SII-7

AGROFORESTRY AND CLIMATE CHANGE: ICRAF'S RESEARCH STRATEGY

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ABSTRACT

Agroforestry Systems for Climate Change Adaptation and Mitigation is one of six global research projects of the World Agroforestry Centre (ICRAF). The research aims to improve the resilience of farming systems and livelihood strategies of small holder farmers to current climate variability as well as long-term climate change, through the increased use of trees for intensification, diversification and buffering of farming systems. The research focuses on vulnerability assessments, the impact of climate change on Agroforestry systems, and synergies between climate change adaptation and mitigation.

Developing countries are going to bear the brunt of climate change and suffer most from its negative impacts. Mitigation efforts will only provide a partial softening of the effects of climate change. Local climates and terrestrial ecosystems will change, threatening biota and human livelihoods. As climate changes, improvements in food security, environmental services and rural livelihoods are still to be pursued. In many areas, smallholders are pursuing these improvements through extensification of agriculture rather than intensification. With increasing inter-annual rainfall variability, cultivation of marginal lands is vulnerable to accelerated rates of degradation of soil and water resources. Agricultural systems affected by unsustainable management, and land and resource degradation are the most vulnerable to climate change. Trees have important roles in reducing vulnerability, increasing resilience of farming systems and buffering households against climate related risks.

This research project is guided by two central hypotheses:

(1) Trees are deep rooted and have large reserves, and are less susceptible than annual crops to interannual variability or short-lived extreme events like droughts or floods. Thus, trees offer diversification options that can reduce production risks for small holder farmers.

(2) Trees are a perennial resource that can be exploited to provide increased income during difficult periods, thereby reducing income risks associated with climate related shocks for small holder farming families.

These hypotheses are being evaluated in different landscapes, farming systems and socio-political contexts to develop knowledge about the potential for trees to help facilitate adaptation, and to help development agencies create an enabling environment for broader implementation of Agroforestry to facilitate climate change adaptation.

Through research on the vulnerability and adaptation of Agroforestry systems to climate change, ICRAF and its partners are analyzing the impacts of climate change on water resources in watersheds, and developing analytical methods and tools for the management of upland farms in response to changing climate. This research will help identify climate constraints to the sustainability and improvement of farm productivity. Enhancing the capacities of national research partners to conceptualize and implement research on climate change adaptation is a key element of our research. Given the increasing recognition of the potential role of Agroforestry in addressing vulnerability to climate change, our research targets the mainstreaming of Agroforestry knowledge in adaptation and mitigation initiatives in agriculture, environment and forestry, and the scaling-up of Agroforestry applications to support smallholder adaptation.

There is also great potential for Agroforestry to sequester atmospheric carbon, and thus to enhance livelihoods while mitigating climate change. Our research is exploring the synergies in Agroforestry systems between adaptation and mitigation. In the context of REDD discussions at the UNFCCC, we are developing tools for analyzing the relationships between land use change and climate change with a specific focus on changes carbon stocks. Given the predicted scale of carbon markets, World Agroforestry Centre is investing considerable effort in overcoming the main obstacles to the mobilization of carbon finance to scale up Agroforestry practices that facilitate adaptation to climate change, by developing tools and methods for measurement and monitoring of the carbon

benefits of improved practices in agricultural landscapes, and by supporting institutional innovations to link small farmers to global carbon markets.

Target regions for mainstreaming knowledge of Agroforestry-based strategies and options include the arid and semi-arid regions of Africa, typhoon-prone areas in the Philippines, high rainfall areas in Indonesia and the climate-sensitive Himalayan region. This presentation includes examples of our research from a range of agroecological settings.

KEYWORDS
Agroforestry, climate change, adaptation, mitigation, research strategy

The World Agroforestry Centre

AGROFORESTRY AND CLIMATE CHANGE: ICRAF's research strategy in SE & E Asia

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Outline

- ICRAF's global research strategy
- Climate change mitigation research in SE and E Asia
- Climate change adaptation research in SE and E Asia
- Conclusions

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PART ONE

ICRAF's global research strategy

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What is ICRAF?

Our Mission…

To generate science-based knowledge about the diverse roles that trees play in agricultural landscapes, and to use our research to foster policies and practices that benefit the poor and the environment.

