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Evolution of land-use types in Indonesia and selection of North Lampung (Tulang Bawang) and Jambi (Batang Hari) transects

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Introduction

The Maglus proposal that tries to establish the impacts of land use change on agrodiversity and specifically on the belowground aspects thereof, has to balance between three questions: does land use change indeed have effects on belowground organisms, does this matter for key soil functions and are these impacts perceived to be important by farmers or external stakeholders.

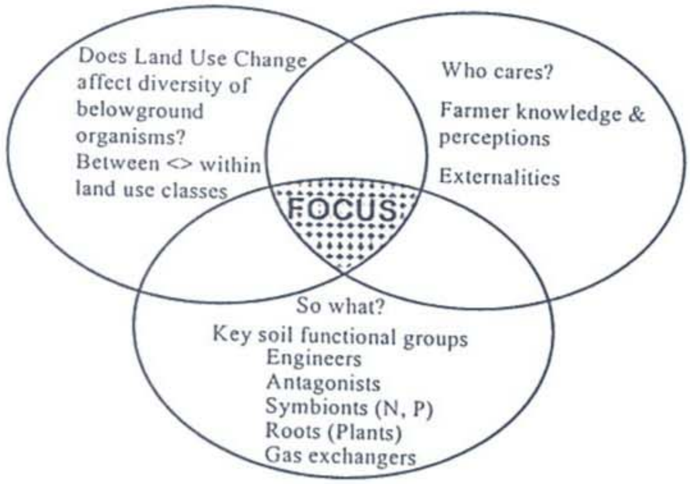

Figure 1. The focus of the Maglus project should be to help identify which real impacts of land use change on belowground biota have a direct effect on key soil functions that are relevant to farmers and/or external stakeholders; the three circles imply different approaches (biological surveys, experiments and models, studies of farmer knowledge and perceptions)

The broader context for the Maglus research in Indonesia can be provided by the ASB project that explored issues of belowground biodiversity under land use change in its second phase. This contribution highlights the current plans for a third phase of ASB, briefly describes the benchmark areas established and then makes some remarks on priority issues in biophysically oriented watershed research.

The ASB project

The Alternatives to Slash and Burn (ASB) project, a global initiative to address the environmental and developmental issues at the margins of tropical forest and the degraded lands that are evidence of past unsustainable land use practices, has made a start with a coherent approach (Table 1) to characterize and diagnose the land use options in a number of 'benchmark areas' in Indonesia (Sumatra), Thailand, Cameroon, Brasil and Peru.

Table 1. Four steps in analysis of land use options and requirements for impact

1. What do farmers do and why do they do so?
- who(gender, wealth, ethnicity)?
- where?
- since when?

2. Does it matter? So what?
- private benefits to farmer
- external impacts at local, regional and global scale

3. Could they do it differently?
- local knowledge and access to external knowledge
- technology development to address bottlenecks identified
- policy constraints

4. Why don't they do it differently (yet)?

Requirements for impact:
- access to existing knowledge/ adaptation of local knowledge
- supply of germplasm, inputs
- market access (physical as well as economical) for products
- policy change: removing current constraints to benign land use options, providing positive and negative incentives to induce more favourable farmers decisions

Put simply, the original ASB perception of the problems in the tropical forest margins was that 'poverty causes people to migrate to the forests, but they don't know how to manage the soils, forcing them to move on and open new forest, leaving a trail of degraded lands behind'. This perception of the problems led to the 'Phase 1 hypothesis' that 'intensifying land use as an alternative to slash and burn can reduce deforestation and reduce poverty'.

ASB phase 1 and 2 generated important conclusions for the benchmark sites in Sumatra, (Indonesia) (Van Noordwijk *et al.* 1995, 1996, 1997, 1998a; Tomich *et al.* 1998a, 1998c):

there is little evidence that the original perception holds true; unsustainable systems used by recent migrants are mostly found under the government sponsored transmigration programs, which are planned at government level, rather than due to spontaneous poverty-driven land-use practices,

