a better understanding of use and management of fires by the community as part of the community adaptive capacity.

- 35th Anniversary Symposium of the International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India, 22–24 November 2007

The symposium had the specific theme of climate proofing innovation for poverty reduction and food security. The symposium gathered experts from the 15 international agricultural research centres under the Consultative Group on International Agricultural Research, which presented their research work on climate proofing. TroFCCA presented the paper ‘Using Tropical Forest Ecosystem Goods and Services for Planning Climate Change Adaptation with Implications for Food Security and Poverty Reduction’. The full paper is available online at the Journal of SAT Agricultural Research at <http://www.icrisat.org/Journal/specialproject.htm> (or a direct link to <http://www.icrisat.org/Journal/SpecialProject/sp17.pdf>).

- Indonesian Second National Communication, Jakarta, Indonesia, 29 January 2008

The meeting, organised by the management of the SNC of Indonesia under the Ministry of Environment, explained the management structure and the taskforces responsible for SNC preparation. The SNC is an obligation of parties of the UNFCCC for reporting their national climate change activities. In this occasion, TroFCCA South East Asia addressed its willingness to contribute and high expectation to collaborate with the manager of the SNC in preparing the SNC, especially in regard to adaptation in the forestry sector.

- Living with Climate Change: Are There Limits to Adaptation?, London, UK, 7–8 February 2008

The conference discussed strategies for adapting to climate change, in particular to explore the potential barriers to adaptation that may limit the ability of societies to adapt to climate change and to identify opportunities for overcoming these barriers. It was organised by Tyndall Centre for Climate Change Research, University of East Anglia, UK. Maria Brockhaus from TroFCCA West Africa presented the paper ‘Decentralisation: Window of Opportunity for Successful Adaptation? A Case Study from Burkina Faso’.

- Expert panel meetings on adaptation
 - First meeting, New York, USA, 11–12 February 2008
 - Second meeting, Rome, Italy, 13–15 May 2008
 - Third meeting, Turrialba, Costa Rica, 16–17 September 2008

The expert panel was established by the Joint Collaborative Partnership in Forestry, as a research initiative on documenting the existing science and technology for adaptation of forests to climate change, for it to be an issue of high concern. The initiative set up an Expert Panel on Adaptation to carry out a comprehensive assessment of available scientific information about the adaptation of forests and the forest sector to climate change and to prepare a report for use by the relevant United Nations’ conventions (UNFF, UNFCCC, and UNCBD). TroFCCA participated in the preparation process of the report, which will be published in early 2009.

- International Conference on Biodiversity and Climate Change, Manila, Philippines, 19–20 February 2008

The conference provided a setting for discussing opportunities for adapting to and mitigating climate change while conserving biodiversity in South East Asia. ICRAF Philippines participated and co-sponsored the conference through provision of USD 1,000 from the TroFCCA project. Highlights of the conference are available online at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm

- Strengthening the Role of Civil Society under the ASEAN Cooperation to Mitigate the Trans-Boundary Haze, Pontianak, Indonesia, 21 February 2008

This seminar, organised by the Ministry of Foreign Affairs of Indonesia, aimed at disseminating to the local community information on the role of Association of Southeast Asian Nations cooperation and Indonesian participation in the cultural and environmental sectors in the last 40 years. It also aimed at identifying how the role of civil society could be strengthened under this regional cooperation in order to mitigate transboundary haze. From a rich seminar discussion TroFCCA learned about government capacity to reduce haze by means of policies and field actions and strategies.

- Climate Change Adaptation Programming workshop, Jakarta, Indonesia, 10–12 March 2008

Adaptation initiatives had started in Indonesia and reached highest attention after CoP13 in Bali. The workshop on climate change adaptation programming, hosted by the United Nations Development Program–Indonesia, was intended to synergise the various initiatives and jointly move forwards the process of adaptation programming in Indonesia through Indonesia’s Climate Change Adaptation Programme. The workshop consisted of plenary sessions and several breakout group sessions in series to identify prioritised cross-sector activities. These included prioritised activities for research; education and awareness raising; spatial planning; climate information management; water management and infrastructure; and health. Activities in specific zones or geographic areas were also identified: marine and small islands, Flores and North Sulawesi. TroFCCA–Indonesia facilitated some of the breakout group sessions in relation to forest and forestry.

- TroFCCA–Indonesia: Mainstreaming Adaptation into the Development, and the Development for Adaptation, Bogor, Indonesia, 18–19 June 2008

This stakeholder workshop organised by TroFCCA in Indonesia was conducted as the continuation of the kick-off and first dialogue meetings on landslides and climate change held in 2006. The workshop was designed to discuss and enhance our understanding of the vulnerability and the causes of vulnerability of a system (social-government system or ecosystem) or a region, and to enhance the ability to identify effective policy oriented adaptations. Specifically, the objectives of the workshop were:

- to identify important factors or indicators of vulnerability of forest and forest-dependent society to forest fires and landslides as affected by climate change;
- to identify methods and tools for evaluating and mapping the vulnerability to climate change in the forestry sector;
- to understand the role of policy in affecting (reducing or increasing) vulnerability, and how to use policy as a tool for adaptive capacity enhancement; and
- to understand the role of traditional knowledge or local initiatives as part of local adaptive capacity, and how to transfer or scale up this capacity to a different or larger region.

TroFCCA used this opportunity to collect as much as possible information for the development of criteria and indicators of vulnerability, synthesising the vulnerability or adaptive capacity from the governance aspect, in particular for mainstreaming adaptation into the development agenda.

- NCCCA+6 Post-Conference and Preparatory Meeting for the Asia Pacific Conference on Climate Change Adaptation, Manila, Philippines, 10 July 2008

The meeting was conducted to present the initiatives of the provincial government of Albay on climate change adaptation six months after the first NCCCA. The initiatives of the Philippine Congress and Senate and the role of the Department of Foreign Affairs on climate change adaptation were discussed. Furthermore, the meeting provided a venue for refining the objectives and design of the first and pioneering Asia Pacific conference on climate change adaptation with the theme: 'Local Governments Take the Lead'. TroFCCA's national partner, ICRAF Philippines, is a co-organiser of the conference.

- International Conference on Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health, Umeå, Sweden, August 25–28, 2008

The conference focused on the current state of knowledge of ongoing changes in climatic conditions in different regions of the world, and the implications of these changes for forest management and conservation. A number of ongoing research projects in various fields of forest and forest-related sciences were presented in parallel sessions. TroFCCA South East Asia with partners presented five papers in relation to its ongoing activities, as follows.

- a) Impacts of climate change on landslides and using vegetation as an adaptation option to reduce the landslide risk (session 7)
- b) The TroFCCA policy research framework on actors, decision-making and policy networks (session 11)
- c) The challenges of assessing climate change vulnerability using an ecosystem approach (session 13)
- d) Mainstreaming climate change adaptation in forest and natural resources management in the Philippines: the role of local governments (session 9)—TroFCCA Philippines
- e) Community-based activities in disaster-prone upland areas as a means of adapting to a changing climate in the Philippine countryside (poster for Session 8)—*TroFCCA Philippines*.

Abstracts are available at <http://www.forestadaptation2008.net/home/en/> and at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

Invited Contributions

- Contributed to the National Action Plan Addressing Climate Change published by State Ministry of Environment, the Republic of Indonesia, November 2007. TroFCCA in Indonesia contributed to the adaptation section of the book, which was officially launched during CoP13 in Bali, December 2007. The electronic version of the document can be found at http://www.adaptationlearning.net/profiles/country/files/IndonesiaNationalClimateChangeActionPlan_2007_English.pdf.

- DAAI TV talk show ‘The Bridge of Hope’, on the topic of climate change and biodiversity, Jakarta, Indonesia, 22 January 2008. The talk show was part of the local DAAI television station’s series called *Titian Harapan* (the bridge of hope). The specific topic highlighted the link between climate change and biodiversity, in particular the orang-utan in Borneo.
- Guest speaker at the Annual Meeting of the Earth Science Deputyship, Indonesian Institute of Science, Bandung, Indonesia, 8 April 2008. The coordinator of TroFCCA in South East Asia was invited to speak on the link between climate change and development.
- Invited presenter in Asian Development Bank’s Regional Review of the Economics of Climate Change, Jakarta, Indonesia, 23–24 May 2008. TroFCCA South East Asia presented CIFOR’s research on forests and climate change in Indonesia. The regional reviews has the following objectives: (i) contribute to the regional debate on economic cost/benefits of unilateral and regional action on mitigation and adaptation; (ii) raise awareness and alert public opinion on the urgency of climate change challenges and their potential socio-economic impact on participating countries, while at the same time informing other stakeholders (e.g. civil society, academe, media, NGO, private sector and donor community); and (iii) indirectly support regional government and private sector actions to implement policies to mitigate and adapt to climate change.
- Invited as resource person to the workshop on Mainstreaming Adaptation into Development, hosted by the provincial government of West Nusatenggara, Mataram, 29–30 May 2008.
- Invited presenter at a meeting hosted by the National Agency for Disaster Management, Indonesia, to talk on forest and land fires in Indonesia in relation to climate change adaptation, in Jakarta, 12 June 2008.
- Invited as a resource person and facilitator of discussions in a workshop linking climate change adaptation and disaster risk reduction, co-hosted by International Federation of Red-Cross and WWF Indonesia, Jakarta, Indonesia, 4–5 September 2008.
- Invited as panellist for reviewing the research proposals submitted to the Competitive Research Programme of the Indonesian Institute of Science under the theme of climate change and food security. Depok-Bogor, Indonesia, 15–16 October 2008.
- Participated in a workshop to develop criteria and indicators for vulnerability assessment of the Javanese rhino to climate change, Ujungkulon, 10–11 November 2008. The event was proposed and hosted by WWF Indonesia and co-sponsored by TroFCCA South East Asia.

Graduate Student Research

TroFCCA in Indonesia provided financial support to two students conducting research in forest and land fire risks as follows.

- A RS/GIS-based multi-criteria approach to forest fire assessment in Indonesia with a case study in West Kutai, East Kalimantan
Mr. Danan Prasetyo Hadi, MSc candidate, Bogor Agricultural University, Indonesia

The research aims at producing spatial-temporal fire risk maps for effective fire prevention and fire control plans (i.e. better adaptive capacity). The assessment used different approaches for two different temporal resolutions: short-term, which relied on a drought index and historical hotspot data, and long-term, which was based on the logistic regression process and analytic hierarchy process. The two approaches integrated physical and social criteria in the assessment using combined remote sensing and GIS technology. This study confirmed the importance of climate, land use or fuel type, and human factors on the fire risk. The thesis is available at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

- Estimating forest fire risk and vulnerability using multi-criteria decision analysis (MCDA) and Geographic Information System (GIS) in West Kutai, East Kalimantan Indonesia
Mr. Arief Darmawan, PhD candidate, University of Tokyo, Japan

The research has the objective to estimate risks of forest and land fires using guided multi-criteria decision analysis and GIS. The MCDA is guided by expert-weighted criteria and indicators that determine areas most prone to fires in a spatially explicit manner. The research produced five different risk levels of forest and land fires. Some research products are available at http://www.cifor.cgiar.org/trofcca/_ref/home/products.htm.

7.3.4 Partners and Collaboration with other Institutions

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; and 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 the 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 the responsibility to prevent and control forest fires. In addition, this ministry has a specific group on clean development mechanisms and other climate change issues in the forestry sector.
- National Climate Change Council, Indonesia: This council coordinates and supervises the Indonesian government in addressing climate change issues.
- 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 Management: 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: 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: This agency has a working group on geo-hazards, which conducts research on landslides, provides models and data, and conducts public awareness on this hazard.
- Center for Vulcanology and Geohazard Mitigation: 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: 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 and other outreach activities.

7.3.5 Project Activities Planned for Implementation in Year 4

In the final year of the project, TroFCCA South East Asia concentrate on three areas: 1) completion of project outputs of regional responsibilities (i.e. regional activities), including project reporting, 2) finalisation of the TroFCCA global output targets as agreed by task groups, and 3) supporting the mainstreaming of adaptation into national policy and preparation of the SNC.

Regional Activities

- i. **Development of C&I for vulnerability assessment**
This is a continuation of last year's activities. The full set of C&I for vulnerability assessment of the selected sectors in Indonesia (vegetation fires and landslides) will be ready in 2009. The activity will involve main partners and stakeholders. The outputs will support the development of project outputs (TroFCCA Global) on tools and methods for vulnerability assessment.
- ii. **Vulnerability assessment mapping**
Vulnerability maps will mark the priority areas that require adaptation and the strategy of adaptation, which are derived from the identified C&I for vulnerability assessment. The outputs will support the vulnerability assessment and mapping, the document to be produced by TroFCCA Global in 2009.
- iii. **Development of adaptation strategies in the context of national policies**
Adaptation strategies will be derived based on the results of the vulnerability assessment, which embraces biophysical modifications, community development, and strategic policies when applicable. Collections of traditional knowledge, good practices, and good management will enrich the designed adaptation strategies.

TroFCCA Philippines will conduct policy research focussing on two aspects: a review of legal and policy instruments related to forest and water resources management to identify gaps for addressing climate change, and an assessment of adaptive capacities of stakeholders involved in the policy making process across scales and sectors. The activities follow the coupled-ecological approach.

The outputs support the project targeted output on adaptation strategies to be published in 2009.

- iv. **Identification of strategies for raising interest (awareness) of actors**
TroFCCA South East Asia will conduct an assessment of how to raise interest (awareness) of national actors and local actors (if applicable) identified during the last stage of the project. The activity will involve partners and relevant stakeholders at the national level (Ministry of Environment, Ministry of Forestry, National Climate Change Council, etc.).

Task Group Activities

TroFCCA South East Asia staff takes the lead or contributes to the production of some agreed task groups aimed at the realisation of the remaining project outputs.

Mainstreaming Adaptation and SNC

TroFCCA South East Asia will be involved in the effort to mainstream adaptation into development. In Indonesia, awareness raising and project result dissemination will be mainly through discussions and through info briefs and flyers disseminated

to key national institutions (National Climate Change Council, Ministry of Environment, Ministry of Forestry, National Agency for Disaster Management). TroFCCA Philippines will conduct a national workshop on forest and climate change adaptation that will facilitate the process for policy recommendations to mainstream climate change adaptation into forest and water resources policies.

8. SUMMARY OF PROJECT OUTPUT TARGETS AND THEIR STATUS IN YEAR 3

The project outputs promised to the donor are summarised in Table 3 with an update of their status in the third year. Also see Annex 12 for project publications.

Table 4. Summary of project outputs and their status in year 3

Product	Comment	Form	Status in Year 3
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.	Set of criteria and indicators as a toolbox	A set of criteria have been identified. They are being tested in the field. There are ongoing activities in the development of the document.
Climate scenarios	Climate scenarios relevant to 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	In progress in West Africa and Central America; preliminary draft results in Indonesia. There are ongoing activities in developing the document.
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	Completed case study for Ghana in West Africa based on changes in forest cover
Tools	Tools used in the project (models, databases, and others) will be compiled in a tool box for future use.	A tool box	The compilation of tools used in the project is in progress.
Identification of priorities	The vulnerability assessment will identify priorities for the work on adaptation.	Document and publishable articles	This activity 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 work is ongoing. A policy brief with some policy recommendations has been published for West Africa.
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 IPCC.	Sections on the relevant chapters	There is a completed draft document awaiting peer review.

Adaptation strategies in the context of national policies	The main product of phase 3 will be the specification of means to incorporate adaptation into development policy as well as sectoral policies of each country. The project expects to incorporate elements of capacity building, finance and research.	Document and publishable articles	Some activities are ongoing and others are commencing.
Guidelines for adaptation measures	The project team will develop a guide for the implementation of actions in the specific context of the project. The project, however, does not foresee the initiation of projects that encompass the application of these activities. The material can be used for formulation of new projects.	Publishable book	No activity has yet commenced on this item. It will constitute a major activity in year 4 and be implemented through the team and commissioned studies.
Strategy for raising interest of actors	The group will develop a strategy for raising awareness of the actors identified in the last stage of the methodology.	Document	The document still needs to be developed. This is planned for 2009.
Innovative mechanisms for financing adaptation	An important effort will be made to identify new mechanisms for financing adaptation, which may include insurance and payment for environmental services.	Document and publishable article or book	The document still needs to be developed. This is planned for 2009.

List of Annexes

- Annex 1. Preliminary studies on local coping strategies in Burkina Faso
- Annex 2. Action pledges to the Nairobi Work Programme
- Annex 3. Mapping vulnerability with forest degradation in Ghana
- Annex 4. Borlaug LEAP Fellow - final report
- Annex 5. Forest use in National Communication
- Annex 6a. Policy Brief
- Annex 6b. Policy Brief
- Annex 6c. Info Brief
- Annex 6d. Enviro Brief
- Annex 6e. Res Brief
- Annex 7. Workshop Report – West Africa
- Annex 8a. Criteria & Indicators for NTFP – West Africa
- Annex 8b. Criteria & Indicators for Water – West Africa
- Annex 9. Student research project summaries – West Africa
- Annex 10. Research project summaries – Central America
- Annex 11. Outsourced research project – Southeast Asia
- Annex 12. List of TroFCCA publications

Annex 1

Rapport de Stage

Perceptions des changements climatiques et stratégies locales d'adaptation dans six villages des régions du centre, nord et sahel du Burkina Faso

Résumé

Le Burkina Faso à l'instar des pays sahéliens est exposé aux effets de la variabilité et des changements climatiques, qui se traduisent par une dégradation continue du couvert végétal et du cadre de vie des populations. Cette rareté de la ressource forestière affecte les moyens d'existence des populations rurales.

Pour évaluer l'accessibilité la perception des changements climatiques par les populations rurales de six villages (saaba, Loumbila, Outendeni, Koukouloungou, Djomga et Gnalalaye) des régions du Centre, Est et Sahel du Burkina Faso, nous avons utilisé des méthodes participatives (MARF) et un guide d'entretien.

Les résultats montrent que les populations dépendent des forêts pour leurs moyens d'existence (santé, nourriture, habitat, revenus financiers, etc.) alors que paradoxalement les populations rurales estiment que la ressource forestière est rare. Aussi, ces populations ont conscience des changements climatiques et développent des stratégies d'adaptation endogènes dans les secteurs du bioénergie, la forêt (santé et alimentation) et l'eau pour faire face aux effets pervers des changements climatiques. Ces stratégies d'adaptation développées par les populations sont de deux types : (i) adaptations autonomes ou par réaction et (ii) adaptations par planification. Les moyens d'adaptation des populations rurales sont fragiles du fait principalement de leur pauvreté et de leurs conditions d'existence matérielles précaires. Ces facteurs font que les populations sont vulnérables aux Changements climatiques, au double plan socioéconomique et écologique.

Pour renforcer leurs stratégies d'adaptation, les populations ont des attentes techniques et économiques vis-à-vis des autorités pour renforcer les stratégies d'adaptation fragiles afin de leurs rendre durables.

Annex 2

The Center for International Forestry Research

CIFOR's PROJECTS ON ADAPTATION SUPPORTS THE NAIROBI WORK PROGRAMME

Action pledges through research on tropical forests and climate change adaptation, to the Nairobi work programme on impacts, vulnerability and adaptation to climate change

Following the invitation by the UNFCCC Secretariat for pledges of actions to support the Nairobi Work Programme (NWP), CIFOR is responding to this request by making action pledges in contribution to the programme, using corresponding areas of the programme, to CIFOR's global research activities on tropical forests and climate change adaptation

About the Institution

The Center for international Forestry Research (CIFOR) was established in 1993 as part of the CGIAR in response to global concerns about the social, environmental and economic consequences of forest loss and degradation. CIFOR's purpose is to advance human well-being, environmental conservation and equity by conducting research to inform policies and practices that affect forests in developing countries. Under CIFOR's new strategy for research operationalized in October 2008, two out of six research domains are on climate change, one of which in on adaptation. Most obvious, forests have now taken centre stage in the international debate on climate change. The research domain (2) on adaptation is on enhancing the role of forests in adaptation to climate change with the principal research themes of bringing climate change adaptation into forest management, and mainstreaming forestry into climate change adaptation.

CIFOR currently have two ongoing projects on climate change adaptation. The first is the Tropical Forests and Climate Change Adaptation (TroFCCA) which is a global project implemented three region across eight countries (Central America: Costa Rica, Nicaragua and Honduras), West Africa (Mali, Burkina Faso, Ghana) and Southeast Asia (Indonesia, Philippines). The second project is the Congo Basin Forests and Climate Change Adaptation (CoFCCA) implemented in Democratic Republic of Congo, Central African Republic and Cameroon. CIFOR is well placed to contribute to the Nairobi Work Programme through these research projects in different global locations and tropical forests types.

CIFOR and the Nairobi Work Programme

Overall Objective

The over goals of CIFOR's projects on adaptation are to ensure that forestry policy and practices adequately address the need to protect forest-dependent livelihoods from adverse climate change and to ensure that adaptation strategies adequately incorporate improved forest management.

The main objective of the projects is to contribute to national processes of adaptation to climate change through the assessment of vulnerability and development of policy-orientated adaptation strategies that also ensure sustainable use of forest resources.

CIFOR and NWP Areas of work

The research activities of the Center for International Forestry Research (CIFOR) on Forests and Climate Change Adaptation can potentially contribute to the following sub-themes of the Nairobi Work Programme (NWP):

SUB-THEME A: IMPACTS AND VULNERABILITY

PLEDGE CONTRIBUTION TO NWP OBJECTIVES:

- (i) Promoting development and dissemination of methodologies and tools for impact and vulnerability assessments, such as rapid assessments and bottom-up approaches, including as they apply to sustainable development;
- (iv) Promoting understanding of impacts of, and vulnerability to, climate change, current and future climate variability and extreme events, and the implications for sustainable development;
- (v) Promoting the availability of information on the socio-economic aspects of climate change and improving the integration of socio-economic information into impact and vulnerability assessments

CIFOR's ADAPTATION PROJECT ACTIONS

CIFOR is developing methodological approaches for the followings:

- a) Prioritization of forest-based sectors for adaptation through engagement and participatory actions of multiple stakeholders sharing the forest ecosystem
- b) Vulnerability assessment of climate change impacts on the prioritized forest-based development sectors.
- c) Development of criteria and indicators for vulnerability assessment in tropical forest ecosystem

SUB-THEME B: ADAPTATION PLANNING MEASURES AND ACTIONS

PLEDGE CONTRIBUTION TO NWP OBJECTIVE:

- (i) Promoting the development and dissemination of methods and tools for assessment and improvement of adaptation planning, measures and actions, and integration with sustainable development;
- (ii) Collecting, analyzing and disseminating information on past and current practical adaptation actions and measures, including adaptation projects, short- and long-term adaptation strategies, and local and indigenous knowledge;

- (iii) Promoting research on adaptation options and the development and diffusion of technologies, know-how and practices for adaptation, particularly addressing identified adaptation priorities and building on lessons learned from current adaptation projects and strategies;
- (iv) Facilitating communication and cooperation among and between Parties and relevant organizations, business, civil society and decision makers, and other stakeholders;
- (v) Promoting understanding and the development and dissemination of measures, methodologies and tools including for economic diversification aimed at increasing economic resilience and reducing reliance on vulnerable economic sectors, especially for relevant categories of countries listed in Article 4, paragraph 8, of the Convention.

CIFOR's ADAPTATION PROJECT ACTIONS

CIFOR projects on adaptation are undertaking the following actions:

- 1) Developing adaptation strategies that emphasise the linkages between climate change, forest ecosystems and livelihood and mainstreaming this into national development policies that will support adaptation by rural and urban people, particularly the most vulnerable.
- 2) Highlighting the special needs of indigenous forest people for adaptation and gender – base vulnerability.
- 3) Documentation of indigenous coping strategies in forest systems

CIFOR's ADAPTATION PROJECT ACTIVITIES

The activities of CIFOR projects are structured into phases each with a central activity guiding the implementation of the overall objective. The phases and activities however are overlapping in providing transition to the other. The principal activities include:

- 1) Setting stakeholders platform, initiating science-policy dialogue process at regional, national and local levels
- 2) The identification and prioritisation of forest-based sectors through a regional science-policy dialogue process, for the assessment of climate risks and the vulnerability of livelihoods linked to these prioritised sectors, for planning adaptation strategies to climate change and climate variability.
- 3) Development of methodology for vulnerability assessment of the prioritized sectors
- 4) The assessment of vulnerability of gender and minority groups including indigenous communities, to highlight their special needs for climate change adaptation, and explore ways of engaging their participation in national adaptation planning processes and policy formulation

The methodology to assess vulnerability of tropical forests to climate change is comprised of twelve steps. The project acknowledges the close link existing between the processes of adaptation and development and, hence, it starts with the identification of the development priorities where the assessment will be focused.

This generic methodology sets the framework for the development of specific methodologies for each of the topics selected by each region and for the assessment of carbon (link between adaptation and mitigation) and biodiversity.