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Global Research Priorities

- GRP 1: Domestication, utilization and conservation of superior agroforestry **germplasm**
- GRP 2: Improving on-farm **productivity** of trees and agroforestry systems
- GRP 3: Improving tree product **marketing** for smallholders
- GRP 4: Reducing **land health** risks and targeting agroforestry interventions to enhance land productivity
- GRP 5: Improving the ability of farmers, ecosystems, and governments to cope with **climate change**
- GRP 6: **Policies and incentives** for multi-functional landscapes with trees that provide environmental services

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GRP 5: Climate change research

- *Goal:* To improve the resilience of farming systems and livelihood strategies of small holder farmers to current climate variability and long-term climate change, through the increased use of trees for intensification, diversification and buffering of farming systems.

Underlying hypotheses:

(1) Trees are less susceptible than annual crops to interannual variability or extreme climate events, and thus offer diversification options to reduce small holders' risk.

(2) Trees can provide income, thereby reducing income risks associated with climate related shocks for small holder farming families.

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GRP 5: Climate change research

Project Objectives

1. **Vulnerability Assessment** – to assess the social, economic and environmental factors that interact to predispose rural households to climate related shocks.
2. **Impact of climate change on Agroforestry systems** – to understand the potential impacts of the different dimensions of climate change (water availability, temperature, rainfall intensity, interannual variability) at different scales: on Agroforestry tree species, on Agroforestry farming systems and on agricultural landscapes.
3. **Adaptation to climate change** – to determine how tree-based systems can be used to buffer smallholder farmers against climate variability and climate related shocks, increasing their capacities to adap (biophysical, economic and institutional assets).
4. **Synergies between adaptation and mitigation**– to assess the carbon sequestration potential of promising adaptation technologies with the view of capturing carbon finance opportunities to scale up adoption of these systems to reduce vulnerability of smallholder farmers.

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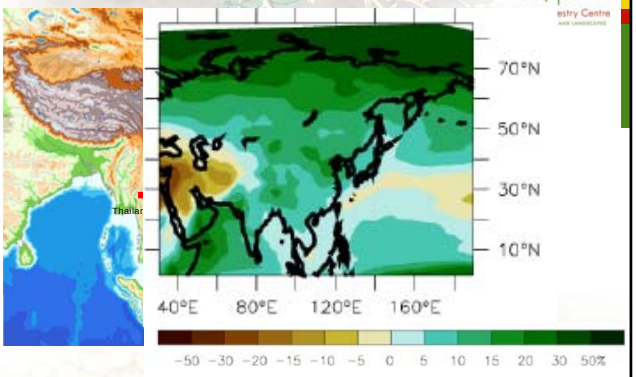
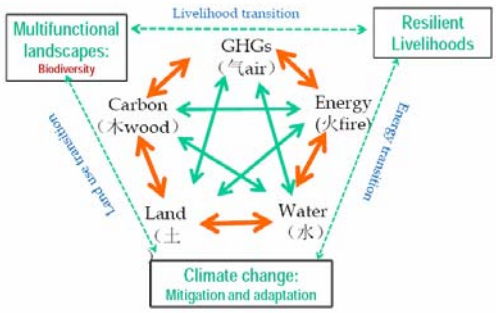
Regional Relevance in Asia



Mean predicted change in annual precipitation 1980-99 – 2080-99

Mitigation & adaptation are multi-dimensional problems



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PART TWO

ICRAF's climate change mitigation research in SE & E Asia

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REDD in SE Asia

Deforestation accounts for 20% of global emissions. Reduced emissions from REDD (3-30tCO2e/ha/yr) are much cheaper than sequestration through afforestation (3-7tCO2e/ha.yr). But REDD was not included in 1st commitment period

Research by ICRAF and partners has shown that REDD is

- *Urgent*: total emissions are substantial (Indonesia has 50% of the emissions of the USA, mostly from forest and peatland)
- Potentially *cost-effective* because most past emissions have small economic benefits (<1 $/t CO e). but
- *Not easy* because there are many stakeholders and actors involved, and several layers of government. A large share of recent emissions was 'illegal'. Early pilots suggest high transaction costs unless international regimes are kept *simple* and *transparent*.
- *Not sufficient*, unless a national land use accounting approaches are used

Units: MtCO2e

Emissions sources	US	Indonesia
Energy	5752	275
Agriculture	442	141
Forestry	-403	2563
Waste	213	35
Total	**6005**	**3014**