- farmers have developed agroforests, based on rubber, damar and other local or introduced trees, as sustainable and profitable alternatives to slash and burn based food crop production, but
- this opportunity has stimulated rather than slowed down forest conversion in the absence of active boundary enforcement mechanisms for natural areas;
- in mountain zones, profitable (local) tree crops such as coffee and cinnamon have speeded up forest conversion, with variable effects on loss of forest functions,
- current forest conversion is a combination of logging, large plantation-style projects, government sponsored migration, and activities of both local and recent migrant smallholders; much of the conversion is planned and sanctioned at government scale,
- small remnants of 'shifting cultivation' remain in Sumatra, but largely in the form of settled fallow rotation, and these do not lead to land degradation and people moving on to new forest margins,
- the land use systems which succeed to forest conversion differ significantly in their sustainability, profitability and impacts on C stocks, greenhouse gas emissions and biodiversity, and
- although agroforests can maintain part of the biodiversity of the original forests, they are clearly no substitute for full protection of biodiversity in dedicated natural areas and conservation reserves.

In northern Thailand, profitable cash crops (formerly including opium) have been a factor in speeding up forest conversion, in combination with people moving across national boundaries. Shifting cultivation systems are still very important in the montane domain of mainland Southeast Asia, and the original problem perception may largely hold true in the upland areas of these countries. A major issue in Thailand, not yet adequately addressed, is the impact of land use change upon watershed functions, particularly the total flow of water, the seasonality and dependability of this flow, its sediment load and quality. There are indications that intensified horticulture, and increased road access, as promoted in successful programs to settle shifting cultivators in these areas, may actually have a more negative impact on these watershed functions than the shifting cultivation systems with less infrastructure that they replaced.

Natural resource management problems ASB aims to address

The issues at the 'forest margins' in SE Asia, as elsewhere, can be seen as choices between sharp boundaries between forests (managed for specific regional or global objectives) and other (agricultural and locally based objectives) land uses, or gradual transitions among natural forests, agroforests and agro - forest landscapes integrating across multiple objectives. Certain local, regional and global objectives can be combined in 'integrated' solutions, but for other values a spatially segregated solution with adequate solutions for boundary problems are essential. The ASB program has made significant progress in the understanding of such choices and the way they should be based on the type of trade-off between the interests of various stakeholders (Tomich et al. 1998a, b).

Three types of natural resource management problems (tradeoff's between public and private interests) can be identified:

1. Problems at local level (upland/lowland): watershed and landscape ecological services; our key hypothesis in this category is:

Complex tree-based systems at plot or landscape level provide an opportunity to minimize conflicts between private interests (in production / profitability of land use) and public interests in local environmental services (hydrology, ecology, air quality)

Problems about at local and regional environmental service functions require mechanisms to manage conflicts between communities and other local stakeholders. Conflict management entails clarifying the options from all perspectives, negotiating compromises, monitoring the outcomes and enforcing compliance. Relevant aspects of this problem are:

- Conflicts between local and downstream stakeholders following forest conversion as evident in the N. Thailand and Indonesian benchmark areas,
- Providing different stakeholders better means of negotiating compromises in conflicts of interests over natural resources
- Identify which agroforestry systems providing spatial integration of 'forest' and 'agricultural' functions may fulfill the needs of downstream land use,
- Reducing conflict over access to forests by focussing on public forest functions (which can be maintained under a range of smallholder agroforestry systems),
- Establishing where boundaries are and should be based on negotiations and how they can be modified by various stakeholders,
- Extrapolation of current trends in land use change in watersheds: does settlement of farmers lead to predictable future trends of further intensification and loss of forest functions,
- Community management of resources: how to provide feedback between actual activities on the ground and the management agreements.

2. Global – local conflicts of interest in biodiversity conservation. Our key hypotheses in this domain are:

For the highest biodiversity values (incl. charismatic megafauna), spatial segregation of functions is an imperative – this means protection of conservation areas

For local biodiversity functions a medium intensity 'integrate' option such as agroforests may be superior in terms of resilience and risk management

Since there is indeed no substitute for spatial segregation of endangered species and humans, socially integrated mechanisms are needed for stabilizing boundaries of conservation areas, including tools for conflict management and actual compensation mechanisms based on agreed performance criteria. Stabilizing physical boundaries of protected and reserved areas implies providing livelihoods to farmers, extractivists and hunters elsewhere, at least as good as they could expect in their current situation. Major unresolved issues remain in the relation between species richness and ecosystem function from a local perspective. Farmers will only perceive reasons to maintain diverse and species rich agro-ecosystems if the direct use value of each element is in balance with its resource use. Focussing attention on 'priority' elements is likely to increase the contrast in value among the components of the system, and thus to undermine the rationale for maintaining agro-diversity.