The following is a description of the 12 steps that comprise the methodology:

1. Definition of the areas/topics from the national development policies:
2. Specification of the goods and environmental services (G/S) that support/relate to the areas/topics identified in the previous step
3. Assessment of the ecosystem functions underlying the goods and services identified in the previous step
4. Assessment of the biophysical processes and parameters that control the functions identified in the previous step
5. Assessment and analysis of the climatic variables/parameters that can have a direct effect in the parameters assessed in the previous step.
6. Selection of case studies
7. Development of climate scenarios
8. Identification of current and future biophysical impacts
9. Assessment of the derived impacts
10. Vulnerability assessment

The assessment of vulnerability is focused at the policy topics/areas identified in step 1. Changes in the provision of goods and services as the edge of the impact chain is assessed in the broader context of other processes that may affect the topic(s)/area(s) under study and the implications relevant for the development policy.

The steps provides a thorough assessment of the importance of forest ecosystems in the respective topic(s)/area(s) as well as how and how likely are impacts from climate change over forests affect the topic(s)/area(s). The assessment of vulnerability will be undertaken at the environmental and socioeconomic levels.

OUTPUTS

- 1) A framework that describes a stepwise approach and the tools to be used in undertaking the assessment of sector vulnerability to climate change associated to climate change impacts on the forests.
- 2) Gender issues will be accounted for in this methodology through the assessment of vulnerability to various climate stresses by different gender groups, in order to identify gender-specific requirement for adaptation.

Which organisations, communities and experts will be engaged in the activity?

- CATIE will undertake several activities of the project. Some of these activities will be centralized (see below).
- NARs in all the participating countries
- Community groups
- Private sectors, forest operators
- National focal point to UNFCCC
- Government departments
- NGOs (international, national and local)
- An expert scientific steering panel
- Consultants
- Doctoral and master students
- ETC

What are the concrete outputs envisaged to achieve the specific objectives?

1) Development of ecosystem services balance sheets as a baseline for outcomes mapping and for progress monitoring and evaluation. That will also highlight the benefits of the forest for policy and decision making process and highly vulnerable areas will be identified for special adaptation measures within development policy context. This will be realized in the first year of the project.

2) Within the framework of the participatory action research approach and outcome mapping, specific methodologies for vulnerability assessments to climate impacts of prioritized regional development topics/ areas highly will be developed. This will be available in mid term of the second year of the project.

3) Simplified sets of criteria and indicators for adaptive forest management, and directly relevant for monitoring adaptation strategies for the specific development sectors identified by the project. This will be achieved in the fourth phase in year two.

4) Vulnerability maps including climate risk maps for the forest ecosystem including for each of the development sectors identified and prioritized by the stakeholders for the sites and country levels and under different scenarios will be produced to guide policy makers and adaptation planning strategies by the local communities. This will realized for each year of the project.

A general methodology for the assessment of vulnerability. The methodology follows the principles and work undertaken in the past by the IPCC and UNEP and incorporates the latest ideas on adaptation in the context of the adaptation policy framework by making an emphasis on the development side of adaptation. This product will be ready in the first half of phase 2.

Specific methodologies for regions: The specification of the general methodology will be undertaken in accordance with the focus of each region. This will result in at least three methodologies for the topics selected for each region. The methodologies will be ready by the end of phase 2.

Methodologies for the assessment of vulnerability of biodiversity: All regions will perform an assessment of the vulnerability of biodiversity to climate change derived from impacts over forests. The methodology will be developed in conjunction for the three regions.

Methodology for the assessment of the link between adaptation and mitigation: All regions will perform an assessment of how climate change can lead to loss of stored carbon and, hence, a feedback from climate impacts from the increased concentrations of CO₂ in the atmosphere. As for the methodology on biodiversity, this will be developed in conjunction for the three regions.

Annex 3

Mapping land use/land cover and vulnerability of forest degradation to climate change impacts in Ghana

Executive Summary

Forests play a major role in the growth and development of the Ghanaian economy, cultural life and environmental quality. In Ghana, forests are mainly exploited to meet growing socio-economic needs mainly through shifting cultivation, uncontrolled logging and charcoal production. However, in recent years, combination of rising temperatures, drought, annual bushfires and floods have exacerbated vulnerability of the already degraded forests. In 2007, extreme climatic events in the form of severe drought followed with floods occurred within the wet season of the year which impacted negatively on forest goods and services.

Though indigenous people are reacting to the impact of climate change by drawing on traditional knowledge to cope with the changes, the need to make reliable information available to help informed sustainable forest adaptation planning poses a challenge.

The overall aim of the study is to map forest dynamics and develop reliable forest vulnerability information to guide and inform forest adaptation and policy planning. This Tropical Forests Climate Change Adaptation (TroFCCA) initiated vulnerability mapping will help establish efficient tracking of forest dynamics and also bring flexibility in use of district, national and regional datasets to help assess forest resource vulnerability and adaptation planning.

The 1990 land cover classification system developed under the Ghana Environment Management Project (GEMP) was used in the LULC mapping. The mapping exercise was done using Landsat images of 1972, 1986 and 2000 with 30-metre spatial resolution. Predictive maps were then generated from the LULC maps using Markov time series analysis of Idrissi Kilimanjaro. LULC change maps were derived for 1972-2000 and 2000-2050 respectively. Data and information used in the simulation were derived from climate, elevation, forest protection, land use /land cover (LULC), population density, poverty levels, soil productivity and wildfires, for the periods of 1972 and 2000. Change in rainfall amount between 2000 and 2050 was also derived using MAGICC. The process was applied to individual risk factors and the resulting maps were used as input for the vulnerability and hotspot assessment. Each risk factor was sliced and reclassified into three (3) cell risk values. The spatial model combined the three grids with values of their spatially risk corresponding cells to generate a composite maps for high, medium and low vulnerability for forest degradation based on threshold of their cumulated weight.

The results from LULC change in 1985 and 2000 using satellite images indicated that the closed forest in the HF reduced from 2,736 km² to 1,623 km² at an annual rate of 1.6%, leaving mainly gazetted forest reserves in 2000. The forest reserves in the HF zone are

being threatened by high demand of forestland for cocoa plantations and open cast gold mining. It was predicted that the HF would reduce to 871 km² in 2050 if appropriate policy intervention is not taken. In the FST zone, both open forest and closed savanna woodland degraded by 85% and 35.5% at an annual rate of 1.0% and 0.7%. Results from 2050 predictive maps from the FST zone also stated a further of 1.2% and 17.8% due to slash and burn method of cultivation, bushfires and timber exploitation. The study also revealed that 10% of the study area within the FST zone is being threatened by desertification. Meanwhile, savanna woodland of S zone decreased from 1,195 km² to 340 km² in 2000 and predicted to further decrease to 126 in 2050 at an annual rate of 1.5%. Major driver of the S zone were high human and livestock population, bushfires and slash and burn method of cultivation.

Hotspots to forest degradation between 2000 and 2050 in the S, HF and FST zones were 74%, 77% and 38% respectively. The result also indicated areas of high vulnerability to forest degradation between 2000 and 2050 in the S, HF and FST zones as 76%, 56% and 29%. While most low vulnerable areas to forest degradation coincided to forest reserved areas, high vulnerability to forest degradation were associated to basins of major stream and rivers of the study areas. Major characteristics of hotspots of change and vulnerability to forest degradation were accessibility to forest resources, LULC change, bushfires and climate impacts. The study also confirms that savanna ecosystems are more susceptible to climate influence compared to the forest ecosystem.

The study made available time series forest dynamics and vulnerability to forest degradation to climate impacts at ecological/district levels. Forests cover dynamics at present and scenarios for 2050, temporal rate of change as well as drivers of change were also obtained as well vulnerability and hotspots of forest degradation and their characteristics. This dataset were provided as essential requirements for addressing forest adaptation strategies for climate change impacts and sustainable forest management at ecological level. It will also help to inform adaptation strategies at ecological level which are essential tools and directions to guide trans-boundary forest policy planning.

It therefore concluded that impacts of LULC and climate impacts will further render most tropical forests and savanna woodlands vulnerable and as hotspots of forest degradation due to rising temperatures and drought in Africa. A situation that will force indigenous farmers to go for the remaining forests for agricultural cultivation since their degraded farmlands will require enough rains and more time to regenerate and restore soil fertility. Most people will also migrate and settle along river basins to access water for their cattle and farming practices and thereby slash the remaining forest resources and also burn them for fuel.

The study recommended mainstreaming forest vulnerability and climate change adaptation issues as priority in formulation of government policies. There is therefore the need to provide funds and transfer technology from Annex1 countries to support forest resources management, encourage use of liquefied petroleum gas, awareness creation and develop forest livelihood programmes on climate change which aim at reversing the degradation trends.

Annex 4

Borlaug Leadership Enhancement in Agriculture Program (LEAP)

Final Reporting Guidelines

1. Final Administrative/Technical Report

a. Introduction

Moussa Koné, recipient of the fellowship, is a PhD candidate in the department of Geography at the University of Illinois, Urbana-Champaign. His dissertation research title is “UP IN SMOKE: Biomass Burning, Land Cover Change and Atmospheric Emissions in the Sudanian Savanna of Côte d’Ivoire”. The research investigates the relationships between fire regimes, vegetation cover, and greenhouse gas emissions. The study examines how farmers and herders use fire as a tool for natural resource management, and how these practices modify landscapes over time.

The research is conducted in the sudanian savanna zone in northern Cote d’Ivoire. The locality selected for the field research is Katiali because of the existence of different vegetation types and different burning practices.

The fellowship covered Mr. Koné’s field research expenses, notably. roundtrip travel to Cote d’Ivoire from Illinois, travel within Côte d’Ivoire to the research site, equipment to undertake the study. The funding also enabled Mr. Koné to travel and finalize affiliations with government officials (Ministry of Environment extension agents, Sub-Prefets, the regional director of Water and Forest Services of the rebellion), national and international researchers (Laminat/IGT, BIOTA, RIPIESCA Cote d’Ivoire, Ecological station of Lamto, CIFOR), and village leaders in Cote d’Ivoire, especially in the research area.

During the field research, the U.S. mentor, Professor Thomas J. Bassett and CGIAR mentor Dr Johnson Nkem Ndi regularly assisted the fellow in field. For instance, the U.S. mentor and CGIAR mentor assisted Mr. Koné in writing questionnaires administered to participants. Professor Bassett traveled to Cote d’Ivoire from March 3rd to May 11, 2008. During that period, he supervised the fellow’s research in Katiali. Mr. Koné received comments and suggestions to improve questionnaires and research methods. The CGIAR mentor traveled to Cote d’Ivoire on April 21-April 26, 2008 and visited the fellow at the research site. Mr. Johnson provided Mr. Koné with helpful comments, encouragement, and financial support to continue the fieldwork.

b. Achievements During the Fellowship

Mr. Koné traveled to Cote d’Ivoire in June 27, 2007 to conduct his doctoral dissertation research. After finalizing his research affiliations, he traveled to Burkina Faso on June 30-July 3, 2007 to visit the CGIAR mentor at CIFOR/TroFCCA in Ouagadougou.

The fieldwork in Katiali involves multiple research projects. Mr. Koné first conducted a census of the village population. One objective of the census was to identify the different actors involved in burning activities. A second goal was to select a representative subset

of the population to participate in more intensive surveys. From the village census data, Mr. Koné selected a survey research sample composed of 40 households. He subsequently conducted group discussions, surveys, and interviews with the 40 participants from October 2007 to May 6, 2008.

A second research project took place between September 13, 2007 and May 6, 2008 that involved an analysis of burning practices and their effects on land cover during one burning season. As part of this project, Mr. Koné took several trips to analyze the vegetation cover and burning practices. The student analyzed vegetation plots to determine tree and grass species, perennial versus annual grass species, height of trees and grasses, measure of available biomass load in different vegetation types. He used a GPS Garmin 12 to record burning positions. These geographical positions will serve as groundtrouthing points for subsequent satellite image analysis. Mr. Koné also conducted transects walks in fields with participants to get their historical understanding of the savanna ecosystems dynamics.

Every morning during the research period, the student recorded the weather station data (wind speed; ambient air temperature; air relative humidity; rainfall). The weather station data recording is still in progress.

From June 27, 2008 to July 4, 2008, the CGIAR mentor invited Mr. Koné at CIFOR/TroFCCA to participate in a meeting and to present his work during the visit of M. Michel Van Dan Boussche of EC-AIDCO (Environment and Forest Sector at European Union) to the TroFCCA Project in West Africa. Currently, Mr. Koné is doing an internship at CIFOR for the period of August 15 to December 15, 2008.

Mr. Koné traveled to Sweden from August 23, 2008 to August 30, 2008 to present his work at the 2008 International conference on “Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health: A review of Science, Policies, and Practices”.

Mr. Koné is currently in the field conducting research. During the next burning season, he will conduct the third study, which is the burning experiments consisting of real-time measurement of greenhouse gases. The student could not conduct the third study of his field research because the gas analyzer arrived at the research site after the 2007-2008 burning season had ended.

Mr. Koné plans to analyze his field data while in Cote d’Ivoire and begin writing his dissertation, which he will complete upon his return to the United States.

c. Perspective of US Mentor

I am very pleased with the progress of Mr. Koné’s doctoral dissertation field research. I was able to visit and advise him in the field between March and May 2008 when I was conducting my own field research in Katiali. I visited Mr. Koné’s field research sites and met with some of his informants. In short, I can testify first hand to the accuracy of Mr. Koné’s report and its promise to expand our understanding of burning practices and climate change scenarios at the regional scale in Africa. I advised Mr. Koné to extend his

research for an additional burning season since his gas analyzer arrived too late for him to collect data on greenhouse gas emissions during the 2007-2008 burning season. This additional field time will delay his progress in the Ph.D program but it is essential to the quality of the proposed research and its contribution to knowledge.

I was also fortunate to meet with Mr. Koné's CIGAR mentor, Dr. Nkem Johnson, in Katiali in late-April 2008. Dr. Johnson brings invaluable skills and perspectives to Mr. Koné's research from his position and experience at CIFOR. I am most pleased with Dr. Johnson's enthusiasm for promoting Mr. Koné's research in international fora where the results of the research have been well-received. Dr. Johnson's agency has also provided Mr. Koné with research funding to cover the unanticipated research expenses for the second burning season.

In conclusion, the Borlaug fellowship program has been an excellent opportunity for Mr. Koné to conduct field research and to broaden his professional development. He has been invited to present his research findings at international forestry and agricultural conferences, which has enhanced his research, communication, and networking skills. I am delighted by Mr. Koné's professional development, especially his capacity to conduct high quality field research and to his integration into international research and policy arenas. The Borlaug program is to be applauded for providing this unique opportunity for the professional development of African students in the agricultural and environmental sciences.

d. Perspective of the CGIAR Mentor

I am very pleased by the scope, scientific content and progress of Mr. Koné's research, which is meticulously implemented. The research cuts across policy, science and cultural practices with a unique blend of stakeholders and gender balance in the integration of livelihood activities. The bottom-up approach of the study in developing scientific knowledge that directly feed into debatable issues in high profile policy discussions like the attribution of greenhouse gas emissions to system practices is a special attribute of the research. The timing and relevance of Mr. Koné's research will have landmark contributions to the global negotiation process on climate change as the world move towards a post-Kyoto agreement in Copenhagen, Denmark in 2009.

I visited and worked closely with Mr. Koné in the field sites at Katiali in April 2008. This was a unique occasion, which coincided with the extended period Professor Tom Bassett, the principal supervisor at the University of Illinois at Urbana Champagne, was spending with Mr. Koné in the field. During that period, we were able to spend time in the field, make observations together, and interact directly with the stakeholders for a complete appreciation of the various components of the research. Three of us had several working sessions and discussed more interactively about the current and future activities of Mr. Koné's research. My visit was very fulfilling and I was particularly pleased with the methodical approach to each aspect of the field research and the participatory engagement of the local community who continuously manifested their interests in the study by asking new questions and regularly inquiring about the weather forecast to plan their personal activities like travels, sunning grains, farm operations etc.

As part of his scholastic development, Mr. Koné has demonstrated strong ability to engage the scientific community in discussions of his research, and the outputs so far. This is crucial in contribution to the knowledge base and also in receiving feedbacks and handle questions from other peers in scientific meetings and conferences. Mr. Koné recently prepared and submitted an abstract that got reviewed and accepted for oral presentation at the “International Conference on Adaptation of Forests and Forest Management to Changing Climate with Emphasis on Forest Health: A Review of Science, Policies and Practices” that was held at Umeå, Sweden, 25-28 August, 2008. Mr. Koné has another abstract reviewed and accepted for oral presentation at the upcoming conference on “Sustainable Forest Management in Africa: Africa Solutions to African Problems in Natural Forest Management” 3-7 November 2008 in Stellenbosch, South Africa.

Mr. Koné’s research is highly beneficial to CIFOR’s TroFCCA project on Tropical Forests and Climate Change Adaptation, and already providing some indications of some crucial aspects to consider in planning climate change adaptation strategy in the Sudanian Savanna region. The adaptive use of fire is essential for both the livelihood activities of the local communities and dry forest management for the provision of other ecosystem goods and services, and also in managing the amount of greenhouse gas emissions associated with the practice.

I will finally like to applaud the excellent and prestigious opportunity that the Borlaug fellowship program offers to young and bright African professionals like Mr. Koné to undertake groundbreaking and cross-cutting edge field research. Supporting such a research in Africa lagging in scientific information and where there are limited capacities to undertake such a study is remarkable. I am privileged to be associated with the Borlaug fellowship program through Mr. Koné’s research and will remain a supporter of the program. I hope that Borlaug fellowship program will be encouraged and motivated by the multiple benefits of Mr. Koné’s research to policy and the livelihoods of people in continuing with the program and participation in African development.

e. Perspective of the Fellow

During the field research the fellow developed four main skills. The first involves field research methods. Mr. Koné is now capable of collecting data in field through participant observation, household surveys, and focus group interviews with diverse populations. Second, the communication skills of the fellow have been enhanced through conference presentations. Also, data gathered during the fieldwork are an important source of course materials and information. Third, contacts with research centers and development agencies such as CIFOR and the Lamto research center are enhancing the fellow’s networking skills. The contacts and knowledge gained during the research is allowing Mr. Koné to become a recognized expert in the area of savanna bushfires and environmental change in West Africa.

f. Summary of Key Technical Findings and Conclusions

The research uses a political-ecological approach to expand our understanding of burning regimes and to present a more accurate assessment of land use and land cover change in

the sudanian savannas. Political ecology is an interdisciplinary approach to the study of human-environmental relationships that integrates social, political, cultural and biophysical processes in order to deepen our understanding of environmental and social change. The approach examines the long-term study of human-environmental interactions based on local history, local knowledge, and local specific ecologies. Political ecology seeks to deepen our understanding of issues through multiscale analysis, and intensive fieldwork.

During the research period, the fellow conducted two main research projects: a fire regimes study and the land cover change study.

The results of the study show that Major actors involved in burning are herders, hunters, farmers, and honey gatherers. The main reasons for burning in Katiali region are fire breaks around mango and cashew orchards, slash and burn agriculture, land clearing, fire set by herders for grass regrowth and to clear the landscape, fire set by hunters for game, honey extraction, cooking, and accidental burnings due to reckless persons. The research shows that biophysical processes such as rainfall, air temperature and relative humidity, and wind influence the length of the dry season and the burning regimes.

I. Results of the burning regimes study

A burning regime refers to the timing, intensity, frequency, and efficiency of fires.

Periods of burning

The research reveals three different periods of burning throughout the dry season: at the beginning of the dry season (mid-October-December), in the middle of the dry season (January-February), and late in dry season (March-April). The study also shows three periods during the day: in the morning before 9am, between 9am and 3pm, and between 3pm and 6pm.²

Burning intensity

The study shows that the burning intensity declined during the period 1975-2008 due to reduced grass biomass from increased grazing, the expansion of mango and cashew orchards, and a larger area under cultivation, early burning, and more fire breaks throughout the landscape. Burning intensity varies during the dry season. There is less intense burning at the beginning of the dry season (mid-October-December), intense burning in the middle of the dry season (January-February), less intense burning at the end of the dry season (March-April). There is a decline in the flame height. Fire flames are not as high as 30 years ago because of the impact of grazing pressure on the height of grasses.

Burning frequency

The research shows that bush fires are currently more frequent compared to 30 years ago. Fire frequency depends on the period at which fire is set and on the quantity of available biomass. Fire set at the beginning of the dry season is not efficient to burn all the available grasses. Those that do not burn can burn a second time during the dry season. Fires during the middle of the dry season are very efficient and burn all the available

grasses. Late dry season burning is not efficient because there is less available biomass left to burn at that period.

Burning efficiency

The burning efficiency analysis shows that the burning efficiency declined during the period 1975-2008. The burning efficiency varies over time because of the availability of grass biomass.

The study of burning regimes shows that the grazing pressure, agricultural intensification (food crops and cash crops), and more firebreaks throughout the landscape modified the burning regimes in the Katiali region. These new burning regimes create a savanna ecosystem composed of several types of vegetations.

II. Land cover change analysis

The land cover analysis shows that savanna is a complex and differentiated landscape. The sudanian savanna ecosystem is composed of open forest, woodland, gallery forest, bush savanna, grass savanna, and cropland and fallow fields.

The sudanian savanna ecosystem is a more wooded landscape compared to 30 years ago. The major wood species are: *Isoberlinia doka*, *Daniallia oliveri*, *Vitellaria paradoxa*, *Pericopsis laxiflora*, *Piliostigma thonningii*, *Entanda africana*, *Azelia africana*, *Ficus capensis*, and *Parkia biglobosa*. The grass biomass load is declining while woody vegetation is increasing over time.

Conclusion

The case study of the Katiali region uses a political-ecological approach to expand the understanding of burning regimes and to present a more accurate assessment of land use and land cover change in the sudanian savannas.

Local resource users increasingly use fire early in the dry season as a management tool. Farmers set fire to protect their cashew and mango orchards while herders burn for new grasses that are more palatable to cattle. Early dry season burning is less intense and less efficient, and over the years favors the expansion of woody vegetation in the sudanian savanna. Less intense burning also produces lower gas and aerosol emissions. The resulting increase in vegetation cover could potentially sequester more carbon dioxide than is presently attributed to the system.

g. Publications and Presentations by the Fellow

The fellow traveled for international conferences and meetings to Ouagadougou (Burkina Faso) and to Umea (Sweden) to present his work. He is also invited to participate at incoming conferences in South Africa and Ghana in November 2008. The South Africa and Ghana presentations will be written in full articles and published.

- Burkina Faso in June 30-July 4, 2008: "*Feux de Brousse, Dynamique de la Végétation et Emissions Atmosphériques dans les Savanes Sudanaïses de Côte d'Ivoire*"

- Sweden in August 25-28, 2008: “*Burning Regimes and Dynamics of the Sudanian Savanna Ecosystems: The Case Study of Katiali, Cote d’Ivoire*”.

Incoming conferences:

- South Africa in November 3-7, 2008: “*Changing Fire Regimes in the Cote d’Ivoire Savanna: Implications for Forest Management and Carbon Sequestration*”

- Ghana in November 18-20, 2008: Title to be listed

Incoming publications:

- An article will be written and published based on the South African presentation

-An article to publish in CIFOR report is a requirement for the Ghana conference

h. Future Plans of the Fellow

The student’s immediate plan is to conduct the greenhouse gas experiment during the next dry season and to write his dissertation thesis. After completing the doctoral program, the student’s goal is to teach at the university level in a graduate program focused on agricultural geography and environmental policy. He expects to consult as well within the Ministries of Agriculture and the Environment on land use and land cover change policies. He will also interact with international networks of scholars and professionals through collaborative research projects, professional meetings, and consultancies with international agricultural research centers and organizations focused on climate and land cover change.

The fellow will apply the knowledge and experience gained from this research into the environmental impact of agricultural and pastoral land use in publications, conference presentations, consultancies, and university-level teaching. After writing the Ph.D. dissertation the fellow will submit manuscripts to journals such as *The Professional Geographer*, *Annals of the Association of American Geographers*, *the Journal of Atmospheric Chemistry*, *Geotrope*, *Land Use Policy*, and *Land Degradation and Development*. The student will also present professional papers at the annual meetings of the Association of African Studies, the Association of American Geographers, African Monsoon Multidisciplinary Analysis (AMMA) and the American Meteorological Society.

The findings for this study will be available to policy makers such as the National Committee for the Protection of Forests and the Control of Bush Fires, Ministry of Environment, Climate Change Bureau in Cote d’Ivoire, United Nations Framework Convention on Climate Change (UNFCCC), and CIFOR.

3. **Research Brief**

Abstract

The environmental change literature depicts West African savanna fires as intense and highly destructive. It assumes that burning takes place in the middle and late-dry seasons. The literature views African savannas as one of the “burn centers” of the planet and considers biomass burning as an important source of greenhouse gas and aerosol emissions.

The proposed research took a political-ecological approach to further our understanding of burning regimes and to present a more accurate assessment of land use and land cover change in the sudanian savanna of Cote d’Ivoire. Fire is an important management tool in farming and pastoral systems of West Africa. The research shows that contemporary agricultural and pastoral practices in West Africa generate early fires that result in low fire intensity, more frequent small burning, and in inefficient combustion. The study shows that the sudanian savanna is a complex and differentiated ecosystem composed of open forest, woodland, gallery forest, bush savanna, grass savanna, and cropland and fallow fields, and diverse tree species. The land cover change analysis shows that grass biomass load is declining while woody vegetation cover is increasing over time. It is argued that increased tree vegetation cover will sequester more carbon dioxide than believed.

