

## **Using Tropical Forest Ecosystem Goods and Services for Planning Climate Change Adaptation with Implications for Food Security and Poverty Reduction**

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### **Abstract**

Tropical forest ecosystems represent a common heritage with livelihood portfolios shared by a great majority of people especially in developing countries but are now threatened by climate change. In spite of their contribution to poverty alleviation and food security, and also for climate change responses (adaptation and mitigation especially through the market-incentive schemes (CDM) of the Kyoto Protocol) forests are still hardly integrated into national planning processes aimed at addressing any of these national development challenges. This is evident in some of the national documents of some developing countries such as the Poverty Reduction Strategy Paper (PRSP) to the World Bank, and the First National Communication to UNFCCC. This paper presents some preliminary outcomes of the Tropical Forests and Climate Change Adaptation (TroFCCA) project of the Center for International Forestry Research (CIFOR) whose overall mission is to underscore the importance of tropical forests for livelihood adaptation to climate change and mainstreaming adaptation into national development processes. The paper also highlights TroFCCA's approach in engaging stakeholders from the onset in setting the agenda with the identification and prioritization of forest-based sectors as the entry point in the process of assessing the vulnerability to climate change and developing adaptation strategies for these selected development sectors. This is a highly crucial area with great policy implications.

Planning with ecosystem goods and services seems to emerge as a prospective approach to demonstrate to policymakers the potential of forest ecosystems for livelihood adaptation to climate change which also enhances the opportunity for achieving food security and community resilience to poverty. TroFCCA's approach in engaging stakeholders at the onset in defining their perception of ecosystem goods and services by virtue of their importance to household livelihoods and their contribution to national development emphasizes the significance of a place-based context in the valuation of ecosystem goods and services. This

approach also contributes to raising public and policy awareness to climate change as part of the continuum of mainstreaming climate change adaptation into national development planning. The study also highlights the opportunities that an ecosystem approach provides for integrated natural resource planning for achieving co-benefits linked to the realization of two (1 and 7) important Millennium Development Goals. However, there are other policy and institutional reform challenges including governance, equity and rights to resources that need to be addressed in order to reap the full suite of benefits for climate change adaptation, poverty reduction and food security.

Keywords: Forest, ecosystem services, climate change, poverty, adaptation, food security

## **Introduction**

Climate change is a global phenomenon posing new challenges in achieving food security and improving the livelihoods of the poor who are in the majority in developing countries. The nature of the exposure to climate change and the adaptive capacity that exists, determines the severity of climate impacts. Poverty, food security and human adaptive capacity to climate change are intricately linked and pose inseparable developmental challenges. Over half of the world's population continue to live on less than \$2 dollars a day, with a billion on \$1 or less (WRI, 2005) and that have the potential of affecting outcomes where planning is not appropriately integrated. As over 1.6 billion people living in extreme poverty continue to depend on forests for some part of their livelihoods (World Bank 2004; WRI, 2005), there is a connection between forests and poverty. Eradicating poverty would therefore be impossible without integrating the concerns of the ~410 million people (including 60 million indigenous people) living in, or at the fringes of, tropical forests and who depend on forests resources for their subsistence (Wiersum *et al.*, 2005). In this framework, community-based planning around shared natural resources is one way that provides an integrated approach to addressing the different aspects of the development challenge (Huq, 2007).

Many tropical developing countries are facing major challenges in successfully implementing national development goals, and achieving global targets and yet they now have to deal with climate change which is another layer of constraints besides other global environmental change issues (*e.g.* land use change, land

degradation, desertification, biodiversity loss etc) which are already limiting national development. Some of the implications include the inability to achieve the Millennium Development Goals by 2015 especially of (1) eradicating extreme poverty and hunger, (7) ensuring environmental sustainability and also (3) promoting gender equality and empowering women. Women's roles are very predominant in household livelihood activities in many developing tropical countries. These same challenges have been highlighted in other global assessment reports besides the Millennium Ecosystem Assessment (MEA, 2005) such as the Stern Review (Stern, 2007), IPCC Fourth Assessment Report (IPCC, 2007), which also demonstrates the vulnerability of tropical countries to climate change impacts and their likely inability to cope at present with such mega-problems.