3. The relation between global interests in carbon stocks and local interest in conversion of forest for profitable land uses. Evidence from ASB suggests that for C stocks annual food crop based systems are better off under a 'segregate' option, maintaining high C stock areas (incl. peat swamp forests) intact and intensifying production elsewhere; for tree cop based production, however, an 'integrate' option is sensible. The key hypothesis is that:

Major options exist for increasing C stocks by expanding tree-based production systems on grasslands and in degraded watersheds through a coherent approach to the land tenure, market, policy, and institutional bottlenecks to application of existing rehabilitation technologies

This type of NRM issue implies 1) a need for institutional and policy reform to eliminate existing disincentives for planting trees ; 2) a need for compensation mechanisms or other means to increase incentives for planting trees.

One constraint to the effective implementation of adaptive co-management (ACM) among diverse interests has been the lack of appropriate resources, capacities, and social institutions to enable social learning, negotiation and action. Partners in the ASB consortium are presently engaged in a number of research activities that attempt to address these problems, including the development of local government-led natural resource management processes, and examining local farmer-led organizations as a mechanism for expanding the search for, and application of, improved land use systems by large numbers of upland smallholders.

The Criteria & Indicators Project of CIFOR, for example, has developed a number of tools to build the capacity of disadvantaged stakeholders to learn from ACM, and to facilitate dialogue among stakeholders. Other projects have tackled the vexing issues of how stakeholders are represented in ACM processes, and what sorts of platforms are most appropriate for negotiations among often antagonistic stakeholders. Many of these tools and concepts, however, have been tested on only a limited basis in the field. Field testing of these tools and concepts is critical to the development of ACM that works in the kinds of conflict-laden forests found throughout much of Southeast Asia. ACM requires that stakeholders have skills in social learning and decision-making. Politically weak groups may not have some of the skills needed to participate effectively in ACM. Further development of ACM tools and concepts that can accommodate such groups is also needed.

Objectives for ASB Phase 3

1. The first objective of the third ASB proposal is ***to apply*** **the methodology for 'integrative' assessment of land use options** from a range of perspectives (local, regional, global) developed during ASB Phase 1 and 2, to *an expanded range of sites and situations in S.E. Asia* and to *improve* the methodology where needed.

The ASB methodology involves (the numbering refers to the global ASB phase 3 proposal: 'local solutions for global problems'):

1.1A Evaluation and technical improvement of land use options from a ***farmers perspective*** (technical description, use of internal and external resources, profitability and sustainability assessment, required institutional framework and support services, resilience and sustainability in view of fluctuations and trends in externally imposed variability of conditions).
1.1B Evaluation of the landscape-level impact of land use changes on regional environmental service functions, including ***'watershed functions'*** (the regular and dependable supply of clean water). In combination with 1.1A, this allows quantification of the relation between on-site use of soil and water resources, and impacts on their lateral flows, and the trade-off between private and social profitability of land use options. These outputs would comprise a basis for policy interventions, land use regulation, and landscape level natural resource management.
1.2A Assessment of the impact of land use systems, in their landscape context, on ***global biodiversity*** concerns; in combination with 1.1A, this allows quantification of the trade-off between private profitability and biodiversity impacts, as a basis for policy interventions to support spatially segregated (biodiversity protection zones and agricultural landscapes) and/or integrated (biodiversity conservation within an agricultural landscape) solutions.
1.2 B Assessment of the impact of land use systems on ***global climate*** concerns based on its C stocks and greenhouse gas emissions; in combination with 1.1A this allows quantification of the trade-off between private profitability and net climate impacts, as a basis for policy interventions and provision of direct incentives ('C projects'),
1.3 Analysis of the (two-way) relations between farmer-level land use decisions (compare 1.1a) and ***macro-economic*** performance and indicators at ***national scale***, in the context of a global market with its fluctuations and trends.