Background

The scientific literature considers biomass burning as an important source of greenhouse gases and aerosols such as sulfur, nitrous oxide, methane and carbon dioxide. The effects of biomass burning on the atmospheric composition lead to several concerns about human health, air pollution, and climate change. Global climate change scientists argue that biomass burning contributes up to 40 % of gross carbon dioxide each year. African savannas are viewed in this literature as a “burn center” of the planet. The research thesis is that the impact of biomass burning on global climate change has been overestimated and that the anti-burning land use policies based on the current scientific literature may be misconceived. Contemporary agricultural and pastoral practices in West Africa generate early fires that result in low fire regimes and bush encroachment. Less frequent and intense fires produce less gas and aerosol emissions into the atmosphere. Increased vegetation cover sequesters more carbon dioxide than believed.

The research takes a political ecological approach to examine burning regimes in the sudanian savanna of Cote d’Ivoire, to present a more accurate assessment of land use and land cover change, and to determine the contribution of biomass burning in Ivorian savanna ecosystems to global climate change.

I. Results of the burning regimes study

The fire regimes study consisted in the analysis of burning practices in Katiali, different burning periods and their effects on fire intensity, burning frequency, and on combustion efficiency.

Data sources used during the research period are group discussions and interviews with key informants about different uses of fire, reasons for burning, and different periods at

which fires are set. A weather station data (wind speed and direction; ambient air temperature; air relative humidity; rainfall) were recorded daily while record of geographic positions of burning sites were taken using a global positioning systems (GPS) device.

Preliminary findings show that there are three different periods of burning throughout the dry season: at the beginning of the dry season (mid-October-December), in the middle of the dry season (January-February), and late in dry season (March-April). The study also shows three periods during the day: in the morning before 9am, between 9am and 3pm, and between 3pm and 6pm.²

The study shows that the burning intensity declined during the period 1975-2008 due to reduced grass biomass from increased grazing, the expansion of mango and cashew orchards, and a larger area under cultivation, early burning, and more fire breaks throughout the landscape. Burning intensity varies during the dry season. There is less intense burning at the beginning of the dry season (mid-October-December), intense burning in the middle of the dry season (January-February), less intense burning at the end of the dry season (March-April). There is a decline in the flame height. Fire flames are not as high as 30 years ago because of the impact of grazing pressure on the height of grasses.

The research shows that bush fires are currently more frequent compared to 30 years ago. Those fires burn small areas throughout the landscape; and that fire frequency depends on the period at which fire is set and on the quantity of available biomass. Fire set at the beginning of the dry season is not efficient to burn all the available grasses. Those who do not burn can burn a second time during the dry season. Fires during the middle of the dry season are very efficient and burn all the available grasses. Late dry season burning is not efficient because there is less available biomass left to burn at that period.

The burning efficiency analysis shows that the burning efficiency declined during the period 1975-2008. The burning efficiency varies over time because of the availability of grass biomass.

The study of burning regimes shows that the grazing pressure, agricultural intensification (food crops and cash crops), and more firebreaks throughout the landscape modified the burning regimes in the Katiali region. These new burning regimes create a savanna ecosystem composed of several types of vegetations.

II. Land cover change analysis

The land cover change study analyzed vegetation plots of 10 meters x 10 meters in each vegetation class to determine tree and grass species, perennial versus annual grass species, height of trees and grasses, measure of available biomass load in different vegetation types. The study also the historical understanding of vegetation dynamics recorded during, transect walks, surveys and group discussions.

Results show that savanna ecosystem is a complex and differentiated landscape. The sudanian savanna ecosystem is composed of open forest, woodland, gallery forest, bush

savanna, grass savanna, and cropland and fallow fields. The sudanian savanna ecosystem became a more wooded landscape compared to 30 years ago. The major tree species are *Isoberlinia doka*, *Daniallia oliveri*, *Vitellaria paradoxa*, *Pericopsis laxiflora*, *Piliostigma thonningii*, *Entanda africana*, *Azelia africana*, *Ficus capensis*, and *Parkia biglobosa*. The research also shows that grass biomass load is declining while woody vegetation is increasing over time.

The case study of the Katiali region used a political-ecological approach to expand the understanding of burning regimes and to present a more accurate assessment of land use and land cover change in the sudanian savannas.

The study shows that local resource users increasingly use fire early in the dry season as a management tool. Farmers set fire to protect their cashew and mango orchards while herders burn for new grasses that are more palatable to cattle. Early dry season burning is less intense and less efficient, and over the years favors the expansion of woody vegetation in the sudanian savanna. Less intense burning also produces lower gas and aerosol emissions. The resulting increase in vegetation cover could potentially sequester more carbon dioxide than is presently attributed to the system.

Practical Implications

The results of this research are useful to analyze the environmental impact of agricultural and pastoral land use systems in West Africa. The climate change literature argues that farmers and herders increasingly contribute to greenhouse emissions and thus to global climate change. Farmers and herders are said to set intense and highly destructive fires in the middle and late dry season. Environmental policies based on such literature may be misconceived and may negatively affect local farmers and herders' livelihoods.

The research shows that West African farming and pastoral systems lead to more tree cover, which will increasingly sequester more greenhouse gas emissions. This knowledge is very important for environmental policy makers during negotiations in the carbon market such as REDD. The research findings for this study will be available to policy makers such as the National Committee for the Protection of Forests and the Control of Bush Fires, Ministry of Environment, Climate Change Bureau in Cote d'Ivoire, United Nations Framework Convention on Climate Change (UNFCCC), and CIFOR. With updated and accurate environmental information and insights, decision makers will generate conceived environmental policies to implement.

Further Reading

Koné M. et al. (forthcoming): "*Changing Regimes in the Cote d'Ivoire Savannas: Implications for Forest Management and Carbon Sequestration*", will be edited by *Southern Forests: A Journal of Forest Science*

About the Author

--One to two sentences, including contact information about the lead author.

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About the Project

The project examines the use of fires in farming and pastoral practices in the sudanian savanna ecosystem of Cote d'Ivoire and their implications on land cover change and greenhouse gas emissions. The project is still ongoing and will measure during the burning season from October 2008 to April 2009, CO₂ emissions from bush fires.

Annex 5

Using forest in the second national communications to ¹UNFCCC for adaptation in Tropical countries: The cases of ²TroFCCA project countries

Summary

The report constitutes a meta-analysis of the research and policy development activities of the TroFCCA (Tropical Forests and Climate Change Adaptation) project of CIFOR (Center for International Forestry Research) and CATIE (Centro Agronómico Tropical de Investigación y Enseñanza). Countries in each of the three global regions where the project is focused in Central America, West Africa, and Indonesia, were individually analyzed. For each of the countries, gap analysis was done for the first national communications submitted to the UNFCCC (United Nations Framework Convention on Climate Change) in which significant climate risks were identified and opportunities for forest information to alleviate these risks were identified. The outline for the second national communication to the UNFCCC was analyzed and for each point, specific suggestions on how TroFCCA work together with other related forest information could be used to address some of the gaps identified in the first national communications were listed.

Climate change adaptation and mitigation policies and programs such as REDD (Reduced Emissions from Deforestation and Ecosystem Degradation) were examined as well throughout the analysis. An overall conclusion is that climate change adaptation policies in the TroFCCA countries require substantial forest information and that this information be integrated into adaptive policy frameworks based on ecosystem goods and services frameworks. Environmental and economic risks are closely related in the study countries. For example, climate change impacts such as droughts may cause economic downturns by reduced agricultural production, whereas over harvesting of wood resources may accentuate the effects of climate forcing and increase the probability of poverty occurrence. Climate change policies must consider these close connections between ecosystems and societies. Ecosystem goods and services frameworks supplemented with quality forest, economic, and social data is necessary to bridge these two issues.

This analysis showed that there is a common theme and distinct similarities and differences in the role of forest information in all eight countries. In all the countries, forests played an important role in the national inventories of greenhouse gases due to their role in absorbing CO₂ through growth stages. Additionally, forests are globally important as regulating mechanisms in the hydrological cycle. Similarities are shown between the roles of forests in contributing to hydroelectric activity as well as regulating the supply of potable water in Central American countries. Distinct differences were shown between Central America, Indonesia and West Africa. For example, West African countries are less vulnerable to the storms and the resulting deluge-induced inland floods experienced in Central America and Indonesia. Land stability as a function of forest management is therefore emphasized in Central America and Indonesia. The main message is that forest information is important for all countries from a standpoint of climate change adaptation. There are unique contexts for each country that must be considered when formulating climate change adaptation policy.

Forest policies and forest resource flow in Burkina Faso, Ghana and Mali

Conflicting or consistent for adaptation to climate change?

Fobissie B. Kalame, Monica Idinoba, Maria Brockhaus, and Johnson Nkem

Environmental Services and Sustainable Use of Forest Programme, Center for International Forestry Research (CIFOR), West Africa Regional office, Ouagadougou, Burkina Faso

This policy brief analyses forest policies in Burkina Faso, Ghana and Mali and their implication for adaptation and conflicts under climate change. It presents results of studies undertaken by Tropical Forest and Climate Change Adaptation (TroFCCA). The policy brief tracks the flow of specific forest ecosystem goods and services and the potential for social conflicts in the form of disagreement. Divergent views, arguments and clashes are identified.

Policy Conclusion

- Governance is central to adaptive management of forest ecosystem goods and services. Different institutions and actors have differing interests in the same forest ecosystem goods and services characterised by conflicting views.
- There is a growing interest in finding ways to include well designed and articulated climate change adaptation strategies into national forest and other development policies and programmes that increase the adaptive capacity in one community or country without creating more vulnerability in another.
- Rights and access to resources shape local adaptation capacity and response options to climate change. Government policies in Burkina Faso, Ghana and Mali are inflexible with standardised rules on access and tenure rights applicable to all forest resources irrespective of the nature of the provided goods and services, their location or existing customary settings and other prevailing circumstances. This makes it difficult for some forest-dependent communities to use forest resources for adaptation.
- Decision making processes regarding forest ecosystem goods and services lack transparency, active participation and the views of the poor.
- Non-timber forest products are pivotal to livelihoods dependent on natural resources and especially for adaptation responses to climate change, but policies and strategies for their management and development are lacking.



Adaptation, Forest Policies and Conflicts

The United Nations Framework Convention on Climate Change emphasises adaptation policies and activities that promise to address the special needs and concerns of Non-Annex I Parties (i.e. developing countries that are not yet obliged to reduce emissions). These adaptation activities must be carefully planned and decided upon at appropriate regional, national and community levels, regarding how best to reduce vulnerability to climate impacts, and do it in the most effective manner. A broad perspective is needed, otherwise an adaptation action at national, district or local level in one country could decrease adaptability in another. Such opposing adaptation situations, especially in the utilisation of forest and other natural resources, often lead to tension and conflict between different stakeholders such as farmers and cattle

herders, and may also affect local, national and even regional authorities.

Forest resources are used in very different ways in West Africa across household, local and national levels as adaptation measures to drought-induced environmental degradation and to enhance livelihood strategies. Nonetheless, the existing national forest policies of Burkina Faso, Ghana and Mali lack clear policies on climate change, and therefore they are insufficient and not up-to-date to deal with the present global climate change crisis (Box 1).

Situation Analysis of Burkina Faso, Ghana and Mali

Some of the national forest policies and forest strategies of these countries are intended to improve livelihoods and to reduce environmental

Box 1. How adequate are the existing national forest policies for climate change adaptation?

The national forest policies of Burkina Faso, Ghana and Mali generally focus on the environment without any specific policy statement and strategy directly aimed at addressing climate change adaptation issues. These policies focus on biodiversity conservation and sustainable forest management, decentralisation processes, and improved human and environmental wellbeing.

Inadvertently, the United Nation Framework Convention on Climate Change (UNFCCC) came into force in 1994 just when most of the current national forest policies in West Africa were being formulated:

- Burkina Faso ratified UNFCCC in 1993, became a member in 1994 and formulated La Politique Forestière Nationale in 1995.
- Ghana formulated its present Forest and Wildlife Policy in 1994, ratified and became a member of UNFCCC in 1995.
- Mali ratified UNFCCC in 1994 and became a member in 1995, the same year La Politique Forestière Nationale was formulated.

Earlier initiatives that resulted in the revision and adoption of these forest policies began long ago. In the case of Ghana, this started even before the creation of the intergovernmental panel on climate in 1988. At that time, there was not much awareness of or concern about climate change and the role of forests in the process. Climate change has emerged today as a major threat to achieving sustainable provisioning of forest ecosystem goods and services and also in attaining the UN Millennium Development Goals numbers 1, to eradicate extreme poverty and hunger, and 7, to ensure environmental sustainability. Despite the shift in paradigm with new scientific information on the role of forests in achieving these global development targets, forest is still unmentioned in any of the Poverty Reduction Strategy Papers of Burkina Faso, Ghana and Mali. These are disturbing concerns in tackling poverty reduction and environmental issues especially under climate change challenges for tropical countries that largely depend on forest resources for national development and household livelihood.



Livestock in savanna woodlands, Burkina Faso (Photo by Daniel Tiveau)

degradation that could potentially enhance both livelihood and ecosystem adaptation to the impacts of climate change. These policies have to be better targeted, however, and reframed with climate proofing for future scenarios. In their current forms, they are increasingly causing insecurity and conflicts as summarised below.

Conflicts in Reforestation and Afforestation Activities

Drought and desertification coupled with human activities are increasing the depletion of forest resources and environmental degradation in Burkina Faso, Mali and the northern region of Ghana. Reforestation and afforestation initiatives by government, private entities, communities and at household level involving planted and natural regeneration, including large-scale industrial plantations, constitute major response activities, which could pass for adaptation strategies in these countries since the droughts of the 1970s. These strategies, however, have their limitations and

in some cases have resulted in conflicts among stakeholders, Ghana being a case in point.

The government of Ghana is keen on expanding teak plantations, but is doing so without properly and explicitly establishing the rights and obligations of the concerned parties with regards to ownership of both the plantations and the land used in their establishment. This blurry situation easily leads to land right conflicts among families, farming communities and Chiefs, thereby disrupting social structures and institutions. Sève et al. (2006) explained the occurring conflicts in the case of a teak plantation project in Abutia Kpota with the lack of a legally signed document transferring land rights from family and community holdings to the project.

These land use conflicts and land tenure insecurity have a high potential for reducing the adaptive capacity of any community, especially the poor and women, because adaptive capacity is determined partly by the rights to

Box 2. The risk of maladaptation for natural resources–dependent poor

Tree tenure is generally unfavourable to local communities in Ghana because a substantial part of the tree resource base is actually alienated from the farmers who are in direct contact with this resource. This is because the Timber Resource Management Amendment Act (Act 617) of 2002 does not allow the forest-dependent poor to harvest timber from any land, including their farmlands, without legally registering and holding a timber right. Getting authorization and timber utilisation contracts is, however, highly complicated for the local communities, and they now see this as a removal of their rights and benefits and an expropriation of their lands and forest resources (Kotey et al. 1998). Farmers need these tree resources for their livelihood but find no incentives to preserve and sustainably manage them on their lands, partly because they rarely own the land, but mainly because they do not own the tree and are compensated inadequately for damages incurred by logging on their farmlands. As a result, the mismanagement of these forest resources by farmers leads to maladaptation in response to climate impacts.

utilise forest and land resources for livelihood security and food in response to drought- or flood-induced famine. In this case, tenure insecurity is liable to turn adaptation into maladaptation (Box 2).

Charcoal Production: The State versus the People

Charcoal production and other human activities coupled with the impacts of drought and desertification are perceived to cause accelerated environmental degradation and desertification in Burkina Faso, Ghana and Mali—a perception not necessarily supported by scientific evidence. There exist public policies based on perceptions rather than science-based evidence (DEAR 2005), whereby Chiefs and District Assemblies (DAs) in some areas of Ghana (also in Burkina Faso) ban charcoal production for use as a household energy although alternative energy sources are seldom provided. Charcoal production provides alternative off-farm income activities for many local households and it drives the trade links between rural and urban communities. The banning of charcoal production has provoked conflicts and accusations among various interest groups. For example:

- Charcoal producers in the Kintampo North and Kintampo South districts in Ghana (Amanor et

al. 2005) and in Burkina Faso (MECV 2005) are accused of catalysing environmental degradation by causing bushfires in the forest and cutting trees along riverbanks. Charcoal producers, however, argue that they use fast coppicing and pyrogenic species and that timber merchants and chainsaw operators authorised by Chiefs are responsible for the bushfires and environmental degradation.

- Conflicts often arise (in Ghana for example) between charcoal producers and farmers over the rights to trees and between Chiefs and DAs that have the custody rights to regulate charcoal (Amanor and Brown 2003). In principle, Chiefs have the authority to issue exploitation rights for non-timber products to any person, while DAs are responsible for developing environmental management regulations which in some situations are deliberately used to regulate and even ban charcoal production, thus overturning the Chiefs' power under the pretext that it encourages desertification.

Like any other interest group, charcoal producers believe they have the right to their livelihood activity. Thus, national policy responses by authorities to either climate change or other drivers for environmental degradation need to consider the

tradeoffs and implications of each measure to avoid new crises. Specifically, a regulatory framework is needed that (a) limits the application of (intended as well as unintended) inappropriate and anti-poor policies implemented by Chiefs, DAs, forestry officers and the state and (b) strengthens participatory approaches that integrate the views of farmers and charcoal burners in the decision making processes to promote a sustainable charcoal production.

Access to Forest Resources for Adaptation

Climate change and some aspects of existing forest policies increasingly undermine livelihood security by reducing access to forest resources that are important to sustaining livelihoods. The Ghana government's Forest Protection Amendment Act (Act 624) of 2002 restricts community access to forest products within forest reserves. By contrast, government policies in Burkina Faso (Articles 55–59 of the Forestry Code) and Mali allow access rights to communities for non-timber forest products within forest reserves especially for subsistence purposes (Box 3). These different access rights determine the resource base communities can act upon to adapt during climatic shocks.



Clearing trees for charcoal production, Ghana
(Photo by Fobissie B. Kalame)

Some policies and regulations that restrict access and user rights tend to encourage the management and provision of particular ecosystem services, however, and are necessary to halt the threat of species extinction. In Mali, the cutting of trees and clearing of vegetation is prohibited around water sources and courses, and also around sand dunes and hills that are at risk of erosion. Tree cutting is only permitted beyond 25m from these areas. Policies and regulations prohibiting the cutting of trees in these areas will rather help in stabilising sand dunes and reducing the vulnerability of communities to the threats posed by the encroaching desert.

Box 3. Non-timber forest products and climate change adaptation

In many parts of West Africa, forest products are central to adaptation, which in turn ensures that livelihoods are not threatened by climate change. These non-timber forest products include deadwood, wild fruits, vegetables, fodder and medicinal plants. They represent the subsistence lifelines and economic base of many forest-dependent communities and act as buffer and safety nets (CIFOR 2006) during periods of climate-induced crop failures and famine especially in marginal agricultural areas. Climate change is already affecting these forest goods threatening livelihoods as well as limiting the implementation of national development programmes.

Despite the central role of forests in local adaptive response, there are no clear policies linking climate change adaptation and non-timber forest products. The lack of clearly articulated financial benefits of non-timber forest products (except for bushmeat, firewood and sheabutter) to the gross domestic products of Burkina Faso, Ghana and Mali has led to insufficient recognition in national planning of their contributions to local livelihoods adaptation response measures.



Non Timber Forest Products (NTFPs), Medicinal plants
(Photo by Monica Idinoba)

Besides the need for a national regulatory framework, it is important for access right policies to be place-based, contextual, locally adapted and highly flexible in application and compliance.

Decentralisation Processes

The decentralisation of natural resource management provides opportunities for adaptation to climate variability and climate change impacts on natural resources and natural resource-dependent communities in West Africa (Elasha et al. 2007). - This situation could be applicable to farming communities in Burkina Faso and Mali that are using integrated land and forest management approaches. It could, however, exacerbate vulnerability in pastoral communities as most grazing corridors around forest areas have been mapped out for permanent farming activities, thereby restricting pastoral mobility for grazing as an adaptation response. This limitation again nurses the potential for conflict between farmers and herders as occurred in August 2007 at Gogo,

Central South Region of Burkina Faso, and in the Niger Delta in Mali between transhumant Peuls and Rimaibes farmers over contested grazing territory, which led to the loss of lives (Maïga and Diallo 1998). In the Central West and East of Burkina Faso, farmlands and grazing corridors have been expropriated by agribusinesses with the financial resources for establishment of commercial export crops like cotton. These ambitions have resulted in extensive forest clearing, sometimes displacing traditional farmers and pastoralists who originally used the land (Ouédraogo 2003). In search of livelihood, there is forced migration of activities increasing the pressure on the remnant forest and starting new cycles of environmental degradation and conflicts.

These examples highlight some of the issues in the process of decentralisation that need to be overcome in improving resource governance and livelihood as a means to enhance the adaptive capacity of local communities. Results from a TroFCCA case study in southwest Burkina Faso indicate that decentralisation offers strong opportunities for design and implementation of adaptation strategies under growing institutional flexibility, higher responsiveness and selective planning and implementation at local level. Success, however, can be hindered by lack of learning capacities, lack of knowledge, growing conflict potential among resource users and a biased agenda setting for adaptation due to perceived tradeoffs among the various sectors.

The Way Forward

The above discussion underscores the limitations of current forest policies in the three study countries in West Africa. There is a need for a comprehensive review and reform of national forest policies and

strategies in West Africa as climate change emerges as the greatest challenge humankind faces in the 21st century. Such integrative reforms are crucial to ensuring national development and peaceful co-existence of the various stakeholders. Policy reform will not only reduce negative impacts of climate change, but also have the potential of creating good opportunities for adaptation.

A participatory action approach that engages all the stakeholders in a dialogue will provide the opportunity to negotiate acceptable outcomes and compromises among stakeholders in balancing their multiple interests in the policy process, because active participation of all stakeholders in decision making processes will (a) help eliminate the risk of any single group dominating or forcing its own agenda and (b) secure active involvement of local communities. Steps should therefore be taken to ensure

- active involvement of local resource users and reflection of their views in the decision-making processes at both local and state levels;
- creation of a multistakeholder and cross-sectoral platform for integrated land use planning;
- improved resource ownership and user rights, especially the rights of smallholders and communities;
- enforcement of mechanisms for conflict mediation among resource users;
- encouragement of political will by politicians and elites to support local activities that promote forest and natural resources for adaptation responses; and
- encouragement of implementation of good governance (accountability, transparency, partnership).



Non Timber Forest Products, Medicinal products in the market
(Photo by Monica Idinoba)

Some of the new policy approaches in integrating climate change adaptation into forest policies include forging links to the ongoing Africa Forest Law Enforcement and Governance process, and also the initiative for a common West African regional forest policy in which Burkina Faso, Ghana and Mali are members. The integration of an adaptation outlook into the existing livelihood improvement aspects of these ongoing forest policy processes has the potential to reduce conflicts and improve the resilience of communities.

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Politiques forestières et utilisation des ressources au Burkina Faso, au Ghana et au Mali

Sont-elles compatibles avec l'adaptation au changement climatique?

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Ce dossier analyse les politiques forestières au Burkina Faso, au Ghana et au Mali et leurs implications pour l'adaptation au changement climatique. Il présente les résultats d'études entreprises par le projet Forêts tropicales et adaptation au changement climatique (TroFCCA). Il suit à la trace le flux des biens et services spécifiques de l'écosystème forestier et analyse les conflits sociaux potentiels qui peuvent survenir dans l'utilisation des ressources tout en identifiant les différents points de vue divergents.

Aspects politiques à prendre en compte

- La gouvernance est fondamentale pour une gestion adaptative des biens et services de l'écosystème forestier. Les différentes institutions et les divers acteurs ont des intérêts divergents par rapport aux mêmes biens et services de l'écosystème forestier et cela engendre des points de vue conflictuels.
- Il y a un intérêt croissant à trouver des moyens d'inclure des stratégies d'adaptation au changement climatique bien conçues et bien articulées dans les politiques forestières nationales et les autres politiques et programmes de développement visant l'augmentation de la capacité adaptative dans une communauté ou un pays sans créer plus de vulnérabilité dans une autre communauté ou un autre pays.
- Les droits et l'accès aux ressources façonnent la capacité locale d'adaptation et les options de réponse au changement climatique. Les politiques gouvernementales au Burkina Faso, au Ghana et au Mali sont inflexibles et comportent des règles standardisées sur les droits d'accès et les droits fonciers applicables à toutes les ressources de la forêt sans tenir compte de la nature des biens et services fournis, de leur emplacement, des arrangements habituels existants ou d'autres circonstances ponctuelles. Ceci pose un certain problème à certaines communautés qui dépendent de la forêt et qui utilisent ses ressources pour l'adaptation au changement climatique.
- Les processus décisionnels concernant les biens et services de l'écosystème forestier manquent de transparence, ne sont pas élaborés de manière participative et ne tiennent pas toujours compte des points de vues des couches défavorisées.
- Les produits forestiers non ligneux sont cruciaux pour les moyens d'existence basés sur l'exploitation des ressources naturelles et particulièrement pour des réponses d'adaptation au changement climatique, mais il manque des politiques et stratégies pour leur gestion et leur développement.