Numerous factors underscore the vulnerability of tropical countries to climate change impacts. One notable aspect is that the livelihoods of the majority of the poor (especially women) are highly dependent on climate-sensitive sectors of the economy such as subsistence agriculture, fisheries, pastoral practices, and on forests for household energy, food security, water supply and traditional medicines (herbs and tree barks) as their front line primary healthcare products. These same livelihood activities also contribute a significant proportion (~75%) to the GDP of most of these countries highlighting the fragility of national development to climate uncertainties, and the unpredictability in successfully implementing any sustainable national economic development plans. This makes it imperative for climate change and climate variability measures to be taken seriously and for adaptation strategies to be fully integrated into project development planning both in the private and public sectors.

As tropical forests continue to play major roles in global climate change systems through the amount of carbon stock they safeguard in various carbon pools (plant biomass, litter, roots and organic matter in the soil) (Righelato & Spracklen, 2007) in mitigation, it is important to consider same carbon resource pool for adaptation (Dresner *et al.*, 2007; FAO, 2005). Forests are equally at high risk from climate change (Schozle *et al.*, 2006) and in extreme cases, could suffer shifts in species composition (Gonzalez, 2001) especially at the ecosystem margins.

According to Stern (2007), adaptation is the only response available in dealing with the impacts of climate change that will occur over the next several decades before mitigation measures can have an effect. In this light, if a high percentage of the world's poorest directly depend on the forest for subsistence, then forests deserve to be a major factor and entry point for adaptation.

Unfortunately, in spite the importance of forests to tropical countries, the value of forest to local livelihoods is not fully captured in national development plans in many tropical countries especially those in sub Saharan Africa. The potential contribution of forest for climate change adaptation is also not well understood and therefore not reflected in official national documents such as the national communication reports to the UNFCCC. Even Poverty Reduction Strategy Papers (PRSP) submitted to the World Bank with regard to the MDG often does not reflect forest in the national strategy of some of these countries. The grand challenge thus, is to increase both public and policy awareness of the role of forests, and to develop livelihood adaptation strategies on a framework of forests goods and services that does not jeopardize the integrity of such forests to future climate impacts, in order to ensure the continuity in the provisioning of forest ecosystem goods and services, that contribute to food security and poverty alleviation.

### **Climate change projections in TroFCCA regions of activities**

Climate change and climate variability patterns vary with regions. Southeast Asia, for example, with high emission of greenhouse gases is expected to be warmer by 1.32 -2.32 °C and with a slight increase in mean annual precipitation of 1 – 3 % by the mid 21<sup>st</sup> century (IPCC, 2007). Under current trends, extreme weather events associated with the El Nino effect are likely to be more frequent and intense, while severe rains and floods are also predicted. Climate-linked natural disasters such as droughts, floods, soil erosion and landslides in this region are likely to increase in frequency and extent. Additionally, human-induced disasters such as forest fires are also likely to increase.

Projected climate variability and climate change in Central America shows an increase in temperature and a decreasing trend in mean annual precipitation (IPCC, 2007).

In West Africa, temperature is projected to increase by 2.0 to 6.0 °C relatively to the present by the 21<sup>st</sup> century (IPCC, 2007). Similarly, mean annual precipitation will decrease by 6 – 20 % by 2025, except in the rainforest zone, where some increases are expected. Extreme weather events are predicted to be more frequent. As a result, there is advancing desert towards the south of the Sahara which is encroaching into agricultural lands. Mixed rain-fed semi-arid systems will also be affected (IPCC, 2007). The total loss in agricultural productivity could be up to 2 - 4% of national GDP. Furthermore, the projections on agriculture still portray major challenges. Climatic change may engender several kinds of impacts on agriculture as indicated by IPCC Fourth Assessment Report (2007). Some of these include;

- Crop production quantity and quality would be directly affected by climate, and also indirectly through diseases, insects, and weed effects.
- Greater frequency and intensity of rainfall, together with increased use of nitrogen, mineral elements and pesticides would lead to leaching or run-off of these substances.
- Rural environment would be abused, even to the stage of land abandonment due to climatic change impacts on certain species or the introduction of new ones, the modification of land-use especially with the development of irrigation projects.