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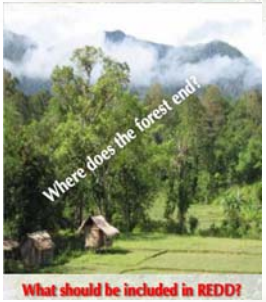
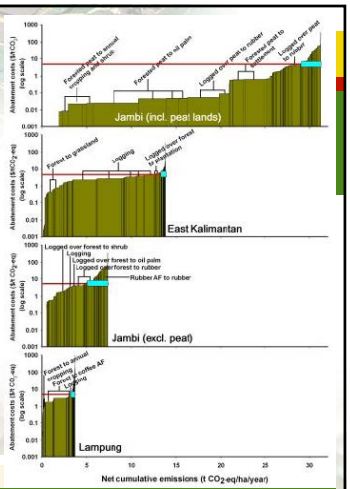
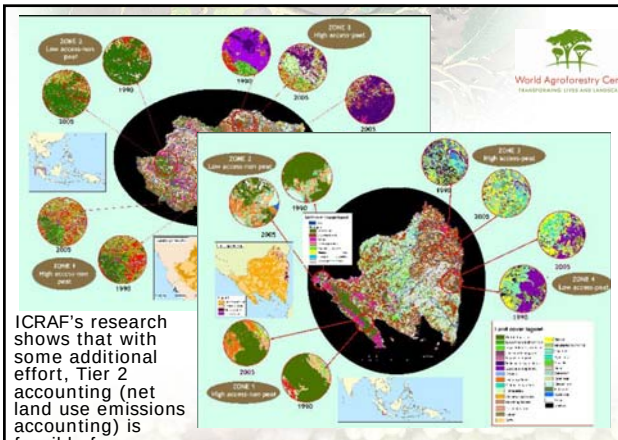
The need for national accounting



The existing mechanisms of A/R CDM + REDD will cover less than 50% of the land-use based emissions from Indonesia



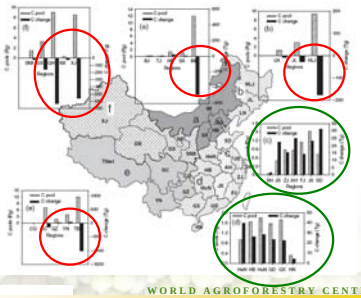


ICRAF's research shows that with some additional effort, Tier 2 accounting (net land use emissions accounting) is feasible for Indonesia

Emission sources	US	China	Indonesia
Energy	5752	3720	275
Agriculture	442	1171	141
Forestry	-403	-47	2563
Waste	213	174	2563
Total	**6005**	**5017**	**3014**

Units: MtCO2e

Soil carbon trends in China



Contrasting issues in China:

Land use carbon sequestration options

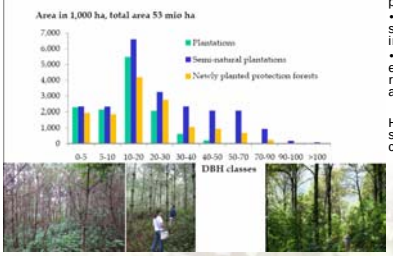
- Land rehabilitation
- Sustainable forest management
- Conservation agriculture
- Improved rangeland management

- What is the potential for carbon finance (or other PES schemes) to provide positive incentives?
- There are substantial potential co-benefits of sustainable land management for China
- Recognizing the potential for C sequestration in the AFOLU sector is an essential part of the global mitigation strategy.
  - National carbon markets
  - International regimes with benefits especially for Africa

The potential of Sustainable Forest Management In China

Low average standing volume (ca. 84 m3/ha).

Age class distribution of new forests in China



Carbon sequestering SFM practices:
- Increasing target diameter/rotation period
- Terminating current practices to extract premature future crop trees while focusing future increment on poor performing trees
- Increasing vertical and horizontal structure by converting monocultures into close-to-nature forests
- Improving site species matching in existing stands by supporting natural regeneration of desired and site adapted tree species.

High potential for additional sequestration in 20 m ha of non-commercial forest.

Carbon potential of conservation agriculture practices

- Large population, low per capita arable land
- High use of water and fertilizer per unit output, falling groundwater levels / increasing reliance on rainwater
- 113 m ha of arable land; 89 m ha medium and low productivity.
- Better tillage and residue mgt can reduce transpiration, and also sequester carbon
- Incentives are required to assist in the transition to sustainable land management practices
- What role for carbon markets?