Adaptation, politiques forestières et conflits

La convention cadre des Nations-Unies sur le changement climatique met l'accent sur les politiques et activités d'adaptation prometteuses pour la prise en compte des besoins et soucis particuliers des Parties Non-Annexes I (c'est-à-dire les pays en voie de développement qui ne sont pas encore obligés de réduire leurs émissions). Ces activités d'adaptation doivent être soigneusement planifiées et déterminées aux niveaux régional, national et communautaire appropriés pour voir comment mieux réduire la vulnérabilité aux impacts climatiques, de la manière la plus efficace. Il est nécessaire d'avoir une vision large pour éviter qu'une action d'adaptation au niveau national, du district ou local dans un pays ne diminue l'adaptabilité dans un autre. De telles situations contrastantes d'adaptation, notamment dans l'utilisation de la forêt et d'autres ressources naturelles, mènent souvent à des tensions et conflits

entre différents dépositaires tels que les agriculteurs et éleveurs. Elles peuvent aussi avoir un effet sur les autorités locales, nationales voire régionales.

Les ressources de la forêt sont utilisées de manières très diverses à travers l'Afrique de l'Ouest aux niveaux ménage, local et national comme mesures d'adaptation à la dégradation environnementale induite par la sécheresse et pour accroître les stratégies de moyens d'existence. Mais, les politiques forestières nationales au Burkina Faso, au Ghana et au Mali manquent de références claires au changement climatique, et de ce fait, elles sont insuffisantes et non-actualisées pour prendre en charge la crise globale du changement climatique (Encadré 1).

Analyse de la situation au Burkina Faso, au Ghana et au Mali

Certaines des politiques et stratégies forestières nationales de ces pays prévoient d'améliorer les

Encadré 1. Quelle place les politiques forestières nationales existantes font-elles à l'adaptation au changement climatique?

Les politiques forestières nationales du Burkina Faso, du Ghana et du Mali se focalisent généralement sur l'environnement sans aucune déclaration et stratégie spécifiques sur les questions d'adaptation au changement climatique. Ces politiques se concentrent sur la conservation de la biodiversité et la gestion durable de la forêt, les processus de décentralisation, et l'amélioration du bien-être humain et environnemental.

Par coïncidence, la Convention Cadre des Nations-Unies sur le Changement Climatique (UNFCCC) est entrée en vigueur en 1994 au moment même de la formulation de la plupart des politiques forestières nationales en Afrique de l'Ouest :

- Le Burkina Faso a ratifié l'UNFCCC en 1993, en est devenu membre en 1994 et a formulé sa Politique forestière nationale en 1995.
- Le Ghana a formulé sa Politique forêt et faune actuelle en 1994, a ratifié l'UNFCCC et en est devenu membre en 1995
- Le Mali a ratifié l'UNFCCC en 1994 et en est devenu membre en 1995 et c'est la même année que la Politique forestière nationale a été formulée.

Des initiatives précédentes qui ont vu la révision et l'adoption de ces politiques forestières ont commencé, il y a bien longtemps. Dans le cas du Ghana, c'était avant la création du comité intergouvernemental sur le climat en 1988. En ce moment, il n'y avait pas une forte prise de conscience du problème du changement climatique et du rôle des forêts dans le processus. Le changement climatique a émergé aujourd'hui comme une menace importante pour la disponibilité pérenne des biens et services de l'écosystème forestier et également pour l'atteinte des Objectifs du Millénaire pour le Développement de l'ONU, notamment l'objectif 1 sur la suppression de la pauvreté et de la faim extrême, et l'objectif 7 sur la pérennité environnementale. En dépit de la variation dans le paradigme avec la nouvelle information scientifique sur le rôle des forêts dans la réalisation de ces objectifs globaux de développement, la forêt n'est pas toujours mentionnée dans les documents de stratégie de réduction de la pauvreté du Burkina Faso, du Ghana et du Mali. Cet état de fait est préoccupant dans le contexte de la réduction de la pauvreté et des questions environnementales particulièrement sous l'angle des défis du changement climatique dans les pays tropicaux qui dépendent en grande partie des ressources de la forêt pour le développement national et les moyens d'existence des ménages.



Le bétail dans la savane arborée, Burkina Faso. Photo Daniel Tiveau

moyens d'existence et de réduire la dégradation environnementale de sorte à potentiellement accroître à la fois les moyens d'existence et l'adaptation de l'écosystème aux impacts du changement climatique. Ces politiques doivent être plus ciblées et restructurées en tenant compte de l'épreuve climatique par rapport à différents scénarios futurs. Sous leurs formes actuelles, ces politiques sont source d'insécurité et de conflits tels que récapitulés ci-dessous.

Conflits dans les activités de reforestation et de reboisement

La sécheresse et la désertification couplées aux activités humaines augmentent l'appauvrissement des ressources forestières et la dégradation de l'environnement au Burkina Faso, au Mali et dans la partie Nord du Ghana. Les initiatives de reforestation et de reboisement par le gouvernement, les entités privées, les communautés et au niveau des ménages comportant la régénération plantée et naturelle, y compris les plantations industrielles à grande échelle, constituent les principales activités de réponse, qui pourraient passer pour des stratégies d'adaptation dans ces pays depuis les sécheresses des années 70. Ces stratégies, cependant, ont leurs

limites et dans certains cas ont eu pour conséquence des conflits entre les dépositaires, le Ghana étant un bon exemple.

Le gouvernement du Ghana encourage l'expansion des plantations de teck, mais il agissait sans convenablement et explicitement établir les droits et les obligations des parties intéressées quant à la propriété des plantations et des terres utilisées. Cette situation peu claire entraîne aisément des conflits de droit de terres entre les familles, les communautés d'exploitation agricole et les chefs, perturbant ainsi les structures sociales et les institutions. Seve et al (2006) ont expliqué les circonstances des conflits dans le cas du projet de plantation de teck à Abutia Kpota en l'absence de documents légalement signés transférant les droits de propriété des familles et les possessions communautaires au projet.

Ces conflits sur l'utilisation des terres et l'insécurité foncière ont un fort potentiel à réduire la capacité adaptative des communautés, particulièrement les pauvres et les femmes, parce que la capacité adaptative est déterminée en partie par les droits d'utilisation des ressources de la forêt et des terres pour la sécurité alimentaire et les moyens d'existence en réponse à la

Encadré 2. Le risque de mauvaise adaptation pour les pauvres dépendant des ressources naturelles

Le système foncier arboricole est généralement défavorable aux communautés locales au Ghana parce qu'une partie substantielle de la base des ressources arboricoles échappe aux agriculteurs qui sont en contact direct avec cette ressource. Ceci en raison du fait que l'acte d'amendement de la gestion des ressources en bois de construction (Acte 617) de 2002 ne permet pas aux pauvres qui dépendent de la forêt de couper du bois de construction sur aucune surface que ce soit, y compris leurs champs, sans légalement enregistrer et posséder les droits de bois de construction. Obtenir l'autorisation et des contrats d'utilisation du bois de construction est une procédure fortement complexe pour les communautés locales, qui, à la longue, perçoivent cette imposition comme un déni de leurs droits et avantages et une expropriation de leurs terres et de leurs ressources forestières (Kotey et al. 1998). Les agriculteurs ont besoin de ces ressources arboricoles pour leur moyens d'existence, mais n'ont aucune motivation à les préserver et les gérer durablement sur leurs terres, en partie parce qu'ils sont rarement les propriétaires de la terre, mais principalement parce qu'ils ne possèdent pas d'arbres et ne reçoivent pas de compensations suffisantes pour les dommages encourus dans l'exploitation du bois à travers leurs champs. Par conséquent, la mauvaise gestion de ces ressources forestières par les agriculteurs conduit à la mauvaise adaptation en réponse aux impacts climatiques.

famine ou à la sécheresse. Dans ce cas-ci, l'insécurité foncière risque de rendre l'adaptation 'inadaptée' (Encadré 2).

Production de charbon de bois : l'état contre les milieux ruraux défavorisés

La production de charbon de bois et d'autres activités humaines couplées aux impacts de la sécheresse et de la désertification sont perçues comme la cause de la dégradation de l'environnement et de la désertification accélérées au Burkina Faso, au Ghana et au Mali - une perception pas nécessairement soutenue par des preuves scientifiques. Dans certaines régions du Ghana (et parfois du Burkina Faso), des chefs et des Assemblées de District (AD), se fondant sur des politiques publiques basées sur des perceptions plutôt que des preuves à base scientifique (DEAR 2005), ont banni la production du charbon de bois à des fins d'énergie domestique pour les ménages alors même que des sources d'énergie alternatives ne sont que rarement fournies. La production du charbon de bois constitue une activité alternative de génération de revenus hors des plantations pour beaucoup de ménages locaux et elle contribue aux liens commerciaux entre les communautés rurales et urbaines. Son interdiction a engendré des conflits et suscité des accusations provenant de différents groupes d'intérêts. Par exemple:

- Les producteurs de charbon de bois des zones Nord et Sud de Kintampo, au Ghana (Amanor et al. 2005) et ceux du Burkina Faso (MECV 2005) sont accusés de catalyser la dégradation

de l'environnement en causant des feux de brousse et en coupant des arbres le long des cours d'eau. Les producteurs de charbon de bois, eux, soutiennent qu'ils utilisent des espèces bourgeonnantes et pyrogènes rapides et que c'est les marchands de bois de construction et les opérateurs de tronçonneuses autorisés par les Chefs qui sont responsables des feux de brousse et de la dégradation de l'environnement.

- Des conflits surgissent souvent (au Ghana, par exemple) entre les producteurs de charbon de bois et les agriculteurs au sujet des droits sur les arbres et entre les chefs et les Assemblées de District (AD) qui ont des droits de surveillance pour réglementer le charbon de bois (Amanor and Brown 2003). En principe, les chefs ont autorité pour délivrer les droits d'exploitation des produits forestiers non ligneux, alors que les AD ont la responsabilité d'élaborer les règlements de gestion de l'environnement qu'ils utilisent dans certains cas pour délibérément interdire la production de charbon de bois, cassant de fait les pouvoirs des chefs sous le prétexte que cela encourage la désertification.

Comme tout groupe d'intérêt, les producteurs de charbon de bois croient qu'ils ont le droit d'exercer leur activité de subsistance. Les réponses des politiques nationales au changement climatique ou à d'autres moteurs de dégradation de l'environnement doivent donc prendre en compte les différences et évaluer les implications de chaque mesure afin d'éviter de

nouvelles crises. Une structure réglementée est nécessaire notamment pour (a) limiter l'application (de manière prévue ou fortuite) des politiques inadéquates et anti-pauvres mises en oeuvre par les Chefs, les AD, les responsables de la sylviculture et l'état et (b) renforcer des approches participatives intégrant les point de vues des agriculteurs et des producteurs de charbon de bois dans les processus décisionnels afin de favoriser une production durable du charbon de bois.

Accès aux ressources forestières pour l'adaptation

Le changement climatique et quelques aspects des politiques forestières existantes sapent de plus en plus la sécurité des moyens d'existence en réduisant l'accès aux ressources forestières qui sont importantes pour l'appui aux moyens d'existence. L'acte d'amendement à la protection des forêts du gouvernement du Ghana (acte 624) de 2002 limite l'accès de la communauté aux produits forestiers dans les réserves forestières. En revanche, au Burkina Faso (article 55-59 du code de sylviculture) et au Mali, les politiques gouvernementales donnent aux communautés des droits d'accès aux produits forestiers non ligneux dans les réserves forestières, en particulier pour des raisons de subsistance (Encadré 3). Ces différents droits d'accès déterminent comment les communautés ayant une même base de ressources peuvent agir pour s'adapter aux chocs climatiques.



Coupe des arbres pour la production du charbon, Ghana.
Photo Fobissie B. Kalame

Quelques politiques et règlements limitant les droits d'accès et d'utilisation et tendant à encourager la gestion et la fourniture de services spécifiques par l'écosystème sont, cependant, nécessaires pour arrêter la menace sur l'extinction des espèces. Au Mali, la coupe d'arbres et le défrichage de la végétation sont interdits autour des sources et des cours d'eau, et autour des dunes de sable et des collines en danger d'érosion. La coupe d'arbres est seulement autorisée à 25m au delà de ces secteurs. Les politiques et règlements interdisant la coupe d'arbres dans ces secteurs aideront plutôt à stabiliser les dunes de sable et à réduire la vulnérabilité des communautés aux menaces posées par l'empiétement du désert.

Encadré 3. Les produits forestiers non ligneux et l'adaptation au changement climatique

Dans beaucoup de régions d'Afrique de l'Ouest, les produits forestiers sont vitaux à l'adaptation et constitue une sorte de garantie pour que les moyens d'existence ne soient pas menacés par le changement climatique. Ces produits forestiers non ligneux incluent les bois morts, les fruits sauvages, les légumes, le fourrage, et les plantes médicinales. Ils constituent des moyens alternatifs de subsistance et la base économique de beaucoup de communautés dépendant de la forêt et servent de remparts de sécurité (CIFOR 2006) en cas de pertes de récoltes et de famines engendrées par le climat particulièrement dans les zones agricoles à faible rendement. Le changement climatique affecte déjà ces biens forestiers et menace les moyens d'existence en plus de limiter l'exécution des programmes de développement national.

En dépit du rôle central des forêts dans la réponse adaptative locale, il n'y a aucune politique claire visant à faire un lien entre l'adaptation au changement climatique et les produits forestiers non ligneux. Au Burkina Faso, au Ghana et au Mali, le manque d'avantages financiers clairement articulés des produits forestiers non ligneux (à l'exception de la viande de brousse, du bois de chauffage et du beurre de karité) dans le cadre des produits intérieurs bruts a conduit à une prise en compte insuffisante dans la planification nationale de leurs contributions aux mesures locales de réponse à l'adaptation des moyens d'existence.



Les produits forestiers non ligneux, les plantes médicinales.
Photo Monica Idinoba

Outre le besoin d'une structure nationale de régularisation, il est important que les politiques de droit d'accès soient localisées, contextuelles, adaptées et très flexibles dans leur application.

Processus de décentralisation

La décentralisation de la gestion des ressources naturelles présente des moyens d'adaptation aux impacts de la variabilité et du changement climatiques sur les ressources naturelles et les communautés dépendant des ressources naturelles en Afrique de l'Ouest (Elasha *et al.* 2007). Cette situation peut s'appliquer aux communautés d'exploitation agricole au Burkina Faso et au Mali qui utilisent des approches de gestion intégrée du sol et de la forêt. Elle pourrait, cependant, aggraver la vulnérabilité des communautés pastorales car la plupart des couloirs de pâturage autour des zones forestières sont utilisés pour des activités agricoles permanentes, limitant de ce fait la mobilité pastorale pour le pâturage comme réponse d'adaptation. - Cette limitation est une source potentielle de conflits entre agriculteurs et éleveurs comme ce fut le cas en août 2007 à Gogo, dans la région Centre Sud du Burkina Faso, et dans le delta du Niger au Mali entre les Peuls transhumants et les agriculteurs Rimaibes sur des zones de pâturage contestées, conflits entraînant toujours des pertes en vies humaines (Maiga and Diallo, 1998). Dans

le Centre Ouest et à l'Est du Burkina Faso, des terres agricoles et les couloirs de pâturage ont été expropriés par des entreprises agricoles disposant de ressources financières pour la production de cultures commerciales d'exportation comme le coton. Ces ambitions ont eu pour conséquence un défrichage inconsidéré de la forêt et parfois le déplacement des agriculteurs et éleveurs qui utilisaient les terres à l'origine (Ouedraogo 2003). Dans la recherche des moyens d'existence, il y a une migration forcée des activités, ce qui entraîne la pression sur la forêt restante, de nouveaux cycles de dégradation de l'environnement et des conflits.

Ces exemples mettent en exergue certains aspects du processus de décentralisation qui doivent veiller à améliorer la gouvernance des ressources et des moyens d'existence comme moyens d'augmentation de la capacité adaptative des communautés locales. Les résultats d'une étude de cas du projet TroFCCA dans le Sud-Ouest du Burkina Faso indique que la décentralisation offre de grandes opportunités pour la conception et l'exécution de stratégies d'adaptation dans un cadre accru de flexibilité institutionnelle, de rendement élevé, et de planification et exécution sélectives au niveau local. Le succès, cependant, peut être entravé par le manque de capacités d'apprentissage, de connaissances, la menace potentielle croissante de conflits entre les utilisateurs des ressources, et un programme d'adaptation biaisée à travers les différences importantes entre les divers secteurs.

Perspectives d'avenir

La discussion ci-dessus montre les limites des politiques forestières actuelles dans les trois pays de l'étude, en Afrique de l'Ouest. Une revue et une réforme complète des politiques et stratégies forestières nationales en Afrique de l'Ouest sont nécessaires, car le changement climatique émerge de plus en plus comme le grand défi auquel l'humanité est confrontée en ce 21^{ème} siècle. De telles réformes intégrantes sont cruciales pour assurer le développement national et la coexistence paisible des divers dépositaires. Les réformes politiques réduiront non seulement les impacts négatifs du changement climatique, mais elles comportent également un potentiel à susciter de bonnes opportunités pour l'adaptation.

Une approche participative engageant tous les dépositaires dans un dialogue direct fournirait l'opportunité de négocier des résultats et des compromis acceptables par tous à travers l'équilibrage des intérêts multiples dans les processus politiques. La participation active de tous les dépositaires dans les processus décisionnels va aider (a) à éliminer le risque qu'un seul groupe domine ou impose son programme et (b) à obtenir la participation active des communautés locales. Des mesures devraient donc être prises pour assurer :

- La participation active des utilisateurs des ressources locales et le reflet de leurs points de vues dans les processus de prises de décisions aux niveaux local et étatique ;
- La création d'une plate-forme multi-dépositaire et multi-sectorielle pour la planification intégrée de l'utilisation du sol;
- L'amélioration du droit de propriété des ressources et des droits d'utilisation, particulièrement les droits des petits exploitants et des communautés ;
- La mise en application des mécanismes pour la médiation de conflits au sein des utilisateurs des ressources ;
- L'encouragement de la volonté politique à soutenir les activités locales qui promeuvent la forêt et les ressources naturelles pour des réponses d'adaptation ;
- L'encouragement de la bonne gouvernance (responsabilité, transparence, partenariat).

Certaines des nouvelles approches politiques d'intégration de l'adaptation au changement climatique dans les politiques forestières incluent la création de liens avec le processus d'application en cours des lois forestières, le processus de gouvernance et l'initiative pour une politique forestière ouest africaine commune dont le Burkina Faso, le Ghana et le Mali seraient membres. L'intégration des perspectives d'adaptation aux aspects existants d'amélioration des moyens d'existence dans ces processus de politiques forestières en cours a le potentiel de réduire les conflits et d'améliorer la résilience des communautés.



Les produits forestiers non ligneux, Produits médicinaux commercialisés. Photo Monica Idinoba

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Adaptation at the interface of forest ecosystem goods and services and livestock production systems in Northern Mali

Maria Brockhaus & Houria Djoudi

Key points

- Spontaneous or autonomous reactive adaptation in response to climate change can be observed in the ecological and human subsystems around forests and local ecosystem services.
- Adaptation in the socio-political subsystem is entirely lacking or lagging behind, and this is hindering the switch from spontaneous to planned adaptation through reflective and strategic decision-making processes.
- Local adaptation needs development interventions that take into account existing strategies, to avoid maladaptive action or even action nullifying local adaptation efforts.
- Coordination needs to improve across all levels, sectors, and actors in public and private spheres, to support sustainable adaptation processes in the social-ecological system.
- Local adaptation needs adaptive governance at all levels to support a planned approach and to meet the criteria for sustainable natural resource management.

Adaptation to climate change is a need and a challenge for ecosystems, for human beings, and for governance systems at all levels. In West Africa, livelihoods depend heavily on forest ecosystem goods and services, often in interplay with agricultural and livestock production systems. Technical and societal adaptation is needed to reduce the growing risk of vulnerability under climate change.

National policies and programs as well as development interventions need to be designed so that adaptation is not hindered but enabled. Revised governance structures may support adaptation at multiple levels and layers (Brockhaus & Kambire, 2009). Local institutions in particular play a key role (Agrawal 2008). However, gaps are often observed between local adaptation realities and the global and national processes. Even though local adaptation frequently occurs autonomously and spontaneously, adaptation and the importance of forest ecosystem goods and services have not yet been sufficiently mainstreamed into governance structures, policies, regulations, and development projects and programs (Locatelli *et al.* 2008). Consequently, local adaptation to climate change for sustainable natural resource management lacks an appropriate political and institutional framework, or can even be counteracted by interventions that do not take account of existing local adaptive responses. Further efforts are needed to link local efforts to national and global approaches, and ensure planned and strategic adaptation to climate change.

This is confirmed by preliminary results from a comparative study on adaptation at the interface

between forests and mobile and sedentary livestock production systems. The study was conducted in the Tombouctou region, district of Goundam, in the northern part of Lake Faguibine, Mali. It was undertaken by the EU-financed research project TroFCCA (Tropical Forests and Climate Change Adaptation) from July to October 2008.

The study was designed as demand-oriented research combining national and local activities. In order to feed research results immediately into on-going adaptation processes, the site selection was based on an initial interview phase at national level to harmonise research activities with national processes. This was followed by further interviews at regional level (Tombouctou) and a workshop on vulnerability and adaptation to climate change at district level (Goundam). An intense field research was then undertaken at two sites north of the Lake Faguibine area (Tin Aicha and Raz'al'Ma), combining bio-physical (transects: forest cover, density, estimation of biomass production, etc.) and participatory social research related to livestock production systems, natural resource utilization and adaptation strategies. To capture various perspectives and preferences in line with other vulnerability studies in Mali, workshops were carried out with three different groups: adult men, women and young people.

The last research phase was aimed at informing national and international stakeholders in Mali on local adaptation responses. Here, science could act as a

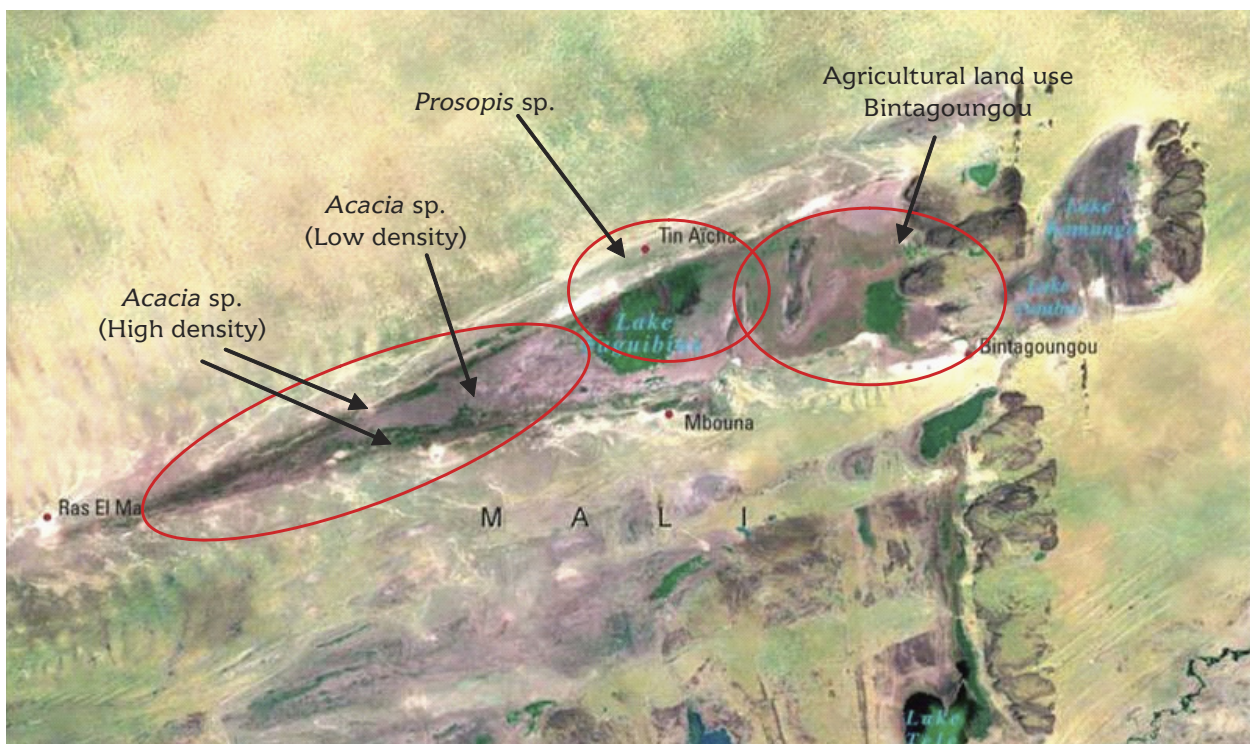
bridge and broker between local realities and national interests.