### **Food security challenges in the tropics**

Agriculture is a critical sector of the world's economy and contributes 24% of global GDP (World Bank, 2003) while providing employment to 1.3 billion people. Yet, it uses more water than any other sector. This is worst in low-income countries, where agriculture consumes 87% of total extracted water, compared to 74% in middle-income countries and 30% in high-income countries (World Bank, 2003). Low inputs and total reliance on natural systems (rainfall, soil fertility etc) characterize agricultural systems especially on smallholders' farms in tropical countries. It is estimated that there are over 525 million farms worldwide with over 85 % in smallholdings (< 2ha) (Nagayets, 2005) supporting over 2.5 billion people in the developing world. This leaning in food production suggests that small farmers will continue to dominate

the agricultural landscape in the developing world, especially in Africa and Asia, for at least the next two to three decades. The future and viability of these small farms under climate change impacts and the implications for food production, the environment and the livelihood of smallholding families remain of great concerns both for research and policy development.

Agricultural expansion taking place in many developing countries is resulting in the increase in share of total land area used for agricultural purposes (Table 1). This is due to many drivers, including loss of soil fertility and per hectare productivity and rapid demographic changes. These will eventually exacerbate further degradation beyond traditional farm holdings to adjacent forest and water resources essential for local livelihoods.

Decreasing per hectare yields are also contributing to the conversion of forests and other remnant vegetation areas into new croplands, thus jeopardizing the provision of essential ecosystem services. This highlights the urgency of the need to seek ways of attaining co-existence between different food supply sources and ecosystem services. The IPCC (2007) report also emphasizes this increasing shift into marginal lands provoked by declining land productivity. Use of these marginal lands will exacerbate the risks of soil erosion and degradation (Lal, 2004) as a large proportion of agricultural lands have already been degraded by excessive disturbance, organic matter loss, salinization, acidification etc (Batjes, 1999; Foley *et al.*, 2005). The capacity of farmers to feed even their own household is getting weaker (Table 2) and this has not improved for over a decade.

Under the declining potential for food security, it would be strategic to develop divergent sources in contributing to food security but with varying sensitivity to climate stimuli, as a way of ensuring safety nets during periods of shortage (e.g. during the cropping season, severe droughts, floods etc) using forest foods. This constitutes the multiple-component strategies in planning food security in rural households.

## **Ecosystem Services & climate adaptation**

The importance of ecosystem services for human wellbeing was succinctly highlighted by the Millennium Ecosystem Assessment (2005) attracting both public interest and stimulating market incentives and investment in payment for ecosystem services (PES). PES has goes a long way to providing another dimension for aligning ecosystem stewardship with financial and economic incentives for enforcing certain norms of practice (Irwin & Ranganathan, 2007). Through the payments for ecosystem services, there are emerging opportunities with revenue flow with the potential of contributing to poverty reduction as demonstrated in Costa Rica (Pfaff *et al.*, 2007; Sanchez-Azofeita *et al.*, 2007).

In spite of the significance of ecosystem services for livelihoods, there is still very limited use of ecosystem services for planning livelihood adaptation even though that approach would provide a pro-poor dimension to climate change adaptation whilst contributing to addressing food security, poverty alleviation and safeguarding other ecosystems in tropical countries. This could probably be due to the lack of clearly definable thresholds and trade-offs of some ecosystem services and their responses to climate change especially in extreme situations, and their likely trajectories in new scenarios in order to be able to determine the flow of the goods and services to facilitate planning. In many situations, there are place-based differences in ecosystem functioning and for the provisioning of ecosystem services especially for transboundary ecosystems. Similarly, ecosystem degradation does not respect political boundaries or occur in a single timeframe.

Planning adaptation under such circumstances poses great challenges in managing both the site of ecosystem and its provision to enable climate proofing of the flow of the ecosystem services. It requires institutional frameworks that facilitate operations across multiple timeframes (short, medium and long term) and spatial scales (local, regional, national, and regional).