Practice	tCO2e/ha/yr
Improved agronomy	0.98
Nutrient management	0.62
Tillage / residue management	0.72
Rice management	0.62
Agroforestry	0.72
Land restoration	3.45
Conservation set-asides	5.36

Source: P Smith et al 2007

C sequestration potential of improved rangeland management

The difference between total C of undegraded and degraded grasslands indicates high C sequestration potential of grassland rehabilitation

undegraded	112.73~130.48 tC/ha
Medium degraded	43.86~56.16 tC/ha
Severely degraded	33.81~54.96 tC/ha

Source: Wang Shiping 2008

C sequestration potential of improved grassland management practices in N China

practice	tCO2e/ha/yr
Avoided cultivation	ca. 4
Grazing management	ca. 2
enclosure	ca. 3
Grass cultivation	ca. 3

Source: Lang Rong, in prep

When multiplied across large grassland areas (313 m ha in total, 117 per hh), the total C sequestration potential of maintaining and rehabilitating grasslands may be significant

How can smallholders benefit?

1) Include AFOLU in future markets
   - Early pilot action projects
   - Realistic estimates of costs
   - Support readiness in the agric. sector
2) Reduce costs of measurement and monitoring:
   - Remote sensing + infrared measurement
   - Indirect monitoring methodology

But without carbon markets…

Combating land degradation is still a key priority.

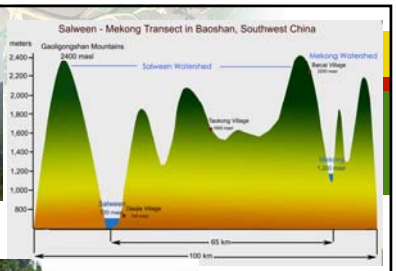
1) ICRAF's Global Initiative for improved land health monitoring

In Asia: "Sustainable Land Management in the highlands of Asia" workshop (May 2009, Lhasa)
- improve understanding of land degradation processes
- improve understanding of impacts of land degradation on economic vulnerability and resilience
- exchange experience on combating land degradation
- build an Asian network for land health monitoring and information exchange

2) Payments for ecosystem services in watersheds and alpine rangelands

PART THREE

ICRAF's climate change adaptation research in SE & E Asia

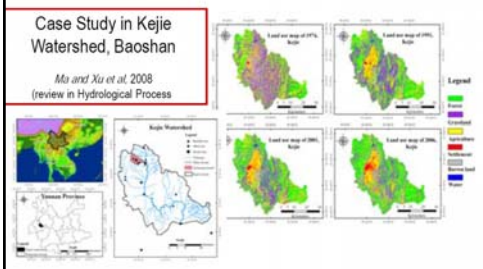


Too much water– how can communities and local governments respond?

水文对土地利用和气候变化的响应

Case Study in Kejie Watershed, Baoshan

Ma and Xu et al, 2008
(review in Hydrological Process



Stream flow is more sensitive to land use change than to climate change

Results:
- Increasing forest by 29% reduces surface water by half, but increases base flow by 18.9%, and decrease of stream flow by 6.3% consequently. The actual ET increased by 5.5%, so forests may lose more water than agricultural crops
- Grassland area increased by 16.2% at the expense of barren land. As a result, surface water decreased by 31.8%. The base flow and lateral flow increased by 19.5% and 9.9%, respectively, because of the increased infiltration under grass cover.

The Right Tree for the Right Place

What shall we plant?

Planting tress in agricultural landscape (tree on farm or agroforestry)

Mitigation & adaptation synergies 'Best practices toolbox'

- Land suitability model + species selection model: ecological and economic selection
- Seed supply: Tree Seeds for Farmers toolbox
- Marketing decision support tools
- C measurement & monitoring tools
- Capacity support to extension systems

PART Four

Conclusions

Challenges on a Himalayan scale

Nine major rivers flow from the Tibetan Plateau

TP provides 70-95% of downstream freshwater in semi-arid and arid areas

TP provides 30% to 60% of downstream freshwater in humid areas

Opportunities in climate change:

Greenhouses in Tibet

Key tasks ahead

Mitigation

- Credible evidence of sequestration potential
- Early pilot action to learn from practice
- Supporting readiness in agriculture sector for engagement with carbon markets

Adaptation

- Supporting generation of improved data on climate change impacts & adaptation options
- Mainstreaming impact assessment and adaptation planning in government development and resource management planning
- Building capacity of local extension services to provide locally responsive services
- Testing our assumptions: Does agroforestry reduce risks of climate change?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感谢！
Thank you
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