The ecological sub-system

In the past, the Lake Faguibine was a priority area for agriculture and fishery, but the Niger River-fed water system dried out with the droughts of the 1970s and 80s. Although the region has a long history of rainfall variability, the trend in recent decades has been consistent with climate change scenarios, with lower rainfall and more frequent, more severe droughts. This trend has contributed to Lake Faguibine drying out completely (Salomon *et al.* 1987). Various development interventions have taken place since then, are ongoing or planned for the near future with the aim, among other objectives, of restoring the traditional water-based economic activities (for example Ministère de l'Agriculture 2005; <http://www.unep.org/pdf/Lake-Faguibine.pdf>).

However, the Lake Faguibine ecosystem has changed drastically and a transition from a water-based to a forest ecosystem has taken place. Indeed, more than a third of the lake area has naturally reforested with *Acacia* sp. and *Prosopis* sp. (which was introduced in the 1980s as a measure against desertification and to protect the lake edges). The highly invasive *Prosopis* sp. has reforested areas at a faster rate than local species such as *Acacia* sp. on the north-western side.

Sites, forest cover and reforestation trends 2008



Source: NASA October 2006, with author additions

Climate-related changes are one driver for the lake's ecosystem transformation, but other factors have also contributed to this natural reforestation. They include the lake area's high soil fertility and the strong reduction in animal pressure during the rebellion in the 1990s. The research results suggest that the area's ecological sub-system has undergone an autonomous adaptation, enabled by a plurality of factors. However, full use of potential forest ecosystem goods and services from *Prosopis* and *Acacia*, such as fodder and charcoal, would need an enhanced forest management system.

The human sub-system

The social sub-system is undergoing adaptive changes to exploit forest resources. Agricultural and fishery-based systems are being transformed into agro-sylvo-pastoral, and the pastoral systems to sylvo-pastoral. The forests play an extremely important role in the livestock systems, especially as a safety net in dry years.

However, there is a strong distortion between the perceived value of the forest and the de-facto use of its ecosystem goods and services. This can be explained by psychological barriers due to the massive change and 'traumatism' attached to the ecosystem's transformation; these may hinder acceptance of the change, followed by strategic and planned adaptation. The wish for a 'return of the lake' is also nurtured by promises from various parties over the past three decades.

Younger people in the villages often regard migration strategies as a necessary but not preferred way of adaptation; many express concern about instability and losing social networks if they leave their communities. Given a choice, they would rather stay home. Migration patterns can be differentiated as reactive adaptation with 'no-return', or as strategic adaptation to support the remaining population/family through external income or knowledge transfer by: a) settling outside the supported system and transferring capital or, b) accumulating capital outside and investing by returning to the community. Women have adapted to the new forest ecosystem by identifying new income-generating activities such as charcoal. However, market access will be the key to their success. Other responses are related to the livestock systems, where herd diversification is a major trend along with changing patterns of mobility including combining partially sedentary and partially mobile herds.

The research results show that the human or social sub-system is adapting to climate change in a spontaneous or autonomous way, but long-term resource management planning and therewith a strategic adaptation for the use of the ecosystem goods and services under climate change was not observed.



Photo by Maria Brockhaus

Adults meeting in Tin Aicha (historical axe and fodder calendar as participatory tools)

The socio-political sub-system

Despite the observed local adaptation efforts, these processes are not accompanied by adequate institutional and political change and so remain isolated and spontaneous. Even in a decentralization context, institutional and political support for local adaptation could not be observed:

- (1) No management plans or other local institutions to sustainably manage the forest resources could be identified.
- (2) No technical or capacity support by governmental bodies to manage the forest could be identified (knowledge, forest infrastructure investments, and so forth).
- (3) No efforts by development or government agencies to valorize the forest ecosystem goods and services (markets, access) could be identified.
- (4) No adaptive legislative framework exists (land not used for agriculture becomes state property after 10 years).
- (5) The ongoing decentralization process has not transferred rights and resources for forest ecosystem goods and services until now.

The local population seems to be entirely disconnected from higher-scale planning and decision-making processes, especially higher-level adaptation activities. Adaptation to the new situation (which has actually existed for more than 30 years) could not be observed in the socio-political subsystem.



Forests providing fodder resources

However, spontaneous or autonomous local adaptive responses will not be sufficient to fulfill criteria for long-term sustainable natural resource management. To ensure sustainable adaptation, the institutional and political governance structure across all levels needs to show willingness and flexibility to ensure strategic and planned adaptation from the local to the global level. Such processes could be supported by improving horizontal and vertical coordination of adaptation and development activities. Further investments are needed in capacity building, and technical, financial, and scientific resources, to support the adaptation already taking place at the interface of livestock production systems and forests, in the Lake Faguibine area, and elsewhere.

Development interventions need to further mainstream adaptation to climate change in the planning and implementation processes, so as to avoid disturbing local adaptation efforts and instead support these spontaneous adaptation processes.

Ongoing efforts for more sustainable long-term development should be supported over realizing short-term economic or political gains.

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Adaptation to climate change in Africa Synergies with biodiversity and forest

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Forests, and the biodiversity contained within them play key roles in supporting national economic activities and providing livelihood portfolios for many in Africa. They provide valuable ecosystem services such as climate regulation, hazard protection, water conservation, watershed protection, and also provisioning goods such as fuelwood, foods and nutritional supplements, and medicinal products etc. Forests are therefore at the frontline in moderating climate impacts on Africa by reducing exposure to climate extremes such as heat, drought and floods, and also the sensitivity and adaptive capacity of forest dependent people. Inarguably, forests should play a major role in national development strategies and be the entry point for climate change adaptation in Africa.

Climate change, biodiversity and forest loss are issues inextricably interlinked and need to be addressed simultaneously. This is especially important with regard to climate change adaptation in Africa particularly with the emergence of contemporary global challenges such as the current food crisis. The same drivers of biodiversity loss in Africa are also largely responsible for increased vulnerability to climate change, most importantly drought, poverty, low institutional capacities that affect the adaptive capacity of communities, and inappropriate policies with preferences for short-term economic gains. The synergy between adaptation to climate change and biodiversity conservation requires a unifying strategy to enhance the sustainability of the forest resource pools on which poor communities directly depend for their livelihoods. This approach has recently been acknowledged in discussions on cooperation between conventions within the Convention for Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC), both of

which have stressed the need for common approaches in their national implementation, which also provides a cost-saving option for African countries.

In spite of the frequency of droughts and floods in several parts of Africa, there are very limited national or regional institutional structures dealing with climate change adaptation, and also for biodiversity conservation outside designated protected areas, such as there is for food and water in response to drought and desertification. The role of biodiversity and the integration of biodiversity conservation into climate change adaptation programs remain insufficiently addressed.

Tropical forests have important roles on the African landscape but they are currently experiencing rapid deforestation and degradation with significant reduction in forest cover and fragmentation across the landscape. Over 4 million ha/yr of forest in Africa is estimated to be lost annually since 2000 (³FAO 2005).



Photo by Marieke Sandker

African Tropical Forests, Cameroon

Carbon emissions resulting from this annual loss in forest and other vegetation are estimated to range from 440 to over 1200 Mt CO₂/yr in sub-Saharan Africa (IPCC (2007)).

Tropical forests provide livelihood opportunities for over 1.6 billion people worldwide living in extreme poverty (UNCCD *et al.* 2004). They also provide an indispensable asset for contributing to national poverty reduction strategies and, consequently, the realization of some of the millennium development goals (MDG 1 and 7) in developing countries.

Forest ecosystems in tropical Africa are important repositories for vital livelihood resources and ecosystem services, and, at the same time, constitute major wildlife habitats including corridors that allow for migration facilitating coping with climate risks. The biodiversity of tropical forests in Africa is being threatened by a range of human activities such as mining, habitat loss due to conversion to agricultural land and logging, over-exploitation for fuel wood, food, medicinal plants, overgrazing, water catchment and river channel destructions some of which are in response to climate change pressures. Such activities



Photo by Daniel Tiveau

Fuelwood, one of Non-Timber Forest Products in Africa

have resulted in habitat modifications and the loss of endemic species and have also endangered other species.

Several studies and predictive models have strongly emphasized the vulnerability of African tropical forest biodiversity to various climate change scenarios, and the resulting direct consequences on wildlife populations, and the livelihoods of humans. Such loss of biodiversity amplifies the vulnerability of the continent to the impacts of climate change. According to the IPCC¹, although there are some conservation plans for ecosystems and biodiversity implementation in many parts of the world, these plans have failed to consider current and projected climate change impacts. The conservation of biodiversity is strongly targeted at protected areas, yet adaptation options need to be designed and executed outside these areas, particularly in complex human-dominated landscapes. Climate change adaptation strategies in Africa should therefore simultaneously have an integrated plan for biodiversity conservation and livelihood adaptation strategies that match local resource use patterns without jeopardizing the resilience of the forest ecosystem to climate change impacts.

Recommendations for synergies with biodiversity and forests

- 1) It is important to recognise the linkages between biodiversity loss and vulnerability to climate change in Africa, and how these could exacerbate poverty and further compromise food security
- 2) Adaptation strategies should encourage the conservation of habitats and biodiversity (fauna and flora) that underlies livelihood adaptation especially in rural areas
- 3) There is need to provide and support participatory actions and multi-stakeholder discussion platforms that encourage the integration of biodiversity conservation into climate change adaptation strategies, and beyond protected areas
- 4) It is essential to build the capacities of actors, sectors and institutions in their use and management of multiple forest resources across scales (local, national and regional) and over time in order to balance economic growth and livelihood adaptation without jeopardising the resilience of the forest ecosystem to climate change
- 5) Implement institutional arrangements and governance structures that promote synergy in the planning and implementation of agro-ecosystems and forestry programmes for mitigation and adaptation projects to derive maximum benefit to the environment as well as the local communities or economies

- 6) Encourage afforestation and reforestation programmes that are in compliance with climate, community and biodiversity standards
- 7) Building regional institutional capacity and decision-support systems for managing transboundary resources that ensure quality, regulation capacity and demand in the use of resources
- 8) Planning management strategies that are long-term and dynamic, and which encourage the sharing of information, intelligence and experiences in tracking natural resource flow across territorial boundaries in curbing illegal trade and practices that affect biodiversity conservation and adaptation.
- 9) Integrate landscape approaches in land use management to avoid maladaptation in other sectors and section of the communities



Multi-stakeholders Meeting, Burkina Faso

The significance of synergies with biodiversity and forests

The significance in jointly addressing biodiversity and forests for adaptation to climate change in Africa include:

- The linkages between livelihood benefits of biodiversity conservation and climate change adaptation could serve as incentives for change of practices such as bush burning and overgrazing that could result in maladaptation
- A space for a direct impact in policy implementation is expected as new forest governance reform schemes are currently ongoing in Africa such as the Forest Law Enforcement Governance and Trade (FLEGT)
- Building climate change adaptation capacity into transboundary resource management strategic plans will reinforce regional initiatives such as wildlife corridors (e.g. Northern Savannah Biodiversity Conservation Project), river basin authorities (e.g. Nile, Niger Rivers), and forest management (e.g. Congo Basin Forests) in response to climate variability in Africa

- Integrating biodiversity conservation strategies into mainstream forestry and climate change adaptation programmes will permit the communities directly involved to appraise the performance of climate change adaptation strategies in terms of both livelihood and biodiversity outcomes
- Cross-national collaboration will be facilitated through networking and the identification of best practices in various regions, sharing of experiences and information of success stories
- Building on initiatives that commonly contribute to the implementation of the CBD and the UNFCCC, including the process of national adaptation programmes of action (NAPAs) and the framework for achieving the 2010 targets set at the Conference of Parties of the CBD² in 2002
- Building biodiversity assessment and management capacity of local communities to enhance their adaptive capacities to climate change especially under the new forest governance reform programmes currently in most countries in the region

Footnotes

- ¹ IPCC Technical Paper V (2002) Climate Change and Biodiversity
- ² Secretariat of the Convention on Biological Diversity (2006) Global Biodiversity Outlook 2
- ³ FAO Global forest resources assessment (2005) FAO Forestry Paper 147
- ⁴ UNCCD, UNCBD & UNFCCC, 2004. Final Report on the Workshop on forest and forest ecosystems: Promoting synergy in the three Rio conventions. 5-7 April 2004, Viterbo, Italy

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Up in Smoke: Biomass Burning, Land Cover Change, and Atmospheric Emissions in the Sudanian Savannas of Côte d'Ivoire

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The environmental change literature depicts West African savanna fires as intense and highly destructive. It assumes that burning takes place in the middle and late-dry seasons, views African savannas as one of the "burn centers" of the planet, and considers biomass burning to be an important source of greenhouse gas emissions. The research presented in this brief, however, took a political-ecological approach to advance the understanding of burning regimes and to present a more accurate assessment of land use and land cover change in the Sudanian savannas of Côte d'Ivoire. Findings show that contemporary agricultural and pastoral practices generate early fires that result in low burning intensity, more frequent and small fires, and inefficient combustion. The results also show that the Sudanian savannas are complex and differentiated ecosystems composed of several vegetation types, and that grass biomass load is declining while woody vegetation cover is increasing over time. Increased tree vegetation cover will sequester more carbon dioxide. The knowledge generated here is crucial for environmental decision-making. Updated and accurate environmental information is critical for formulating sound environmental policies. The findings are particularly relevant to current debates on the environmental impact of agricultural and pastoral systems in West Africa and to policy discussions focused on global climate change.

Background

The existing scientific literature considers biomass burning to be an important source of greenhouse gases and aerosols such as sulfur, nitrous oxide, methane, and carbon dioxide. The effects of biomass burning on the atmospheric composition lead to several concerns about human health, air pollution, and climate change. Global climate change scientists argue that biomass burning contributes up to 40 percent of gross carbon dioxide each year (Levine et al. 1999). African savannas are viewed in this literature as a "burn center" of the planet. The argument presented in this brief, however, is that the impact of biomass burning on global climate change has been overestimated and that the anti-burning land use policies based on the current scientific literature may be misconceived. Contemporary agricultural and pastoral practices in West Africa generate early fires that are less intense and thus conducive to bush encroachment. Early fires produce less gas and aerosol emissions into the atmosphere. Furthermore, increased vegetation cover sequesters more carbon dioxide than is recognized by climate change scientists.

The research took a political-ecological approach to examine burning regimes in the Sudanian savanna of Côte d'Ivoire to present a more accurate assessment of land use and land cover change and to determine the contribution of biomass burning in Ivorian savanna ecosystems to global climate change. Political ecology is an interdisciplinary approach to the study of human-environmental relationships that integrates social, political, cultural and biophysical processes.

The approach examines the long-term study of human-environmental interactions based on local history, knowledge, and ecologies. Political ecology seeks to expand the understanding of issues through multi-scale analysis and intensive fieldwork.

The research was conducted in the Sudanian savanna region of Côte d'Ivoire located in the north of the country and characterized by widespread biomass burning during the dry season. Fire is facilitated by the existence of continuous grass layers. The research site selected was Katiali, a village of more than 3,000 people. Agricultural activities in the area include cotton as cash crop, food crops, tree crops, hunting, and honey gathering. Livestock rearing is an important land use activity, especially for FulBe households who practice a highly mobile form of cattle rearing. Biomass burning in Katiali begins early in the dry season in late October and November when FulBe herdsman burn grasses to encourage regrowth for cattle grazing.

Preliminary Findings

Results of the burning regimes study. The fire regimes study consisted of the analysis of burning practices, different burning periods and their effects on fire intensity, burning frequency, and on combustion efficiency.

Data were collected through group discussions and interviews with key informants. Government officials were interviewed about their perceptions of current burning

trends in savanna landscapes and how these understandings are inscribed into laws, policies, and technical institutions. At the village level, village leaders (men and women), farmers, pastoralists, and hunters were interviewed about burning practices, motivations and perceptions of savanna fires. A census of all the Katiali inhabitants revealed different actors involved in burning and was used to select a representative sample of 40 households for subsequent surveys. Household heads were surveyed on different uses of fire, reasons for burning, different periods at which fires are set and why, and fire management practices used by farmers and pastoralists. Weather station data including wind speed and direction, temperature, humidity, and rainfall were recorded daily, and records of geographic positions of burning sites were taken using a global positioning systems (GPS) device. The research was conducted during one dry season from late October 2007 to May 2008 to examine fire regimes in different vegetation types throughout the burning season.

Preliminary findings show that there are three different periods of burning throughout the dry season: at the beginning of the dry season (mid-October to late December), in the middle of the dry season (January to February), and late in dry season (March to April) (Images 1, 2, and 3). The study also shows three periods in the day during which fires are typically set: in the morning before 9am, between 9am and 6pm, and after 6pm.

Preliminary research results show that burning intensity declined from 1975-2008 due to reduced grass biomass from increased grazing, the expansion of mango and cashew orchards, increased area under cultivation, early burning, and more fire breaks throughout the landscape. Thus, fire intensity declines because there is less biomass to burn and more firebreaks are placed throughout the landscape. There is also reduced use of fire around mango and cashew orchards because of their economic values.

Results also show that burning intensity varies during the dry season (Images 1, 2, and 3). Burning is less intense at the beginning of the dry season (mid-October to late December) and at the end of the dry season (March to April), while it is comparably more intense in the middle of the dry season (January-February). There has also been a decline in flame height compared to 30 years ago because of the impact of grazing pressure on the height of grasses. The results demonstrate that bush fires are currently more frequent than they were 30 years ago. Contemporary bushfires start at the beginning of the dry season (late October) when grasses are not very dry. These fires produce patches of burned and unburned areas in the landscape.

The burning efficiency analysis shows that efficiency varies over time because of the availability of grass biomass and relative humidity during the period of bushfires. Because



Left: Image 1. Early dry season burn in Katiali. Burning takes place from late-October to late-December. Burning intensity is very low and the landscape is composed of burned and unburned patches.

Bottom left: Image 2. Mid-dry season burn in Katiali. Mid-dry season burning occurs during the months of January and February. Burning intensity is high compared to the first period and the dry vegetation efficiently burns.

Below: Image 3. Late dry season burn in Katiali. Fire intensity during the late dry season (March and April) is not as high compared to mid-dry season fires. Only dry grasses burn efficiently. Young trees are stressed for a few weeks before starting to regrow.

All photos by Moussa Koné.



of the humidity contained in air and in plants, fires set at the beginning of the dry season are not efficient enough to burn all the available grasses. Unburned grasses can burn a second time later in the dry season. Fires during the middle of the dry season, on the other hand, are very efficient and burn all the available grasses (Image 2).

Late dry season burning is not efficient because there is less available biomass left to burn at that period. The study of burning regimes shows that the grazing pressure, agricultural intensification (food crops and cash crops), and more firebreaks throughout the landscape modified the burning regimes in the Katiali region. These new burning regimes create a savanna ecosystem composed of several types of vegetation.

Land cover change analysis. The land cover study aimed to examine the nature and the direction of land cover change in the Sudanian savanna landscapes under new fire regime conditions. Study investigators analyzed vegetation plots of 10 meters by 10 meters in each vegetation class to determine tree and grass species, perennial versus annual grass species, height of trees and grasses, and measures of available biomass load in different vegetation types. The study also recorded the historical understanding of vegetation dynamics of local people through transect walks, surveys, and group discussions.

Results show that the savanna ecosystem is a complex and differentiated landscape. The Sudanian savanna ecosystem is composed of open forest, woodland (Image 4), gallery forest, bush savanna, grass savanna (Image 5), and cropland and fallow fields (Image 6).

The Sudanian savanna ecosystem has become more wooded over the past 30 years. The major tree species are *Isoberlinia doka*, *Daniellia oliveri*, *Vitellaria paradoxa*, *Pericopsis laxiflora*, *Piliostigma thonningii*, *Entanda africana*, *Azelia africana*, *Ficus capensis*, and *Parkia biglobosa*. The research also shows that grass biomass load is declining, while woody vegetation is increasing over time.

The research reveals that local resource users increasingly use fire early in the dry season as a management tool. Farmers set fire to protect their cashew and mango orchards, while herders burn for new grasses that are more palatable to cattle (Image 1). Early dry season burning is less intense and less efficient in burning biomass, and over the years, favors the expansion of woody vegetation in the Sudanian savanna. Less intense burning also produces lower gas and aerosol emissions. Furthermore, the resulting increase in vegetation cover could potentially sequester more carbon dioxide than is presently attributed to the system. Therefore, early dry season burning contributes less to global warming than is actually believed by climate change scientists.

Below: Image 4. A savanna woodland in the Katiali region.

Right: Image 5. A grass savanna in the Katiali region.

Bottom right: Image 6. A fallow field in the Katiali region.

All photos by Moussa Koné.



Practical Implications

The results of this research are useful to analyze the environmental impact of agricultural and pastoral land use systems in West Africa. The climate change literature argues that farmers and herders increasingly contribute to greenhouse gas emissions and thus to global climate change. Farmers and herders are said to set intense and highly destructive fires in the middle and late dry season. Environmental policies based on this literature may be misconceived and negatively affect local farmers' and herders' livelihoods. Contrary to this view, the research results presented here demonstrate that West African farming and pastoral systems lead to bush encroachment, which will increasingly sequester more greenhouse gas emissions. Such conclusions are important to climate change scientists who seek environmental change information at the

regional scale and for environmental policy makers involved in negotiations in the carbon market. The research findings for this study will be available to those scientists and policy makers such as the National Committee for the Protection of Forests and the Control of Bush Fires, Ministry of Environment, Climate Change Bureau in Côte d'Ivoire, United Nations Framework Convention on Climate Change (UNFCCC), and Center for International Forestry Research (CIFOR). With updated and accurate environmental information and insights, decision makers will be better informed to generate and implement more appropriate environmental policies. Finding synergies between GHG emission reduction programs and local livelihood adaptive management practices based on local knowledge in the Sudanian savanna ecosystem will require this type of information in setting baselines and developing methodologies for monitoring and evaluation.

Further Reading

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The project presented in this brief examines the use of fire in farming and pastoral practices in the Sudanian savanna ecosystem of Côte d'Ivoire and their implications on land cover change and greenhouse gas emissions. The Borlaug LEAP program was an excellent opportunity to conduct this field research. The fellowship allowed the examination of the dynamics of burning regimes and the investigation of land use and land cover change. The project is ongoing and will measure CO₂ emissions from bush fires during the burning season from October 2008 to April 2009.

The Norman E. Borlaug Leadership Enhancement in Agriculture Program (LEAP) provides fellowships to enhance the quality of thesis research for graduate students from developing countries who show strong promise as leaders in the field of agriculture and related disciplines.

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Methodology workshop in Ghana

From the 14th to the 24th of January 2008, Yacouba Coulibaly and Monica Idinoba visited Ghana. The purpose of the visit was to:

- Discuss project draft methodology on vulnerability assessment with partners with particular emphasis on the parameters (criteria and indicators) and tools selected that should be considered at all levels when assessing vulnerability.
- To participate in TroFCCA graduate student seminar, provide inputs into student's research select and visit sites for research work.
- Discuss collaborative research inputs with partners in soil research Institute of Ghana
- Collect climatic data from the Ghana Meteorological Agency

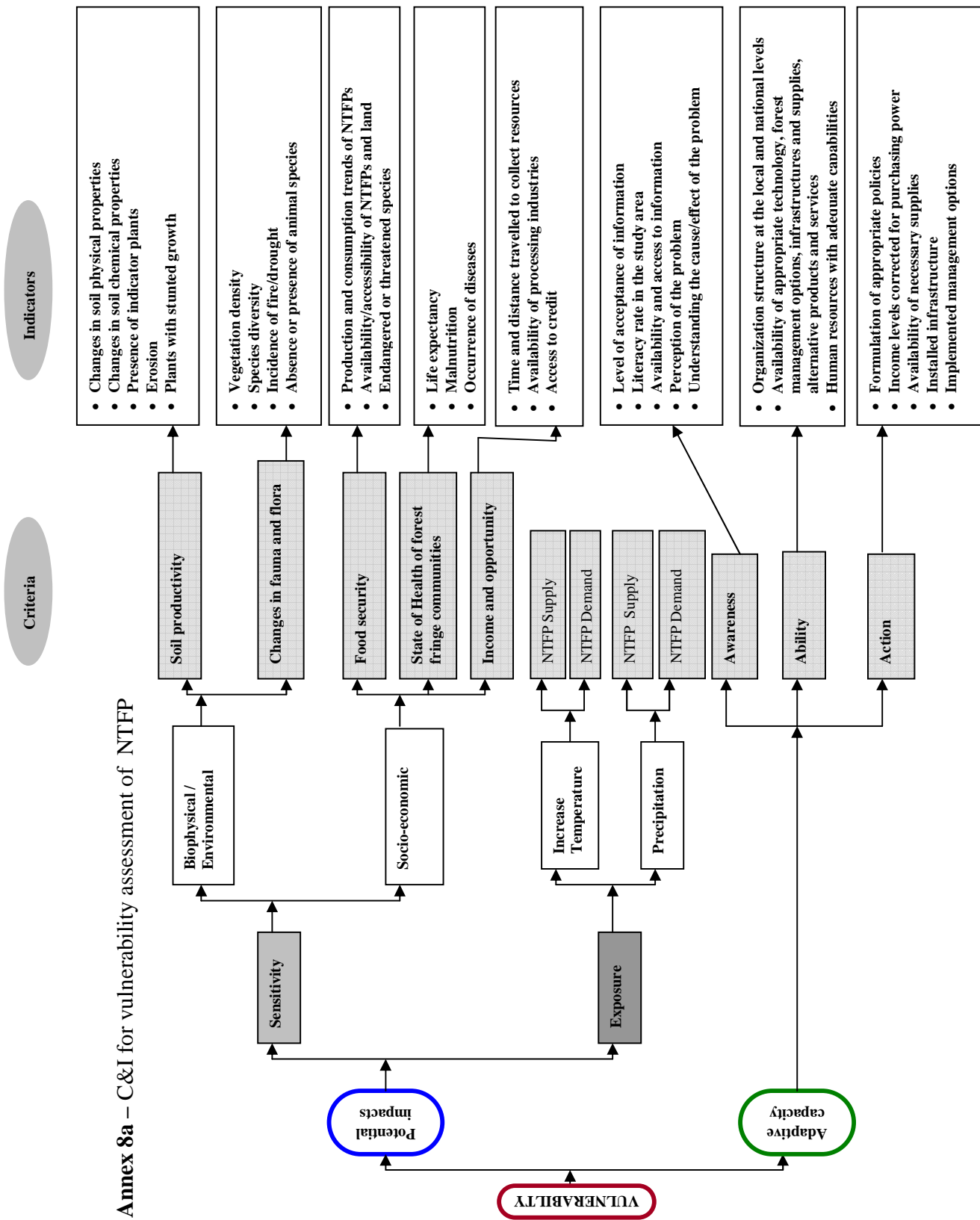
A two days workshop was organized in Kumasi with partners from the forest research institute of Ghana and the Kwame Nkrumah University of science and technology (table 1) to review, discuss and deliberate on the draft TroFCCA methodological document on vulnerability assessment and also have students present their on going research work and planned work for 2008 academic year. After presentations from the TroFCCA team and the students, all participants agreed on simple and measurable indicators for the region, the need for description of the indicators and tools for measurement in the final document and involvement of partners in testing the methodology on the field. After students presented their research work, discussions were oriented mostly on objectives and methodology. Participants gave useful comments to aid improve the quality of students research work. Participants' contribution also brought out the relevance of taking into account the component of forest ecosystem in the student's work and the need to better formulate their research objectives and expected outcomes of their work.