Most tropical forests fall in the category of transboundary ecosystems (e.g. Amazon, Congo basins) shared by several countries, and at a lower scale, shared by several communities thereby requiring planning

adaptation at multiple but inter-related levels. With forest degradation, planning adaptation using forest ecosystem services becomes extremely difficult. Following the last global forest assessment, in spite of a global decline in deforestation for example, Africa experienced an increase in deforestation accounting for more than 50% of the global damage to forest areas by wild fires (FAO, 2007). Although there was a decrease in Asia and the Pacific region, there was still a net loss of forest in Southeast Asia (FAO, 2007). This poses more constraints in addressing poverty, food security and adaptation to climate change. One approach to planning climate change adaptation across multiple levels is through the formation of bridging organizations. Such organizations provide forums for bringing together a range of formal and informal actors, sharing a diversity of knowledge, and developing collective solutions on a specific issue. By identifying and coalescing around common interests, participants develop trust amongst themselves and can implement opportunities for action appropriate to a range of issues at different spatial and temporal scales and political levels.

### **TroFCCA Framework and Approach**

This paper presents the preliminary outcomes of the Tropical Forests and Climate Change Adaptation (TroFCCA) project of the Center for International Forestry Research (CIFOR). TroFCCA is a global initiative on forests and adaptation with three regional locations; Central America (Costa Rica, Honduras, Nicaragua), West Africa (Mali, Burkina Faso, Ghana), and Southeast Asia (Indonesia, the Philippines). The ultimate goal of the project is to contribute to national processes of adaptation to climate change, through the assessment of vulnerability and the development of adaptation strategies, and mainstreaming these into policy. The paper however emphasizes the methodological pathway for defining the adaptation agenda linking multiple levels and spatial scales in a science-policy dialogue process that allows for the appropriate management of the socio-ecological complexity associated with integrating ecosystem functioning and ecosystem services that might be spatially separated, in the same plans.

TroFCCA uses an ecosystem approach to adaptation by planning and developing adaptation strategies using ecosystem services. This allows for climate proofing these ecosystem services as livelihood



portfolios for adaptation. This seems to provide a robust approach to adaptation that has general applicability and implications for poverty, food security, and energy security within the framework of sustainable development. The approach also allows regional planning for adaptation for transboundary ecosystems shared by several nations such as forests, river catchments, and watersheds etc. These are potential hotspots of conflict under climate change which may provoke a scramble for resources.

As an entry point, the forest ecosystem is highlighted in the contextual framework of household livelihood and national development such that the subsequent assessment of vulnerability and adaptation primarily focuses on specific socio-economic sectors/areas/topics that were mutually prioritized 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/topics.

During the project induction phase, several consultations with different stakeholder groups were organized, and a science-policy dialogue platform instituted as a main vehicle for communication and planning to be used throughout the life of the project. The participatory approach was used for setting the agenda and planning of the implementation activities interactively with all stakeholders, which in this initial phase, guided the process of identifying and prioritizing the sectors or areas of regional interest, with respect to their relevance to livelihood, national development but also perceived by the stakeholders to be highly vulnerable to climate change. The approach engages the stakeholders from the on-set to ensure future policy dialogue particularly at a time when discussions of development strategies in developing countries is geared towards ensuring adequate stakeholder participation in deciding development pathways. This approach also enabled the stakeholders to make the link to the adaptation process for their national economy and connections to global development targets like the Millennium Development Goals (MDGs) especially (1) on eradicating extreme poverty and hunger and (7) on ensuring environmental sustainability.

### **Forest-based sectors and regional prioritization of ecosystem services**

Although tropical forests remain the common ecosystem across the three global regions of TroFCCA activities, the sectors/topics prioritized using common criteria were completely different and were directly linked to ecosystem goods and services that corresponded to different quadrants in the categorization of ecosystem services (provisioning, regulating, cultural and supporting services) (Table 3).

Stakeholders relate to, and regard ecosystem services as, sectors related to livelihoods. These sectors in some cases could directly represent an ecosystem service (MEA 2005) but could also be encapsulated by a couple of ecosystem services. Thus, making their connections evident or defining their equivalence is important in using ecosystem services for planning adaptation strategies. Besides the differences in priorities, all the sectors in the three regions have correspondingly degraded ecosystem services (Table 3) using the Millennium Ecosystem Assessment (2005). This matches and confirms the stakeholders' perceptions of these sectors and explains why the sectors are considered to be most vulnerable to climate change and constitute high priorities for adaptation efforts.