A visit to student's research site allowed us to see the relevance of their study site for vulnerability assessment. We met with experts from Soil Research Institute of Ghana to discuss a collaborative study using the students research sites to establish trends of degradation in chemical and physical properties along the riparian zones, which may help students in the assessment of forest ecosystem services important for regulation of water, We also met with Dr Bernard in IWMI who agreed to continue as our contact person for the student's. He also offered an office space with use of internet facilities to TroFCCA graduate students. The Ghana meteorological agency agreed to send long term climatic data for all the parameters to enable the analysis of the PRECIS model output.

Table 1 LIST OF PARTICIPANTS

No	Name	Institution	E-mail
1.	Dr. K. Twum-Ampofo	Faculty of Renewable Natural Resources (FRNR), Kwame Nkrumah University of Science and Technology (KNUST)	ktampof02001@yahoo.co.uk
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Annex 8a – C&I for vulnerability assessment of NTFP



Indicators

Criteria

- Changes in soil physical properties
- Changes in soil chemical properties
- Presence of indicator plants
- Erosion
- Plants with stunted growth

- Vegetation density
- Species diversity
- Incidence of fire/drought
- Absence or presence of animal species

- Production and consumption trends of NTFPs
- Availability/accessibility of NTFPs and land
- Endangered or threatened species

- Life expectancy
- Malnutrition
- Occurrence of diseases

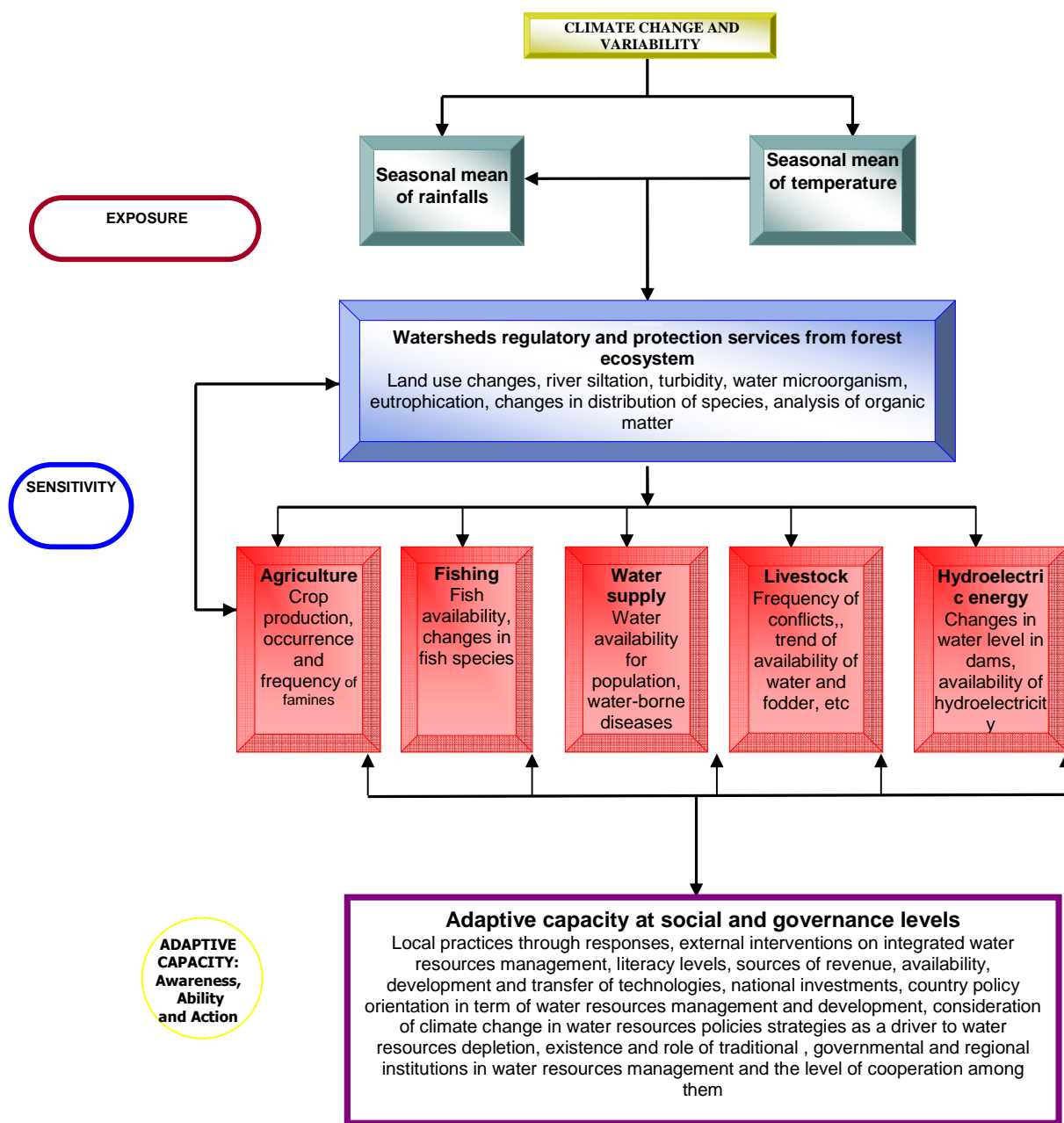
- Time and distance travelled to collect resources
- Availability of processing industries
- Access to credit

- Level of acceptance of information
- Literacy rate in the study area
- Availability and access to information
- Perception of the problem
- Understanding the cause/effect of the problem

- Organization structure at the local and national levels
- Availability of appropriate technology, forest management options, infrastructures and supplies, alternative products and services
- Human resources with adequate capabilities

- Formulation of appropriate policies
- Income levels corrected for purchasing power
- Availability of necessary supplies
- Installed infrastructure
- Implemented management options

Annex 8b - C&I for vulnerability assessment for water



Annex 9

Summaries of students' research and internship projects in West Africa

1) Sidiki Boire (2006/2007 Graduate student, University of Bamako, Mali): Vulnérabilité des ressources en eau aux impacts des changements climatiques dans le bassin versant du Bani à Douna.

Le but de cette étude est d'évaluer les impacts des changements climatiques sur les ressources en eau du bassin versant du Bani et d'analyser la sensibilité des activités socio-économiques à ces impacts. L'étude porte sur la zone spécifique du Moyen-Bani à Ségou, la quatrième région administrative du Mali (Ségou). Pour ce faire, nous avons collecté les données de pluviométrie et de température moyennes annuelles de 1952 à 2001 de la station de San à la Direction nationale de la météorologie du Mali (DNM) et celles des débits moyens annuels de la station de Douna, de 1952 à 2001 à la Direction nationale de l'hydraulique du Mali (DNH). Nous avons effectué des analyses d'échantillons d'eau au laboratoire de la DNH. Les données sur l'agriculture, l'élevage et la pêche ont été collectées au projet Programme de mise en valeur des plaines du Moyen- Bani (PMB), à travers des enquêtes de terrain, des observations directes et des entretiens.

Les résultats obtenus montrent une régression de la pluviométrie de décennie en décennie, une tendance à la hausse de la température, une baisse de l'hydraulicité du fleuve Bani, une dégradation des paramètres physico- chimiques et bactériologiques des eaux ainsi qu'un amoindrissement de la production agricole, de la capacité de charge des pâturages et de la prise de poisson. Tous ces facteurs ont entraîné la dégradation des galeries forestières suite à la pression humaine.

2) Pauline Kaboré (2006/2007 Graduate student, University of Ouagadougou, 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 Yagma et de Wayen, province du Ganzourgou (Burkina Faso).

Les forêts sèches tropicales sont des lieux uniques et importants où se déploient des dynamiques controversées de construction sociale et de précarisation écologique. Au Burkina Faso, elles sont des milieux de vie qui pourvoient à de nombreux besoins. Elles représentent pour les communautés qui en dépendent une source économique importante. La coupe et la commercialisation du bois contribuent aux revenus des ménages, atténuant ainsi les impacts des périodes de sécheresses et de pénurie. La forêt est de ce fait un espace-refuge qui permet la survie au quotidien. Elle est bien plus dans le cadre de cette étude, un habitat, une résidence ; ce qui accélère la dégradation du massif forestier, classé *a priori* selon les textes réglementaires. Ainsi nous avons entrepris d'appréhender les implications de cette étroite dépendance entre communautés et forêt à travers une approche qui a combiné des outils quantitatifs et qualitatifs à une observation participative. Cela nous a permis de relever que l'exposition à la pauvreté ne semble pas laisser beaucoup d'options aux populations. La précarité des conditions de vie conduit les

populations à des pratiques qui dégradent leur forêt. Ce qui est de nature à influencer sur leur implication dans la gestion des ressources naturelles. Les forêts deviennent des espaces stratégiques qui contribuent à la production d'histoires sociales. Elles portent les marques du milieu environnant avec lequel est établi un ensemble de liens, de dépendances. Ces éléments sont importants à être pris en compte dans l'élaboration des mécanismes institutionnels et locaux de gestion des ressources naturelles. Cette étude sur la vulnérabilité contribue également à la construction de l'objectif 2 du projet **TroFCCA** (Tropical Forests and Change Adaptation) du Centre de Recherche Forestière Internationale (**CIFOR**) qui est d'identifier et hiérarchiser conjointement des secteurs extrêmement vulnérables reposant sur la forêt, qui sont importants pour les sources de revenus ménagers et pour le développement national.

3) Chantal Sessi Vivena Agbahungba (2006/2007 Graduate student, University of Abomey Calavi, Benin): Vulnérabilité des formations forestières ligneuses aux changements climatiques au Burkina Faso : cas du Parc National Kabore Tambi, des forêts classées de Dibon et de Maro, de la réserve de la mare d'Oursi Faso.

L'étude de la vulnérabilité des formations forestières ligneuses aux changements climatiques au Burkina Faso a permis d'étudier les impacts d'éventuels changements climatiques sur les formations végétales ligneuses des forêts classées de Dibon et de Maro, du Parc National Kabore Tambi et de la réserve de la mare d'Oursi au Burkina Faso. L'interprétation par numérisation des images Landsat de deux périodes (1986 et 2000) à l'aide du logiciel Arc-view 3.2, a permis de ressortir les différentes unités d'occupation du sol et d'utilisation des terres de 1986 et 2002. Les formations végétales ligneuses ont diminué au détriment des formations végétales anthropiques. Dans la forêt classée de Maro, les savanes arbustives sont passées de 13 881 ha en 1986 à 9 382 ha en 2002 alors que les cultures pluviales ont augmenté de 1918 ha en 1986 à 2 284 ha en 2002 ; dans la forêt classée de Dibon, les galeries forestières ont régressé de 1364 ha en 1986 à 759 ha en 2002 et les cultures pluviales sont passées de 207 ha en 1986 à 465 ha en 2002 ; la savane arborée a diminué de 49 722 ha en 1986 à 48 277 ha en 2002 alors que les cultures pluviales sont passées de 2359 ha en 1986 à 7960 ha en 2002 ; dans la réserve de la mare d'Oursi, la steppe arbustive est passée de 47 446 ha en 1986 à 43 555 ha en 2002 alors que les cultures pluviales ont augmenté de 6 013 ha en 1986 à 12 955 ha en 2002. Les climats futurs sont projetés sur la base des émissions du scénario SRES A2 et des scénarii analogues sec et humide. Les données thermométriques et pluviométriques de 2050, sont extraites de SCENGEN. En 2050 par rapport à la référence 1961-1990, les températures augmenteront de 1,7°C à l'horizon 2050 sur tous les sites. On observe des baisses de précipitation de 0,43 mm, de mars, avril, mai à septembre dans la réserve de la mare d'Oursi et 3,62 mm à 18 mm dans la forêt classée de Maro. Dans ce cadre, avec la modification des conditions climatiques des espèces ne pourront plus survivre dans leur milieu habituel.

4) Benjamin Gyampoh (2006/2008 Graduate student, Kwame Nkrumah University of Science and Technology (KNUST), Ghana): Climate Change and Vulnerability of Livelihoods in the Offin River Basin, Ghana.

Communities in the River Offin basin in the moist semi-deciduous forest region of Ghana are generally rural and poor. The people are predominantly natural resource dependent, rain-fed crop farmers. The study was to establish the climatic trends in the Offin River basin; to assess the vulnerability of Offin River and the basin communities to climate change and variability; and finally to explore possible and suitable adaptation strategies to climate change in the Offin River basin. Historic climate and river flow data were analysed using linear regression to establish the trends in climate. Questionnaires, focus group discussions, interviews, expert contributions and future climate scenarios were used to assess current and future vulnerability and propose sustainable adaptation strategies. The results show a 1.3°C and 1°C rise in maximum and minimum air temperature in the River Offin basin between 1961 and 2006. Monthly temperature trends have continued without much variation over the last 4 decades with a consistent gradual increase in mean monthly temperature recorded for individual months. Annual precipitation has also decreased by 17% for the same period though the last decade has recorded some slight appreciation in precipitation. Rainfall has been erratic and the rainfall pattern shows significant shifts in recent years, with clearly observed changes in the beginning of the rainy season in recent years. Decadal analysis of Daily duration of sunshine shows an increase of 7.87% in the last decade (2001-2006). Mean maximum and minimum relative humidity reduced by 2.18% and 2.24% respectively between 1961 and 2006. A close relationship between duration of bright sunshine and temperature was established. There has been a 45.3% reduction in discharge of River Offin with the highest discharge of 8.177m³/s recorded in 1963 and the lowest discharge of 0.139m³/s in 1976 (during the Ghana droughts). Regression analysis shows that temperature did not have any major effect on the discharge of River Offin whilst precipitation showed a stronger effect on the discharge. The effects of these climate changes on the basin are prolonged dry periods, inadequate rainfalls and extreme heat and these have affected the water availability to the communities in the basin in terms of quality and quantity; low crop yield and crop failures; increased incidence of water quality and heat related diseases like malaria and bilharzias. The people draw on their traditional knowledge in agriculture and water management to cope with the new changes but these coping strategies are becoming insufficient as the climate changes worsen. This increases their vulnerability to climate change as they do not have any alternative sources of livelihood apart from agriculture and the natural resources. It is recommended that there should be close relationship between farmers, researchers and policy makers in order to build upon the current coping strategies of the people into sustainable adaptation strategies which would be streamlined into national forestry, agricultural, economic and climate change adaptation policies

5) MEDAH Nayélé Moïse(2007/2008 Graduate student, University of Ouagadougou, Burkina Faso): Impact de la gestion forestiere par les organisations locales sur la dynamique de la vegetation ligneuse dans le contexte des changements climatiques: Cas du Chantier d'aménagement de Bougnounou, au Burkina Faso

La gestion durable des ressources naturelles en générale et surtout forestière en particulier, est au cœur de toutes les politiques de développement des pays sahéliens. En effet, ces pays ne pouvaient continuer d'assister à la réduction exponentielle des forêts avec des conséquences catastrophiques. Le Burkina Faso a, depuis les années 1985, pris à bras le corps la destinée des forêts sèches pour une gestion rationnelle durable. C'est ce qui justifie l'élaboration d'une politique nationale d'aménagement des forêts naturelles mise en œuvre par divers projets en ce sens. Avec la participation de la population locale à l'aménagement et à la mise en œuvre du plan d'aménagement et de gestion, il y a eu certes des acquis positifs reconnus par tous les acteurs. Mais, après 15 ans de gestion communautaire dans un contexte où les facteurs climatiques subissent des évolutions négatives d'une année à l'autre, il convenait donc d'investiguer sur les impacts de cette gestion. Un inventaire forestier par échantillonnage et des enquêtes ont permis de mesurer les impacts écologiques et socio-économiques des forêts protégées de Bougnounou. Des impacts sur l'amélioration des revenus des populations par l'exploitation et la préservation des massifs forestiers ont été observés et sont à mettre à l'actif de la gestion communautaire. Aussi, ont été faites des recommandations pour surmonter certaines difficultés rencontrées et surtout pour intégrer des actions de gestion adaptative pour faire face aux changements et variabilités climatiques. Ces actions doivent occuper une place importante dans le plan d'aménagement et de gestion pour la rotation à venir

6) Kologo Oumarou (2007/2008 Graduate student, University of Ouagadougou, Burkina Faso): Thème : Le karité (Vitellaria Paradoxa Gaertn.) et sécurité alimentaire au Burkina Faso : vulnérabilité face au changement climatique dans la Bougouriba.

L'importance du karité et des produits qui en découlent n'est plus à démontrer au Burkina Faso où ses produits constituent la troisième (3^e) source de devises. Arbre aux vertus diverses, le karité contribue aussi à l'enrichissement de l'alimentation locale par ses produits (chenilles, beurre, fruits, etc.) et entre dans les usages traditionnels de soins et de pratiques coutumières et rituelles. Dans un contexte marqué par des bouleversements du régime climatique, la production de l'arbre connaît aussi des mutations. Malgré cela, les revenus issus de l'exploitation du karité servent à palier aux insuffisances de ressources et à répondre aux besoins multiples des ménages. C'est fort de ce constat que le 29 mai 2008, s'est tenue à Léo, une marche de plaidoyer pour la revalorisation des produits du karité et la lutte contre la vulnérabilité croissante de l'arbre à beurre face au changement climatique. Les femmes venues de toutes les contrées du pays où l'exploitation du karité est une activité de survie, ont battu le pavé pour inviter les autorités politiques à plus d'attention sur le sort de cet arbre. La présente étude a démontré que le karité joue un rôle majeur dans l'amélioration des conditions de vie des populations et donc dans la sécurité alimentaire dans la Bougouriba, eu égard aux revenus

généralisés et aux domaines de dépenses et d'investissement desdits revenus. Le changement climatique conduit les populations à exercer une pression sur les ressources forestières, en particulier, le karité ; toutes choses qui accroissent la vulnérabilité de l'arbre et partant des populations qui en dépendent. Les sécheresses répétées ont certes entraîné la mort de pieds de karité, mais les populations notent la disparition progressive d'autres pieds attaqués par des parasites et sous l'effet des coupes systématiques (par les producteurs de charbon, sculpteurs, etc.) et des défriches. Les données révèlent aussi que les revenus issus du karité ont connu une évolution en dent de scie, à cause de la fluctuation de la production et des problèmes d'écoulement. En outre, les groupements consacrés à cette activité sont confrontés à des difficultés d'accès aux crédits qui leur auraient permis de mieux tirer partie de l'exploitation du karité. Le manque d'organisation du secteur de la production (problème de transformation) et de la vente des produits favorise l'intrusion des acheteurs étrangers et la fixation de prix dérisoires. Malgré la création du programme national karité (PNK), cette donne n'a pas changé. De ce qui précède, les hypothèses n° 1 et 2 se trouvent vérifiées dans la mesure où la vulnérabilité du karité et des populations de la zone a été mise en évidence et la place prépondérante du karité dans l'amélioration des conditions d'existence prouvée malgré que sa production fluctue au gré des saisons. Face au changement climatique, les populations entreprennent des actions qui sont le fruit d'une dynamique interne et l'action d'une intégration de techniques exogènes. Les différentes mesures développées s'inscrivent dans une logique de survie socioéconomique et culturelle. En effet, l'objectif premier recherché est la préservation de l'arbre de karité afin de répondre aux besoins économique, culturel et sanitaire. Ces diverses options de protection ou de régénération de l'espèce ne permettent cependant pas de garantir la pérennité de l'arbre car les pratiques anthropiques néfastes (feux de brousse, coupes abusives) sont non négligeables. Bien que le reboisement constitue une mesure efficace, les populations ne le pratiquent pas avec des plants de karité. Les pratiques de protection de l'arbre sont certes pertinentes mais elles restent peu durables, ce qui justifie l'hypothèse n°3 formulée dans ce travail. Enfin, l'étude montre l'absence de mécanisme d'alerte précoce qui aurait permis aux populations de la localité de se parer à toute éventualité. Les mécanismes traditionnels de prédiction des saisons méritent d'être étudiés et renforcés pour donner des instruments efficaces d'alerte précoce aux populations.

6) Stephen Lartey Tekpetesy (2007/2008 Graduate student, Kwame Nkrumah University of Science and Technology (KNUST), Ghana): Vulnerability Assessment of Climate Change Impacts on the Production and Utilization of Bioenergy in Ghana: The Case of fuel wood.

Bioenergy, in its varied forms, is increasingly gaining attention worldwide because it is an environmentally friendly energy source. In Ghana, like most developing countries, biomass is the major domestic energy source with about 80% of her population relying primarily on fuelwood. In the absence of cheaper and more available energy source, its demand is projected to increase by about 34% by 2020 in most developing countries, including Ghana. In recent times, however, concerns have heightened about climatic change and its impact on a number of livelihoods and the readiness of 'vulnerable communities' to adapt effectively. Serious threat to domestic energy security, especially

fuelwood production and utilization- is envisaged and there is the urgent need for appropriate adaptation strategies to be developed and implemented in Ghana. Although a number of researches have been carried out on fuelwood production and utilization in Ghana, there is a gap in knowledge on the impact of climate on fuelwood production and utilization and appropriate adaptation strategies in climatic- risk context. This has been buttressed by findings in Assessment of Impact and adaptation to Climate Change report of adaptation Deficiency in most African countries (AIACC, 2007). This study, therefore, aimed at making a preliminary assessment of the vulnerability of fuelwood production and utilization in Ghana in two districts of Ghana: Kintampo North District and Akwapim North District. The specific objectives included: i) to map out major fuelwood producing areas in different ecological zones of Ghana ii) to assess the active players in the production/supply trend of wood fuel from different ecological zones in Ghana (iii) to estimate the vulnerability of major fuelwood producing communities in Ghana and iv) to identify local coping strategies the 'active players' adopt under changing climatic condition. The five task method proposed by Downing et al 2002 was adopted for this project. Results indicated that the mode of production of charcoal - the Earthmound method and the technologies of stoves used in cooking using charcoal and firewood has not changed significantly to reflect current threats. The Active players in the fuelwood production –supply chain identified were predominantly subsistence farmers, local restaurant operators and bread bakers in the case of firewood and rural and middle household for charcoal. In all cases, low capacity to adapt to climate impact was observed. To ensure domestic energy security in Ghana in the wake of climatic risk, a multisectoral adaptation strategy is recommended with further capacity building in climate change and adaptation in Ghana and other developing countries at large.

7) Boukare Sawagogo (2007/2008 Graduate student, University of Ouagadougou, 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).

Au cours des cent dernières années, le climat de la planète s'est réchauffé d'environ 0,5 degré celsius, en partie à cause des émissions de gaz à effet de serre dues aux activités humaines. Les modèles climatiques projettent que la terre se réchauffera encore de 1,4 à 5,8°C au cours du siècle prochain. Ces changements auront un effet déstabilisant considérable sur le cycle hydrologique, qui se traduira par une plus grande variabilité des précipitations et des débits des cours d'eau et une augmentation de l'intensité des événements hydrologiques extrêmes.

En effet, les recherches montrent que la zone soudano sahélienne est soumise depuis une trentaine d'années à une sécheresse persistante. Dans les déserts et dans les régions arides de l'Afrique en général et du Burkina Faso en particulier, l'accès à l'eau pour les besoins divers constitue un facteur à la fois vital et limitant. Les services rendus par les écosystèmes, surtout celui forestier en termes de satisfaction des besoins humains fondamentaux, de production agropastorale, de fourniture de moyens d'existence dépendent de manière cruciale de la disponibilité des ressources en eau qui sont par essence, non seulement rares dans les zones arides, mais limitées encore plus par la

surexploitation et par les répercussions des changements climatiques et de la désertification (Bauer, 1996).

Face à cette situation, les analystes s'accordent donc à dire que la vulnérabilité des ressources en eau occupera une place prépondérante parmi les impacts potentiels des changements climatiques.

Le problème qui fait l'objet de notre préoccupation dans notre étude se situe donc autour de la question suivante : « *Comment mettre en œuvre des stratégies d'adaptation viables en matière de gestion des ressources en eau prenant en compte l'écosystème forestier pour un développement durable à travers une évaluation de la vulnérabilité socioéconomique ?* ».

L'objectif principal de notre étude est l'évaluation de la vulnérabilité des ressources en eau d'une part et de donner des informations sur les opportunités qu'offre l'écosystème forestier dans les stratégies d'adaptation face au changement climatique. Cet objectif s'inscrit en droite ligne de trois objectifs spécifiques de TroFCCA qui sont les suivants :

- 1- Identifier les secteurs prioritaires de développement dont la vulnérabilité pourrait s'accroître à cause des impacts du changement climatique sur les forêts ;
- 2- Elaborer des méthodologies pour évaluer la vulnérabilité des forêts et de leurs biens et services environnementaux,
- 3- Contribuer aux processus nationaux d'adaptation.

8) Aude Verchère (Stagiaire au CIFOR en 2007), étudiante en BTSA, option gestion et protection de la nature, Spécialité gestion des espaces naturels, LEGTA Edgar Faure Montmorot (39), France : L'Arbre à beurre et l'Arbre de vie : Deux espèces incontournables au Burkina Faso.

L'objectif principal de cette étude est d'évaluer l'état actuel de deux espèces que sont : *Adansonia digitata* (le Baobab) et *Vitellaria paradoxa* (le Karité).

Une méthodologie a été adoptée pour caractériser les espèces au sein des différents sites choisis, puis pour déterminer les composantes du milieu dans lequel elles se trouvent. A cet effet, des fiches d'inventaire ont été réalisées pour la description de divers paramètres dendrométriques. D'autre part une étude socioéconomique a été indispensable pour mesurer l'impact humain sur ces deux espèces.

D'un point de vue édaphique, les sites ne sont pas très favorables à ces deux espèces. Les facteurs anthropiques sont également des facteurs limitant pour *Adansonia digitata* et *Vitellaria paradoxa*. Un diagnostic écologique a été également effectué pour évaluer la diversité et la régularité de la communauté végétale.

Des propositions de gestion du suivi des populations des espèces considérées, viseront à compléter le travail de cette présente étude. Les autres propositions de gestion s'attacheront à améliorer la régénération du Baobab et d'atténuer la compétition

intraspécifique du Karité. La sensibilisation des acteurs économiques locaux, sera également une proposition indissociable des autres.

8) Frederic Bationo (Stagiaire au CIFOR en 2008), Université de Ouagadougou, Burkina Faso : Perceptions des changements climatiques et stratégies locales d'adaptation dans six villages des régions du centre, nord et sahel du Burkina Faso.

Le Burkina Faso à l'instar des pays sahéliens est exposé aux effets de la variabilité et des changements climatiques, qui se traduisent par une dégradation continue du couvert végétal et du cadre de vie des populations. Cette rareté de la ressource forestière affecte les moyens d'existence des populations rurales.

Pour évaluer l'accessibilité la perception des changements climatiques par les populations rurales de six villages (saaba, Loumbila, Outendeni, Koukouloungou, Djomga et Gnalalaye) des régions du Centre, Est et Sahel du Burkina Faso, nous avons utilisé des méthodes participatives (MARP) et un guide d'entretien.

Les résultats montrent que les populations dépendent des forêts pour leurs moyens d'existence (santé, nourriture, habitat, revenus financiers, etc.) alors que paradoxalement les populations rurales estiment que la ressource forestière est rare. Aussi, ces populations ont conscience des changements climatiques et développent des stratégies d'adaptation endogènes dans les secteurs du bioénergie, la forêt (santé et alimentation) et l'eau pour faire face aux effets pervers des changements climatiques. Ces stratégies d'adaptation développées par les populations sont de deux types : (i) adaptations autonomes ou par réaction et (ii) adaptations par planification. Les moyens d'adaptation des populations rurales sont fragiles du fait principalement de leur pauvreté et de leurs conditions d'existence matérielles précaires. Ces facteurs font que les populations sont vulnérables aux Changements climatiques, au double plan socioéconomique et écologique. Pour renforcer leurs stratégies d'adaptation, les populations ont des attentes techniques et économiques vis-à-vis des autorités pour renforcer les stratégies d'adaptation fragiles afin de leurs rendre durables.

9) Mirjam Buedenbender, University of Sussex, UK (4 weeks in April/May 2008)

The intern prepared a summary (2-5 pages) on financing mechanisms on adaptation, with a particular focus on forests and adaptation, by doing a literature review based on an internet research. The summary contains:

- What: financing mechanisms at global, regional, national, local level (NAPA process and Adaptation Fund, CDMs, etc)
- Who: private-public partnerships (for example payments for environmental services - PES), public-public, public-private, private-private etc
- How: involved institutions, volume of funds, size of projects, regions, etc..
- List of relevant webpages
- List of relevant projects

Annex 10

TroFCCA - Central America

Summaries of studies conducted to better understand the vulnerability-adaptation of forest to Climate Change, either through shifts in ecological conditions; disturbances to forests, such as forest fires; and evaluating adaptation options for protecting hydrological services for hydropower production; and the threat to hydrological ecosystems services.

Forest Fires Occurrence in Central America under Different Climate Change Scenarios.

The objectives of the study were: 1) Know the impact of climate change in forest fires distribution and forest fires risk in Central America; 2) Analysis of the relationship amongst the different variables explaining forest fires occurrence/non occurrence; 3) Construction of a forest fire risk map for Central America; 4) Modeling of future forest fires risk considering climate change scenarios. Results must be carefully considered, because there were only taken into account the changes in the climatic variables. The results: a) *By countries*: Belize, Honduras, Nicaragua and Guatemala are those with larger surface under risk of fire. The strongest increase of risk is detected in Nicaragua and Panamá; b) *By ecoregions*: Centroamerican pine-oak forests and Petén-Veracruz moist forests; c) *Current ecological integrity*: Most affected areas are those in worst conservation stage (poor or acceptable). These are the zones of priority interest. d) *Protected areas and biological corridor*: Surface susceptible of being under fire risk increases in the future. However, there must be remarked that this increase is produced because the surface with low risk of fire increases. The study was finalized by Elena Palacios, supervisors: Pablo Imbach, Bruno Locatelli and Luis Molina, in the first trimester 2008.

Impact of the Climate Change on Forest Plantations in Central America.

A model in GIS was developed to evaluate the impact that will have the Climate Change on the potential distribution in plantations of *Tectona grandis*, *Gmelina arborea*, *Pinus caribea*, *Swietenia macrophylla* and *Vochysia guatemalensis* in Central America. Initially the areas with present potential for plantations with base in the climatology of period 1950-2000 (WordClim) and edafic variables of SOTERLAC were identified. Soon one considered the results of the regional model the PRECIS-Caribbean for three horizons of future climatology (2010 - 2040; the 2040 - 2070 and 2070 - 2100) and scene of A2 emissions, maintaining constant the edafic variables. The climatic change will affect in a favorable way the introduced species and in negative way the native ones, especially those located to the limit of its natural distribution. For period 2010 - 2040, the areas with favorable conditions for the native species will have been reduced in an equivalent area to 5% of the region, whereas the introduced ones gain approximately a 3% of the regional surface. This tendency will become serious towards the end of the present century, where the native species will see reduced their area of potential distribution in an 18%, and the areas with favorable conditions for introduced species will be increased in an 8% of the regional total. The results of this work can be improved at two levels, first, concentrating in a national scale and including imperceptible particularities at regional level, and

second, using a data base that takes into account the uncertainties as far as the projections of the climate future.

Responses from society to changes in ecosystem services, One of the studies conducted by Trofcca since January 2007 has been entitled “Determinants of social decisions for landscape management as an adaptive response to changes in the provision of hydrological ecosystem services in Costa Rica”.

This study has selected two case studies: 1) The creation of the Commission for territorial planning and management of the upper watershed of the Reventazon River –COMCURE– mainly linked to hydroelectric power generation; and 2) The Commission for the recovery, protection and conservation of water recharge area of Los Santos, mainly for public water consumption.

In this two cases, society and socio-economic sectors decided to create institutions and important decisions were made to change landscape management practices. The study is aiming at determining the sources of motivation, conditions, rules and steps made toward the creation of institutions. It is expected that this study will provide important lessons for adaptive landscape management, including forest ecosystems. During the period January - June 2007, the steps already performed include: designing the methodology based on Robert K. Yin (2002) “Case Study Research Design and Methods” and a model proposed by Selin & Chavez (1995) to study collaborative processes to Environmental Management and Planning; revision of key documents such as memoirs of meetings, annual reports, institutional missions, etc.; field visits to perform a series of interviews to different institutions and upper landscape dwellers. The study was finalized by Angela Diaz, her final project as M. Sc. candidate within the Graduate Program in CATIE. The results of these investigations were delivered at the end of 2007.

Evaluating adaptation options for protecting hydrological services for hydropower production: inputs for decision-making in Birris watershed, Costa Rica. More than 80% of energy in Costa Rica is produced by hydropower. The highest amount of hydroenergy in the country is produced in the Reventazon watershed through large dams. In the first National Communication to the UNFCCC, this watershed was set as a priority for its relevance for national development and for its vulnerability to climate change. Indeed erosion and dam siltation are recognized as two important issues that are observed and projected to increase under the growing number of extreme precipitation events in the area. During the Watershed management plan, the Birris sub-watershed was prioritized in conservation management due to its high conflict of land use due to steep slopes and loose soils and intensive agricultural management. Indeed this area, whose land vocation is forest, is used for highly market-connected agriculture which unsustainably exploits soils causing high erosion rates. Actual conservation programs are not covering the required area in terms of extension and location. Moreover, the decisions faced by farmers and those of interest for the hydropower agents are not aiming at the same objectives of watershed management. While erosion in some cases is perceived and taken into account for implementing erosion control by some upland farmers, in some others these conservation activities are not perceived as a private benefit. This research is

characterizing where private and social benefits are perceived by the two interested agents (i.e. upstream farmers and hydropower) in order to inform the structuring of a cost-efficient soil conservation program. This study will be performed by Raffaele Vignola (M.Sc.) during the period January 2007 until the second trimester of 2009.

Climate adaptation decisions in environmental contexts: Seeking robust alternatives and building institutional mechanisms. In climate change adaptation, robust decision-making is a mean of addressing irreducible uncertainties that arise from climate change and impacts models. Robust decision making is defined as a way of selecting alternatives that appear to do reasonably well over a wide range of future scenarios. However, questions such as: what is reasonably well? How to gauge it?, and what is a wide range? Need to be addressed.

Judgement-based approaches provide a simpler, more readily applied, intuitive and flexible way to face the numerous climate adaptation decisions that will arise in the world. Experts can express judgement on basic questions such as numerous of scenarios, performance of the system under different scenarios. On the other side, interested parties can build alternatives based on guided structuring of their objectives. An example is the identification of an alternative for forest management in British Columbia that outperformed the status quo average over all participants, all objectives and all climate and impacts scenarios. Interestingly, participants wanted to talk about governance, creating alternatives, not just give impact judgments.

Another example is developed in TroFCCA Central America, where the focus is on an important development sector such as hydropower and its vulnerability to the degradation of hydrological services under land use and climate change. In such a context, ecosystem services are seen as a context for new institutions since their providers and their beneficiaries are often not in the same groups, they don't know they might have a context for joined gains and thus need norms and rules for appropriate management. Thus, to support the design of robust institutions two types of uncertainties should be characterized. Empirical uncertainties about the dynamic of the erosion and sediment production under current/ future land use and climate change. Value-based uncertainties on the decision processes, and objectives of relevant stakeholders in the design and implementation of the mechanism for soil conservation should be characterized and discussed.



To support the design of a collaborative mechanism between upland users ES providers and downstream beneficiaries, negotiation analysis where objectives, alternatives and interests of the parties need to be clarified is a useful framework. Results show that, interestingly for farmers, besides classical tenure variable, non-monetary aspects prevail in their decision and interest in a conservation program. Consideration of fairness of contracts and distribution of incentives, freedom to renegotiate incentives, and access to technical assistance are all non-monetary variable that should be taken into account. On the other side, hydropower agents express concern over transaction costs and related legal framework associated to monitoring and enforcing the implementation of sustainable soil management practices. This study will be performed by Raffaele Vignola (M.Sc.) during the period January 2007 until the second trimester of 2009.



Photo by Raffaele Vignola (Birris dam)

The provision of forest ecosystem's hydrological services is of major importance for sustainable development.

Climate change will have an impact on the distribution of ecosystems and the pattern and variability of precipitation. Consequently, the provision of hydrological ecosystem services is expected to change. We aim at evaluating the impacts of climate change on ecosystem functions providing hydrological services in the Mesoamerican region by modeling the actual and future distribution of the functions and services. Our results will help to develop adaptive measures at regional and national level.

The study will be applied at a regional scale in the Mesoamerican region from southern Mexico (Chiapas) to Panama. However, local studies will be developed in parallel by the Trofeca C.A. project to complement the regional modeling, for instance watershed hydrological modeling and socioeconomic studies about the users of hydrological services. This study will be performed by Pablo Imbach (M.Sc.) during the period January 2007 until the first trimester of 2009.

Spatial priorities for the payment for ecosystem services (PES) in Costa Rica.

Payment for Ecosystem Services (PES) is a promising approach for preserving ecosystem services that are critical for sustaining human societies. A variety of schemes involving PES have been implemented around the globe and new initiatives are starting in many places. One of the key issues in the design of such schemes is deciding which lands and land-use activities should be compensated for the ecosystem services that they provide in order to make the payments more efficient. Here we present a methodological framework for identifying spatial priorities for PES.

Using a Geographical Information System (GIS), we developed a spatial model that calculates priorities depending on two main criteria (i) the level of provision of ecosystem services (ES) at given location (e.g. a pixel), and (ii) the risk of losing the provision of such services at that same location due to land-use change. A multi-criteria decision structure was used to combine different indicators of provision of ES and risk of land-use change. The model was implemented in Costa Rica, where a nation-wide PES scheme is functioning since more than one decade. In 1996, Costa Rica's new Forest Law established which ES are of interest to the society, which land-use activities provide them, and how land owners have to be compensated for implementing these land-use activities.

Accordingly, the provision of ES was evaluated for biodiversity conservation, carbon storage, scenic beauty and water provision for human consumption, irrigation and hydroelectric generation. The risk of losing the provision of ES was evaluated as the risk of deforestation in forested area, and as the risk of land-use change from less to more intensive land-uses in non forested areas. The level of provision of ES and the risk of land-use change were combined to obtain an indicator of priority for PES. We found that the priorities for each service have distinctive spatial distribution and that services of local use (different water uses and scenic beauty) have a high spatial correlation. This indicates that in Costa Rica, the payment for one service will ensure the provision of another since higher priorities share the same places.

Our methodology is flexible as it can be adapted for different objectives, for instance a separate priority evaluation for each ES or for particular groups representing different value perceptions regarding the importance of services or risk factors. Further work has to be done in order to evaluate results in the field and the methodology robustness. This study was made by Imbach, P. L. Pedroni, and T. Koellner.

Annex 11

Summary of outsourced research activities - TroFCCA Southeast Asia

Climate Change and Forest Fire Risks in Indonesia

Principal Investigator: Dr. Erna Sri Adiningsih, National Institute of Aeronautics and Space (LAPAN)

Project Abstracts

Climate is one of the biophysical factors affecting forest/land fire risks in prone areas of Indonesia. Many works on fire risks have been made. However, it is still necessary to reveal exact effect of climate on fire risks. This works is aimed to quantify the relationship between climate variable and fire risks. Since one of the fire risk parameters is fire occurrences, the parameters are commonly represented by hotspot data. This project falls under the Tropical Forests and Climate Change Adaptation (TroFCCA) in Southeast Asia of CIFOR.

Some statistical models, i.e. regression and Adaptive Neuro Fuzzy Inference System (ANFIS) models, are developed to quantifying the relationship between climate variable, particularly rainfall, and fire risk in Indonesia. Some statistical correlations between rainfall and the number of fire hotspots are first conducted for the whole Indonesian region, to get the global picture of the climate impact to fire occurrences. Furthermore, these correlations are carried out for several fire prone areas in Sumatera, Kalimantan, and Papua to identify the areas which are potentially get burnt during a specific period of time. The analyses include the above-ground and below-ground fuel types, which can be used as the base-line condition of risk.

The outcomes of this project are expected to be a valuable contribution to address the current knowledge gaps in the increased risk of forest and land fires driven by future climate change and climate variability.

Impact of climate change on landslide susceptibility in West Java Province: Case Study of Bukit Sentul Area, District of Bogor

Principal Investigator: Dr. Adrin Tohari, Research Centre for Geotechnology, Indonesian Institute of Sciences (LIPI)

Summary

This current research project was conducted to model the effect of the increase of precipitation on landslide in order to evaluate the impact of climate change on landslide susceptibility in a landslide hazard prone area in West Java. The research project consisted of numerical simulations to predict the change in precipitation due to global climate change, and to evaluate the effect of the changes in precipitation on the change in landslide susceptibility level in the District of Bogor, West Java.

The modeling of climate change using MAGICC/SCENGEN (NCAR, 2003) indicated that the change in precipitation in the SE Asia region will increase up to 99.52% in

2090s, and the maximum change in precipitation in West Java area will increase up to 26.7% in February 2100's with respect to the precipitation in 1990s. For the predicted maximum changes in precipitation during wet month period in West Java region, it is shown that the study area is highly susceptible to deep landsliding. The susceptibility is likely to increase significantly in 2020s with respect to the present susceptibility. However, further change in precipitation will be unlikely to change their spatial distribution.

In the response to the global climate change, hollows and steep hillsides in Ciawi, Caringin and Pacet sub-districts will be more susceptible to landsliding. Thus, landslide hazard in hilly areas in Bogor District will be likely to increase in the future.

The role of trees outside forest in anchoring soil and reducing landslide risk during high rainfall episodes

Principal Investigator: Dr. Kurniatun Hairiah, Brawijaya University (in collaboration with the World Agroforestry)

Abstract

The conversion of the agroforests and reduction in tree cover in Kabupaten Bogor (District of Bogor) for urban development has been followed by large landslides. Strategy for reducing land movement based on "bioengineering" provide by trees reducing accidents will require information on strategic locations for trees with confirmed capacity to anchor soil. The rate of root development will determine the options for recovery. Study of the areas at risk in Bogor can contribute to future prevention strategies, in the context of climate change adaptation, when the incidence of 'extreme' rainfall periods is expected to increase and the need for landslide prevention will be more pronounced.

Research were conducted in Bukit Sentul area, Bogor District in areas classified as highly at risk of landslides. The observations in the high risk areas were:

1. Rapid survey for landslide site selection along the Ciherang and Cibadak sub-catchments
2. Characterization of soil properties at selected sites near landslides scarp
3. Inventory of tree species and population density in the selected area which are potentially at risk of landslides (*based on the existence of a hardpan in the sub soil layer*),
4. Inventory of potential tree root system as an anchor to maintain slope stability
5. Estimation the role of vegetation to reduce land slides at landscape level using the 'spatially explicit individual tree-based forest simulator' (SEXI FS) model

The results shown that four types of landslides occurred in Karang Tengah village i.e. overland landslides, slope failure (topple), creep and road-cut landslides; 60% of the total were overland landslides. Factors affecting landslides are rainfall intensity, topography (slope >45%), and features of the soil profile: existence of bed rock or compacted soil layer as sliding plane, existence of unstable soil layer such as sandy loam layer in the sub soil with a low soil shear strength due to higher sand content.

Dominant woody vegetation in the study area were banana (non-woody), *Maesopsis eminii*, *Pangium edule*, *Ceiba petandra* and *Sandorium koetjape*. The highest tree population density was found in agroforestry system near the scarps of overland landslides; weight of the aboveground tree biomass probably increases landslide risk. Two tree root indices (Index of Root Anchoring, IRA and Index of Root Binding, IRB) can be used to evaluate tree suitability for stabilizing slope. Local fruit trees pisitan or duku (*Lansium domesticum*), kemang

(*Mangifera kemanga*), limus (*Mangifera foetida*), mindi (*Melia azedarach*) have an IRA higher than 2.0. Duku and timber tree puspa (*Schima wallichii*) potentially can reduce overland landslides as shown by high IRA (>1.5) and IRB (1.25-2.0). A mix of tree species with deep roots and ground cover species with intense and strong fine roots will provide the highest slope stability in the area.

The SExI-FS (Spatial Explicit Individual-based Forest Simulator) model is able to simulate the role of trees to reduce the risk of landslide through the quantification of species IRB and IRA within a tree plot. The simulation may apply the plot management sensitive scenario. The simulation result on plot management sensitive shows that maintaining the plot density to the optimum size is would be better because increasing the density over the optimum size was not significantly increase the plot root binding. Although the plot root anchoring are known to be increasing. The species selection based on the IRB and IRA value is acceptable. Other consideration may depend on the farmer preferences. The cost benefit of some agroforestry scenario is possible to be predicted using the computer experiment.

Underlying Problems in Regulation, Law Enforcement, Government Aspects on Forest and Land Fires in Indonesia

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Conclusion

The repetitive forest and land fires in Indonesia still pose a big challenge for Indonesia. There are various underlying problems, which require special attention from all of the stakeholders. This research identifies several underlying problems in the regulation and government system. So far the problem of forest and land fires is still regarded as the problems, which must be managed with reactive approach and has not been accepted as a “systemic” problem. In the areas vulnerable to forest and land fires such as Kalimantan and Sumatera reactive approach is still used.

The most basic underlying problem in the regulation is that the regulation for the management of forest and land fires is not composed with the purpose to change behaviour but only to solve short term problem. From the many regulations in Indonesia related to forest and land fires, there is no regulation which gives solution to avoid forest and land fires. The policy makers have understood that the fires were caused by human behaviour and not an act of nature. However, the question concerning the reason of the man to set the fire cannot be answered by the prevailing forest and land fires policies. As a result the prevailing policies only become a “sweetener”, without ever implemented properly.

The sanction in a policy may be very severe; however, the sanction does not result in deterrent effects. This is due to the law enforcement often does not reach the actors behind the setting of fire. The scapegoat is often the physical perpetrator that sets off the fire such as the community but the companies masterminding the fire always escape from the law. It is because the limitations of the law enforcement in the quantity and quality. Also the sectoral approach in handling fires becomes an obstruction in law enforcement. The evidences, suspect and witnesses are still the main obstruction in the continuation of the proceedings. Although the matters are solved with the implementation of strict liability and corporate criminalization, but seems that the law enforcement officers have not grasped the concept comprehensively.

The institutional aspects in the forest and land fires control still pose a challenge which needs to be answered. The research revealed that the form of the institutions handling the forest and

land fires have very limited authority. Consequently, the ability of the institutions to solve the problems of forest and land fires systemically also obstructed. The coordination, which is expected to answer the problem in sectoral handling of forest and land fires, cannot run optimally when the coordination is conducted without performance evaluation. As a result the handling of forest and land fires by the available institutions only focused to the extinguishing of fire, and it is done repetitively. Without regard to the effectiveness of the method which is very reactive in nature and does not solve the underlying problems.

Administrative instruments should have been an effective control instrument in supervising a case of forest and land fires. However, the current administration instruments such as licenses and Environmental Impact Analysis is yet to be implemented fully. This is because the sectoral approach of licensing and ridden with the interests of a certain sector and the minimum sanction in regulating the requirements of Environmental Impact Analysis in the licensing.

The underlying problem which causes the repetitive and endless forest and land fires is because in many ways the matters is unsolved. It is understood that although the problems mentioned is answered, we cannot be certain that forest and land fires shall stop completely. However, at the minimum the tidying up in governance sector becomes an important aspect. So that, the solution for the forest and land fires problem can be more systematic and structured. As for the existing problem (whatever the problem might be, technical, instruments, infrastructure, officers' abilities or policies) is actually a structural problem.