The focus in Central America of ensuring a sustainable water service from the forest is understandable especially with the prediction of increases in temperature which is likely to reduce the quantity and quality of water from cloud precipitation. Mindful of the link of cloud precipitation to the forest ecosystem, climate risks will be amplified with changes to the forest ecosystem structure with greater risks from fires, pests and diseases.

Disasters linked to climate change are likely to increase in frequency and intensity, including fires, floods, droughts, soil erosion and landslides yet the ecosystem service of natural hazard regulation is highly degraded. These disasters also have impacts on food security and poverty with the loss or destruction of crop land and biodiversity and other infrastructure including family property as aftermaths of such disasters.

Adaptation in Indonesia focuses on the recurrence of forest and land fires and landslides. Fires are human induced disasters but the extent is amplified by drought. Big fires in Indonesia in 1982-1983, 1991, 1994, 1997-1998, 2002 and 2006 were associated with intense drought. Fires in 1997-1998 caused a total loss of USD 9.1 billion, that included losses from plantations and agricultural areas (Tacconi 2003). Soil erosion and landslides add to the loss and degradation of soil resources for farming. This may seriously impair the livelihoods of poor farmers and local economic activities. The adaptation approach in Indonesia therefore, is to lean towards disaster prevention that specifically aims at enhancing human capacity for coping with such potential risks.

The long history of drought and desertification in West Africa probably explains the emphasis on provisioning ecosystem services especially fresh water. It has significant impact on food and poverty resulting from loss of agricultural land, reduction of forest land as the source of income and food, loss of biodiversity and wildlife migration, and the increased risk of fires. It is therefore clear why adaptation activities in this region focuses more on coping with resource degradation affecting human development and strengthening the resilience of the community to climate change.

The underlying element in the adaptation activities in the three regions is their common focus on people and the community as the central issue. This then demands both socio-economic adjustments and some extent of ecosystem adjustments.

TroFCCA's approach not only demonstrates the issues arising from the adaptive management of forest ecological systems in the various regions, but also the challenges in undertaking sustainable development projects in economically impoverished countries. The ecosystem approach highlights the contextual importance of community preferences in ecosystem services as indicated by the perceptions of the stakeholders. These have major implications for adaptation planning, and also for international processes that involve forests such as carbon dioxide mitigation schemes e.g. CDM, since this would depend on other comparative needs of forests ecosystem services by that community. For example, is payment for carbon sequestration likely to be more important than the other provisioning livelihood services of fresh water,

wood fuel, medicinal products etc by the forest in sub Saharan Africa as highlighted here in this study? This may also explain the low adoption rate of CDM process in some global regions like in sub Saharan Africa emphasizing the incompatibility of such schemes to the ecosystem service priorities from either planted or natural forests. The contextual aspects should also be taken into consideration within the planning process of payment for ecosystem services schemes. This has the potential of giving rise to ecosystem service districts whereby countries may have local regions or districts responsible for providing certain category of services such as flood protection or watersheds for potable water supply (Irwin & Ranganathan, 2007).

From a policy perspective, the ecosystem approach of this study has provided a platform to facilitate engagement between government and local community groups which is not always necessarily present in some of the regions. Planning the future in partnership improves the likelihood by fostering the resilience and adaptive capacity of the eco-social systems in these three TroFCCA regions. However, time will tell whether this approach is successful given weaknesses that even well framed problems with target-driven activities can suffer governance issues especially in the face of massive contextual changes and personnel turnovers in government departments common in most developing countries.

Additional outcome from the TroFCCA approach is its value in poverty reduction whereby the prioritized sectors for developing adaptation strategies directly represent asset bases for the community rather than simply income sources. This is crucial for both poverty reduction and adaptation because it guides the formulation of policy with far reaching implications rather than just using the conventional income-based approach. UNDP (2005) considers the expansion of the asset base of the poor and raising the productivity of those assets for generating income and well-being, as the way to sustainable poverty reduction. Furthermore, it emphasizes the role of stakeholders in the process, which falls in the category of 'participation by consultation' as described by Walker *et al.* (2002). The approach however depends on the specific national forest policies, institutions, ownership structures, ecosystems, laws, and other national circumstances to enhance the process.