Recommendation

To solve the underlying problems the following actions are proposed

- A re-plan and re-inventory of the status of the land and forest in Indonesia is required. This may prevent the occurrence of abandoned land resulted from the unclear licensing of the utilization of land or forests. This re-planning shall confirm the status and the function of the peat land which is often misused.
- The tidying up of administration system such as Environmental Impact Analysis and licensing so that there is strong control mechanism and supervision in the implementation of the utilization of forest and land.
- The revisions of the laws and regulation by using the problem solving method. This is important considering that the current handling of forest and land fires uses the reactive approach and do not address the problems faced by the public.
- The provision of incentive and public assistance is crucial and must be conducted as soon as possible to prevent the public from burning the land and in the end the public may get a concrete solution given by the government.
- A one roof law enforcement system is required to shorten the bureaucracy chain of the prevailing law enforcement.

Annex 12

List of TroFCCA Publications as of 2008

1. Journal Papers

A. Peer Reviewed Journal

1. Murdiyarso, D., Adiningsih, E.S. 2007. Climate anomalies, Indonesian vegetation fires and terrestrial carbon emissions. *Mitigation and Adaptation Strategies for Global Change* 12 (1) :101-112; DOI: 10.1007/s11027-006-9047-4.
2. Ilstedt, U., Malmer, A., Verbeeten, E., Murdiyarso, D. 2007. The effect of afforestation on water infiltration in the tropics: systematic review and meta-analysis. *Forest Ecology and Management* 251: 45-51.
3. Nkem, J., Santoso, H., Murdiyarso, D., Brockhaus, M., Kanninen, M. 2007. Using tropical forest ecosystem goods and services for planning climate change adaptation with implications for food security and poverty reduction. *Journal of Semi-Arid Tropical Agricultural Research* 4 (1) :1-23
4. Locatelli, B., Rojas, V. and Salinas, Z. 2008. Impacts of payments for environmental services on local development in northern Costa Rica: a fuzzy multi-criteria analysis. *Forest Policy and Economics* 10(5): 275-285. <http://dx.doi.org/10.1016/j.forpol.2007.11.007>
5. Benegas, L., Jiménez, F., Locatelli, B., Faustino J. and Campos, M., 2008. A methodological proposal for the evaluation of farmer's adaptation to climate variability, mainly due to drought in watersheds in Central America. *Mitigation and Adaptation Strategies for Global Change*. In press. <http://www.springerlink.com/content/rp07741161896767/>
6. Kalame, F. B., Nkem, J., Idinoba M. and Kanninen, M. 2008. Matching national forest policies and management practices for climate change adaptation in Burkina Faso and Ghana. *Mitigation and Adaptation Strategies for Global Change*.
7. Gyampoh, B. A., Idinoba, M. and Amisah, S. 2008. Water Scarcity under a changing climate in Ghana: Options for livelihood adaptation: *Development* 51: 415-417.
8. Forner, C., Blaser, J., Jotzo, F. and Robledo, C. 2006. Keeping the forest for the climate's sake: avoiding deforestation in developing countries under the UNFCCC. *Climate Policy* 6: 275–294

B. Non Peer Reviewed Journal / Technical Journal

1. Garay, M., Locatelli, B. and Louman, B. 2006. Socioeconomic impacts of Payment for Ecosystem Services and Forest Certification en Costa Rica [Impacto socioeconómico del pago por servicios ambientales y la certificación forestal voluntaria en la sostenibilidad del manejo forestal en Costa Rica]. *Recursos Naturales y Ambiente* 46-47: 99-108
2. González, H.C., Locatelli, B., Imbach, P., Vignola, R., Pérez, C.J. and Vaast, P. Identificación de bosques y sistemas agroforestales proveedores de servicios ecosistémicos para el sector agua potable en Nicaragua, *Recursos Naturales y Ambiente* 51: 35-41.
3. Gonzalez, C., Locatelli, B., Imbach, P., Vignola, R., Campos, M., Pérez, C.J. and Vaast, P. 2007. Forestry and agroforestry systems providing ecosystem services to the drinking water sector in Nicaragua [Sistemas forestales y agroforestales proveedores de servicios ecosistémicos para el sector agua potable en

- Nicaragua]. *Recursos Naturales y Ambiente* 51-52: 33-39.
4. Leguía, E., Locatelli, B., Imbach, P., Alpizar, F., Vignola, R. and Perez, C. 2007. Forests providing ecosystem services to hydroenergy sector in Nicaragua [Bosques proveedores de servicios ecosistémicos para la generación de hidroelectricidad en Nicaragua]. *Recursos Naturales y Ambiente* 51-52: 40-47.
 5. Leguía, E. Locatelli, B., Imbach, P., Alpizar, F., Vignola, R and Perez C. 2007. Identificación de bosques proveedores de servicios ecosistémicos para hidroelectricidad en Nicaragua. *Ambientico* 165: 25-27.
 6. Leguía-Hidalgo, E.J., Locatelli, B., Imbach, P., Alpizar, F., Vignola, R. and Perez, C. 2007. Servicios ecosistémicos e hidroelectricidad en Nicaragua. *Recursos Naturales y Ambiente* 51: 41-51.
 7. Leguía, E.J., Locatelli, B., Imbach, P., Pérez, C.J. and Vignola, R. 2008. Servicios ecosistémicos e hidroenergía en Costa Rica. *Ecosistemas* 17 (1): 16-23.
 8. Locatelli, B., Imbach, P., Molina, L.G., Palacios, E. and Corrales, L. 2008. Futuro de los incendios forestales bajo escenarios socioeconómicos y de cambio climático en Centroamérica. *Mesoamericana* 12 (3): 132-133.
 9. Benegas, L., Jimenez, F., Locatelli, B., Faustino, J. and Campos M. 2007. Evaluation of farmers's adaptation to climate variability and drought in Central American watersheds [Evaluacion de la adaptacion de los productores a la variabilidad climatica, principalmente a la sequia en cuencas hidrograficas en América Central]. *Recursos Naturales y Ambiente* 51-52: 107-123.
 10. Perez, C.J., Locatelli, B., Vignola, R. and Imbach, P. 2007. Integrar los bosques tropicales en las políticas de adaptación al cambio climático. *Ambientico* 165: 22-24.
 11. Pérez, C., Locatelli, B., Vignola, R. and Imbach, P. 2007. The importance of tropical forests for climate change adaptation policies [Importancia de los bosques tropicales en las políticas de adaptación al cambio climático]. *Recursos Naturales y Ambiente* 51-52: 6-13
 12. Pérez, C., Locatelli, B., Vignola, R. and Imbach P. 2007. The integration of tropical forests in policies for adaptation to climate change [Integrar los bosques tropicales en las políticas de adaptación al cambio climático]. *Ambientico* 165: 19-21.
 13. Murdiyarsa, D., Lebel, L. 2007. Southeast Asian forest and land fires: how can vulnerable ecosystems and peoples adapt to changing climate and fire regimes? *iLEAPS Newsletter* (4) :28-29.

C. Papers in preparation or submitted

1. Brockhaus, M., Vignola, R., Santoso, H. and Lasco, R. Forests and Adaptation to Climate Change: The TroFCCA Policy Research on Actors, Decision-making and Policy Networks. Paper based on the presentation in Umea conference, to be finished and submitted.
2. Chineke, C. and Idinoba, M. 2008. A regional and seasonal analysis of evapotranspiration dataset for hydrological processes under a changing landscape, south of the Sahara. Paper submitted to *Journal of Hydrological Processes*.
3. Coulibaly, Y. N., Idinoba, M., Nkem, J. and Alkassoum, M. 2008. Analyse de la vulnérabilité de trois secteurs de développement basés sur la forêt au sud ouest du Burkina Faso dans le contexte du changement climatique. Under Review *La Secheresse*.
4. Forner, C., and Nkem, J. N. Will forests survive in the adaptation debate? Linking ecosystem services to development and adaptation. Under Review *Agriculture, Ecosystem & Environment*

5. Gyampoh, B., Idinoba, M., Nkem, J.N. and Amisah, S. 2008. Adapting river basins to Climate change and variability in West Africa. The case of Offin river basin in Ghana. Paper Submitted to the Journal of Mitigation and Adaptation strategies for global change.
6. Gyampoh, B.A, Amisah, S and Idinoba, M.E. 2008. Coping with Climate Change: How Local Communities use Traditional Knowledge in rural Ghana. Paper submitted to *Ambio*.
7. Idinoba, M., Nkem, J.N., Kalame, F., Niasse, M., Coulibaly, Y. and Niang-Diop, I. 2008. Water Outlook in the West African under a changing climate. Paper submitted to 'Development' special issue on "Water for People" (2008: Volume 51.1).
8. Kabore, P., Maiga, A., Idinoba, M., Coulibaly, Y. N et Nkem, J.N. 2008. Vulnérabilité socio économique, précarité écologique et rôle de l'Etat dans la gestion des ressources forestières, cas de la forêt classée de Wayen, province du Ganzourgou, Burkina Faso. Paper submitted to *Secheresse Journal*.
9. Lasco, R. D. Pulhin, F. B., Jaranilla-Sanchez, P. A., Delfino, R. J. P. and Garcia, K. Mainstreaming climate change in developing countries: The case of the Philippines, Under Review *Climate and Development*.
10. Marks, E., Aflakpui, G.K.S, Nkem, J.N., Poch, R.M., Khouma, M., Kokou, K., Sagoe, R. & Sebastia, M.T. Conservation of soil organic carbon, biodiversity and the provision of other ecosystem services along climatic gradients in West Africa. Under Review *Biogeosciences*.
11. Nkem J.N., Kalame, F.B., Idinoba, M.E. and Nyong, A. Reducing Emissions from Deforestation and Degradation: Implications for African Development and Adaptation to climate change. Under Review *Climate Policy*
12. Vignola et al. Evaluation of gaps in the formulation of climate change adaptation policies in Costa Rica y Nicaragua. Article in preparation.
13. Vignola et al. Farmers' decision making affecting the provision of hydrological ecosystem services in the context of global change: case study of Birris watershed, Costa Rica. Article in preparation.
14. Vignola et al. Negotiation analysis of upstream and downstream actors around hydrological services. Article in preparation.
15. Imbach P., Locatelli B., et al. 2009. MAPSS model calibration and climate change scenarios for hydrological functions of ecosystems.
16. Imbach P., Locatelli B., et al. 2009. Impacts of CC on ecosystems hydrological functions in Meso-America, Population density mapping of Meso-America.
17. Locatelli B., Imbach P., et al. 2009. The future of forest fires under CC and socioeconomic scenarios in Central America. In prep.
18. Locatelli B., Imbach P., et al. 2009. Landscape connectivity and adaptation of ecosystems to climate change in Central America. In prep.
19. Locatelli Vignola 2009. Meta analysis on Hydrological services. Submitted FORECO
20. Locatelli Imbach 2009. Ecosystem services hotspots. To be submitted
21. Wertz Kannounikov S. Locatelli B. et al. 2009. PES and adaptation. (planned)

2. Books and edited special journal issues

A. Published or in press

1. Murdiyarso, D., Lebel, L., eds. 2007. Local to global perspectives on forest and land fires in Southeast Asia. Mitigation and Adaptation Strategies for Global Change 12 (1) . 201p. ISSN: 1381-2386.
2. Locatelli B., Kanninen M., Brockhaus M., Colfer C.J.P., Murdiyarso D., Santoso H., 2008. Facing an Uncertain Future: How forests and people can adapt to climate change. Forest Perspectives no.5. CIFOR, Bogor, Indonesia.
3. Robledo, C., Blaser, J., Byrne, S. and Schmidt, K. 2008. Climate Change and Governance in the Forest Sector: An overview of the issues on forests and climate change with specific consideration of sector governance, tenure, and access for local Stakeholders. Rights and Resources Initiative, Washington D.C.

B. Submitted or in preparation

1. Idinoba, M., Coulibaly, Y., Nkem, J. and Fobissie, K. Step-Wise Guideline for Climate Change Vulnerability Assessment of Forest Ecosystems Goods and Services. CIFOR, Bogor, Indonesia. (in preparation)
2. NKem J.N., Oswald, D. 2009. Forests and adaptation in National Communications to the Climate Convention: gaps and possible inputs to selected countries (in prep.)

3. Book Chapters

A. Published or in press

1. Verbeeten, E., Barendregt, A. 2007. Assessing the impact of climate change on the water balance in semi-arid West Africa: a SWAT application. In: Probst, F., Keßler, C. (eds.). GI-Days 2007 - Young Researchers Forum proceedings of the 5th Geographic Information Days, 10 - 12. September 2007. 309-312. Münster, Germany. IfGIprints. ISBN: 978-3-936616-48-4.
2. Murdiyarso, D., Lebel, L. 2007. Southeast Asian fire regimes and land development policy. In: J.G. Canadell, D.E. Pataki, and L.F. Pitelka (eds.). Terrestrial ecosystems in a changing world. 261-271. Berlin, Germany. Springer.
3. Brockhaus, M. and Kambire, H., 2009, Decentralization - Window of Opportunity for Successful Adaptation? In: Adger, N.W., Lorenzoni, I. and O'Brien, K. (eds.), Adapting to climate change: thresholds, values, governance" Cambridge University Press, Cambridge (in press)

B. Submitted or in preparation

1. Santoso, H. among others, 2009. Chapter 1- Background and conceptual framework for the report. In: IUFRO report in preparation for Expert Panel on forests and adaptation to climate change, sections on governance, institutions and policy. To be published
2. Santoso, H. among others, 2009. Chapter 4- Future environmental impacts and vulnerabilities. In: IUFRO report in preparation for Expert Panel on forests and adaptation to climate change, sections on governance, institutions and policy. To be published

3. Nkem, J.N. among others, 2009. Chapter 5 - Socioeconomic impacts and vulnerabilities. In: IUFRO report in preparation for Expert Panel on forests and adaptation to climate change, sections on governance, institutions and policy. To be published
4. Brockhaus, M. among others, 2009. Chapter 5 - Socioeconomic impacts and vulnerabilities. In: IUFRO report in preparation for Expert Panel on forests and adaptation to climate change, sections on governance, institutions and policy. To be published
5. Santoso, H. among others, 2009. Chapter 7- Policy options for adaptation. In: IUFRO report in preparation for Expert Panel on forests and adaptation to climate change, sections on governance, institutions and policy. To be published
6. Vignola, R. and Locatelli, B. Ecosystem services and adaptation to climate change: existing and potential funding synergies. In: "Quantifying, Valuing and Selling Ecosystem Services in the Neo Tropics". CATIE-CIRAD. In preparation.

4. Reports and working papers

A. Published or in press

1. Brockhaus, M and Kambire, H. 2008. Gouvernance Locale: Des opportunités et des limites à une adaptation effective dans le domaine du changement climatique et des biens et services de l'écosystème forestier. CIFOR, Ouagadougou-Burkina Faso.
2. Cervi, A.P., Imbach, P., Vallejo, A., Tito, M. R. and Pérez, C. J. Zonas edafoclimáticas aptas para especies forestales bajo escenarios de cambio climático: un estudio de caso en Costa Rica. CATIE, Turrialba-Costa Rica.
3. Perez, C.J., Vignola, R. and Perez, E.H. Community based adaptation to climate variability and change in agriculture and water resources in the dry tropics of Nicaragua: The Case of San Pedro del Norte. CATIE and Both ENDS, Turrialba, Costa Rica and Amsterdam.
4. Ramirez, P. 2005. Climate, Climate Variability and Climate Change in relation with forest ecosystems in Central America. Review of experiences, actors and needs in tropical forest climate change adaptation in Central America. Consultancy Report. CATIE, Turrialba, Costa Rica.
5. Shlisky, A., J. Waugh, P. Gonzalez, M. Gonzalez, M. Manta, H. Santoso, E. Alvarado, A. Ainuddin Nuruddin, D.A. Rodríguez-Trejo, R. Swaty, D. Schmidt, M. Kaufmann, R. Myers, A. Alencar, F. Kearns, D. Johnson, J. Smith, D. Zollner and W. Fulks. 2007. Fire, Ecosystems and People: Threats and Strategies for Global Biodiversity Conservation. GFI Technical Report 2007-2. The Nature Conservancy. Arlington, VA.
6. Vignola, R. 2005. A literature review on Forest and hydrological services: perspectives for Climate Change Adaptation. CATIE, Turrialba, Costa Rica.
7. Vignola et al., 2008. Costos y beneficios de la conservación de suelos bajo escenarios de uso del suelo y de cambio climático en la cuenca del Birrís. CATIE, Turrialba, Costa Rica.

B. Submitted or in preparation

1. Santoso, H., Imbach, P. and Idinoba, M. Climate Scenarios: Why we need them and how to generate them. CIFOR working paper. CIFOR, Bogor, Indonesia. (In preparation)
2. Santoso H. et al., 2009. Vulnerability assessment of selected sectors: fires and landslides. CIFOR working paper. CIFOR, Bogor, Indonesia (In preparation)
3. Santoso H. et al., 2009. Identification of response options (derived from Vulnerability Assessments on fires and landslides). CIFOR working paper. CIFOR, Bogor, Indonesia (In preparation)
4. Santoso H. et al., 2009. Materials for national communications (climate change adaptation in the forestry sector: containing the summary of conceptual framework of vulnerability, and strategies). CIFOR working paper. CIFOR, Bogor, Indonesia (In preparation)
5. Santoso H. et al., 2009. Adaptation strategies in context of national policies (containing the conceptual framework of vulnerability and strategies). CIFOR working paper. CIFOR, Bogor, Indonesia. (In preparation)
6. Locatelli B., Herawati H., et al., 2008. Tools and methods for vulnerability assessment. CIFOR
7. Nkem, J.N. 2008. Priorization of sectors relevant for ecosystem adaptation. CIFOR

5. Policy Briefs

A. Published or in press

1. Amwata, D., Archer, E., Brockhaus, M., Butterfield, R., Callaway, J., Denton, F., Dorsouma, A.H., Flint, L., Hamza, M., Idinoba, M., Kalame, F., Klein, R., Abou, M.N., Nkem, J., Nyong, T., Elasha, B.O., Shale, M., Smith, B., Tadross, M., Tas, A. and Taylor, A. 2008. Climate Change Adaptation in Africa. Scoping Paper for the Expert Group Meeting on Climate Change Adaptation of the African Ministerial Conference on the Environment.
2. Both ENDS. 2007. Adapting to climate change: How local experiences can shape the debate. Both ENDS, Amsterdam.
3. Kalame, F.B., Idinoba, M., Brockhaus, M. and Nkem, J.N. 2008. Forest policies and forest resource flow in Burkina Faso, Ghana and Mali: Conflicting or consistent for adaptation to climate change? TroFCCA Brief Number 1. CIFOR, Bogor, Indonesia
4. Kalame, F. B., Idinoba, M., Brockhaus, M. and Nkem, J.N. 2008. Politiques forestières et utilisation des ressources au Burkina Faso, au Ghana et au Mali: Sont-elles compatibles avec l'adaptation au changement climatique? TroFCCA brief Numéro 1. CIFOR, Bogor, Indonesia
5. Brockhaus, M. and Djoudi, H. 2008, Adaptation at the Interface of Forest Ecosystem Goods and Services and Livestock Production Systems in Northern Mali. Info Brief No. 19. CIFOR, Bogor, Indonesia.
6. Nkem, J.N., Idinoba, M., Brockhaus, M., Kalame, F. and Tas, A. 2008. Adaptation to Climate Change in Africa: Synergies with biodiversity and forests. Environment brief No.3. CIFOR, Bogor, Indonesia
7. World Agroforestry Centre-Philippines. 2007. Local initiatives for climate change adaptation strategies in Albay, Philippines. World Agroforestry Centre-Philippines, Los Baños, Philippines

8. Jaranilla-Sanchez, P.A., Lasco, R.D., Villamor, G.B., Gerpacio, R.V., Nilo, G.P. and Villegas, K.L. 2007. A primer on climate change adaptation in the Philippines. World Agroforestry Centre Philippines, Los Baños, Philippines.

6. Communications

A. Communications with abstract or text published in conference proceedings

1. Blay, D., Idinoba, M., Nkem, J. and Kalame, F.B. 2008. Climate Change and Non-Timber Forest Products in Ghana: Impacts, Vulnerability and Adaptations. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå – Sweden, 25-28 August 2008.
2. Brockhaus, M. 2008. Climate Change, Governance and the Role of Science and Research: the TroFCCA Project Approach. 2008 Berlin Conference on the Human Dimensions of Global Environmental Change. International Conference of the Social-Ecological Research Programme, “Long-Term Policies: Governing Social-Ecological Change”, Berlin, 22 - 23 February 2008.
3. Brockhaus, M. 2008. Forestry-related development policies and climate change adaptation: The TroFCCA Project approach to a science policy dialogue. The ECPR conference 6-8 September 2007, Pisa, Italy.
4. Brockhaus, M. 2006. Science for development-Policy broker ivory tower. Deutscher Tropentag 2006 ‘Prosperity and Poverty in a Globalized World - Challenges for Agricultural Research’. Bonn, Germany.
5. Brockhaus, M. and Kambiré, H. 2008. Decentralization - A Window of Opportunity for Successful Adaptation to Climate Change? Conference on Living with climate change: are there limits to adaptation? London, 7-8th February 2008.
6. Brockhaus, M., Vignola, R., Santoso, H., Sanchez, P., Siagian, Y. and Lasco, R. 2008. Tropical Forests and Adaptation to Climate Change: The TroFCCA Policy Research Framework on Actors, Decision-Making and Policy Networks. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
7. Gyampoh, B. A., Amisah, S. and Idinoba, M. 2008. Coping with Climate Change: How Local Communities Use Traditional Knowledge in Rural Ghana. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
8. Gyampoh, B.A., Idinoba, M., Nkem, J. and Amisah, S. 2007. Adapting watersheds to climate change and variability in West Africa. The case of Offin River Basin in Ghana. The Third International Conference on Climate and Water 3-8th September, 2007, Helsinki, Finland.
9. Kalame, F. B., Brockhaus, M., Nkem, J., Idinoba, M. and Kanninen, M. 2008. Using Forest Ecosystem Goods and Services for Climate Change Adaptation in Burkina Faso and Ghana: Policy Gaps and Constraints. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
10. Idinoba, M.E., Nkem, J., Kalame, F. and Coulibaly, Y. 2008. A Framework for Vulnerability Assessment of Non-Timber Forest Goods for Planning Adaptation to Climate Change and Variability in West Africa. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
11. Imbach, P., Locatelli, B. and Guillermo, M. L. 2008. Impacts of Climate Change on Hydrological

- Ecosystem Functions in Mesoamerica. . International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
12. Lasco, R., Jaranilla-Sánchez, P., Delifino, R. and Rangasa, M. 2008. Mainstreaming Climate Change Adaptation in Forest and Natural Resources Management in The Philippines: The Role of Local Governments. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008
 13. Locatelli, B and Imbach, P. 2008. A Conceptual Model for Studying the Effects of Landscape Connectivity on Ecosystem Adaptation to Climate Change in Central America. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
 14. Locatelli, B, Imbach,P, Guillermo, M. L. and Palacios,E. 2008. The Future of Forest Fires in Central America Under Climate Change and Socio-Economic Scenarios. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
 15. Murdiyarso, D., Santoso, H. and Idinoba, M. 2008. The Challenges of Assessing Climate Change Vulnerability Using an Ecosystem Approach. International Conference on Adaptation of Forests and Forest Management to Changing Climate, Umeå- Sweden, 25-28 August 2008.
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4. German, L. and Brockhaus, B. 2007. The role of governance in climate change adaptation: understanding and managing the interface between individual and institutional responses. Workshop on a Global Change Research Network in African Mountains 23-25 July 2007. Kampala, Uganda.
5. Gyampoh, B. A. 2007. Kumasi: The making of a big city-A future without water? International Conference on Sustainable Cities and Villages with a focus on Urban and Rural Ecological Sanitation, Organic Waste Management Agricultural Reuse, 27-31 August 2007, Dongsheng, China.
6. Gyampoh, B. A., Amisah, S. and Idinoba, M. 2007. Climate change/variability and vulnerability of livelihoods in Offin River Basin, Ghana. IPCC Expert Meeting on Integrating Analysis of Regional Climate Change and Response Options, 20 – 22 June 2007, Nadi, Fiji.
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7. Posters

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13. Lasco, R., Delfino, R.J. and Pulhin, F. Climate change adaptation and natural resource management - Seeing two sides of the same coin: the Albay, Philippines experience
14. TroFCCA. Principles (P) and criteria (C) for assessing the vulnerability of coupled human-environment systems

8. Flyers

1. Tropical Forests and Climate Change Adaptation (TroFCCA)
2. Forêts Tropicales et Adaptation au Changement Climatique (TroFCCA)
3. Bosques Tropicales y Adaptación al Cambio Climático (TroFCCA)
4. Tropical Forests and Climate Change Adaptation (TroFCCA) West Africa
5. Forêts tropicales et Adaptation au changement climatique (TroFCCA) Afrique occidentale
6. Tropical Forests and Climate Change Adaptation (TroFCCA) in Southeast Asia
7. Tropical forests are important for adaptation to climate change in Central America

9. Theses

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10. Datasets available online

A. In preparation

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3. Trofcca Central America, 2008/9. Compilation and format conversion of available Climate Change Scenarios climate data (CRU, WorldClim, TNC dataset) (CRU data with the new format will be posted in CATIE website)
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11. Internal documents

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