The ecosystem approach of this study also provides the opportunity for integrating human and ecological priorities into development programmes that require comprehensive strategies for the utilization of agriculture and forest systems in pragmatically addressing multiple developmental goals such as poverty reduction, food, energy security and community resilience to shocks.

### **Outcomes and implications for planning national development programmes using ecosystem services**

Prioritization of the sectors/areas/topics of focus set the stage and the agenda for the national response and for steering the implementation of the adaptation strategies. A list of partners and their potential roles in the adaptation process and in the implementation of national adaptation activities were constituted. The starting meetings provided the platforms for contextual placement of the project within the national development framework and a landscape perspective for regional collaborations was required for transboundary resource management. The science-policy forum in each region also served as a platform for the coordination of climate change related projects in the region, as several organizations and projects attended the meetings.

The project through the participatory research approach connected forest to national development issues, this time not through timber logging but through other forest ecosystem goods and services recognizable as important to household livelihoods and national development. Also these were used with the aim of looking at the trajectories of these ecosystem services to future climate responses. The introduction of a science-policy dialogue platform on climate change, which never existed before in most of the regions, paves the way for mainstreaming climate change into national development planning and served as an outreach mechanism capable of altering the policymaking environment by engaging stakeholders of the future landscape for national development processes.

The role of ecosystem services have been emphasized and encouraged with market schemes such as payment for ecosystem services (PES), CDM etc as mechanisms for reducing emission and as incentives for conservation. However, their roles in livelihood security, especially as a pro-poor approach for poverty

alleviation, food and energy security and adaptation, have still not been adequately exploited in any of the proposed schemes. In order to achieve relevance, there are contextual factors that need to be assessed in the valuation of ecosystem services for planning development strategies for poverty reduction, food security, energy security or climate change adaptation as is highlighted in the outcomes of this project. The duplication of activities where resources are limited has been highlighted as one of the short-comings in the realization of development planning. This drives the need for the pooling of resources and knowledge for use in fully integrated planning (Ogden & Innes, 2007; Sharma, 2007). There are however, barriers to achieving such synergies some of which include institutional frameworks, political processes, information systems and practitioner communities that have developed independently and thus remain largely separate in their systems of functioning. In contrast, the environmental services approach provides the synergy to simultaneously pursue national development goals, natural resource conservation objectives and market opportunities for better livelihood security (Shackleton *et al.*, 2007; Tschakert, 2006).

There are interactive roles for mitigation and adaptation foreseen for the agricultural sector, which may occur simultaneously, but differ in their spatial and geographic characteristics (IPCC, 2007). Similarly, there are complementary roles for forests in achieving food security and poverty alleviation thereby also constituting a framework for adaptation and mitigation. Agricultural systems in the twenty-first century should need to also contribute to GHG emissions reduction (principally CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O) and adapt to climate change to simultaneously continue to satisfy the vital needs of increasing populations for food, energy, fibers, and other products. (Perarnaud *et al.*, 2005). Agricultural mitigation practices may influence non-agricultural ecosystems. For example, practices that diminish productivity in existing croplands (*e.g.*, set-aside lands) or divert products to alternate uses (*e.g.*, bio-energy crops) may induce conversion of forests to cropland elsewhere. Conversely, increasing productivity on existing croplands may ‘spare’ some forest or grasslands (Balmford *et al.*, 2005; Mooney *et al.*, 2005). The likely net effect of such trade-offs on biodiversity and other ecosystem services has not yet been fully quantified (Huston & Marland, 2003; Green *et al.*, 2005).

The synthesis and integrated analyses of stakeholder-identified agro-ecosystems together with the forest ecosystems and overlying governance regimes would facilitate the development of decision-making frameworks for both policies and farm-level operations to ensure co-benefits, co-existence, resilience and adaptation to climate impacts.

### **TroFCCA outcomes for addressing poverty, food security and climate change adaptation**

In many developing countries, food production systems represent livelihood activities interwoven with legacies and cultural heritage and transferable skills and traditional knowledge that contribute to the empowerment of the community and the strengthening of the social capital pool associated with food production. Disruptions to the food system by climate impacts could consequently disrupt and weaken existing social structures and networks. With the projections that climate change could likely have devastating consequences at all levels of national development and the economy of the region there are potential implications for family integrity that are likely to have other consequences such as the chances of achieving universal education for children at school age whose roles could primarily shift into labour for food production.

Governance and institutional reforms (access rights etc) needed, constitutes a challenge in the improvement of the abilities of individuals and communities to respond when faced with climate change. TroFCCA is elucidating institutions and governance issues, especially those linking rights, equity and access to resources, to highlight constraints to, and opportunities for adaptation through collaboration, and communication between government departments. Integrating climate change trends into policies, long-term strategies, national development programs and food security planning is crucial in achieving sustainable development in developing countries.

With a large proportion of the population directly dependent on agricultural activities which is highly sensitive to climate, there are substantive social implications arising from climate change impacts, which are likely to amplify other major challenges like hunger, malnutrition, diseases and migration. Furthermore,

there will be severe developmental implications to the loss of other natural resource-base like forests, catchments etc which provide vital economic and livelihood resources, through the expansion and migration of farmlands into these other ecosystems. Regional instability, especially over trans-boundary resources, stakeholders' conflicts over multiple needs for resources like water, are examples of the potential for unrest and destabilization arising from climate impacts on agriculture.

The TroFCCA project is providing a crucial support to the policymaking process by facilitating a dialogue between stakeholders and engendering a participatory approach to ensure the integration of climate change adaptation into national development and livelihood programs.

The facilitation of production opportunities by selecting suitable climatic windows, re-enforcing other sources of food from the forest (baobab, Shea butter etc), reforming governance and access rights to resources - all are interventions that have the potential of improving smallholder farming and transforming livelihoods from subsistence to commercial profitability thereby contributing to adaptation and livelihood security. Forests are relevant for diversification of activities and are additional family income sources contributing to poverty alleviation, food security and community resilience.

## **Conclusion**

Ecosystem services provide the opportunity for promoting synergy in the planning and implementation of multiple development programs (poverty, food security, climate change response with mitigation and adaptation). This would however require integrated strategies for example, involving agro-ecosystems and forest ecosystems in order to achieve maximum benefits for the environment as well as for the local livelihoods or national economies. This study demonstrates the multiple benefits that are achievable by using ecosystem services as a framework for planning climate change adaptation measures. This also has implications for achieving poverty reduction targets and improved food security in developing countries. Current institutional and governance structures in some developing countries are likely the most important



limiting factors for achieving such synergies and the realization of the suite of benefits. In many cases, this is also due to the lack of communication between major actors within and between sectors; weak institutions, competitive use of funds, and the fact that in many cases both activities are designed differently with different targets. However, some of these constraints could be overcome through a participatory approach as demonstrated by TroFCCA, in engaging stakeholders in a science-policy dialogue process for setting the agenda and planning the implementation strategies at different levels (national, local etc.).

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**Table 1. Changes in total land area used for agriculture in 1992 and 2002 (%)**

Region	1992	2002
Latin America & Caribbean	37.5	38.9
East & South East Asia	38.2	40.2
Africa South of the Sahara	40.0	40.2

Source: Adapted from FAO Statistics 2004

**Table 2. Ratios of producers to consumers in 2000 and 2010 for different regions**

	2000	2010
Region	Producer: consumers	Producers: consumers
USA	1:44	1:60
West Europe	1:22	1:34
Australia	1:22	1:26
Latin America & Caribbean	1:4	1:5
East & South Asia	1:1.2	1:1.5
Africa South of the Sahara	1:0.6	1:07

Source: Adapted from FAO Statistics 2004

**Table 3. Prioritized sectors of TroFCCA regions and their corresponding ecosystem services and the level of degradation as described by the Millennium Ecosystem Assessment (MEA, 2005)**

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

▼ Degradation