2. The second objective is to develop and test tools (at a range of scales) to have ***impact* on the *actual* management of local natural resources** in a 'forest margin' setting, by the actual range of stakeholders in S.E. Asia.

The tools and methods involve:
2.1 Predictive understanding of ***stakeholder land use decisions*** (including but not limited to the aspects covered in 1.1A) in actual landscape contexts, responding to the macro-economic context (as analyzed in 1.3),
2.2 Tools and methods for ***local natural resource management, including conflict management*** between multiple stakeholders using participatory approaches,
The objectives of the local natural resource management and adaptive co-management component of ASB are to test whether sustainable natural resource management in upland landscapes, including forest management, can be achieved by:

- Obtaining more comprehensive and accurate information about the results of forest management 'experiments' available to stakeholders, and to do so in a more timely fashion than is currently the case.
- Reducing destructive conflict among stakeholders
- Improving the level of collaboration among stakeholders
- Empowering politically weak stakeholders to take active part in social learning and decision-making

2.3 Analysis of ***changes in national policies and institutions*** required to achieve effective local conflict resolution between multiple stakeholders.

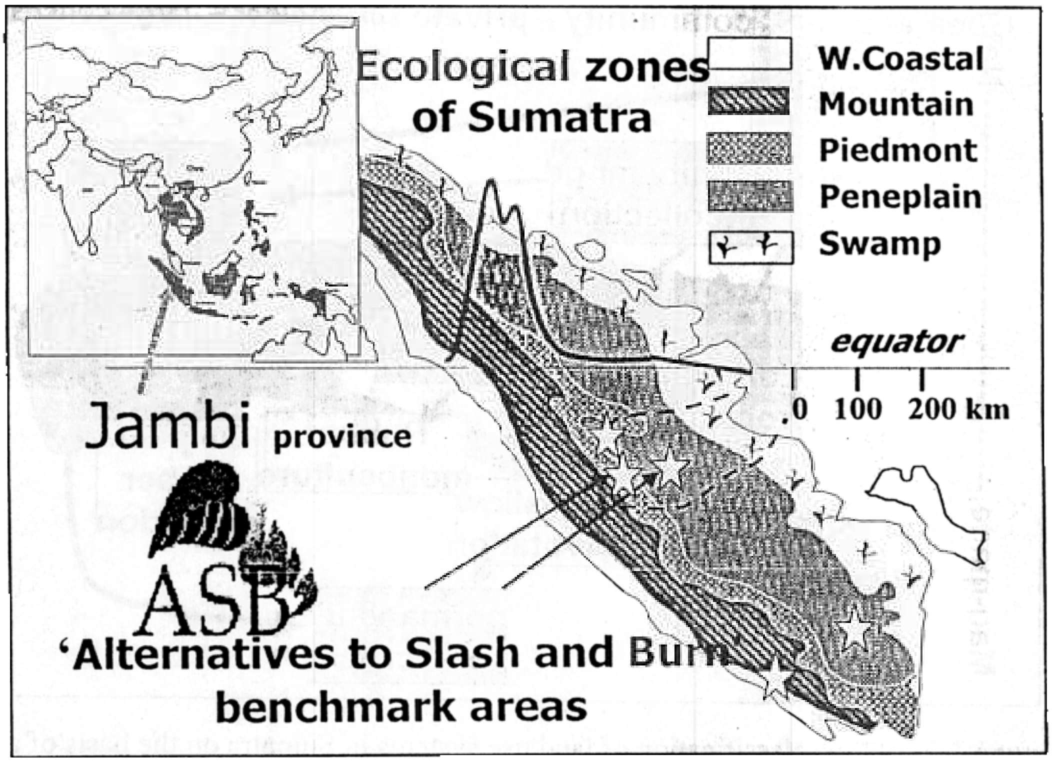

Figure 2. Ecological zones of Sumatra and the benchmark areas of the ASB project in Jambi (Batang Hari watershed) and Lampung (Tulang Bawang water shed plus Krui)

ASB Benchmark watersheds in Jambi and Lampung

ASB Indonesia has established a series of benchmark areas (Fig. 2) that represent the major ecological zones of Sumatra (mountain, piedmont, lowland peneplain and swamp zone), as well as the gradient in population density and pressure on natural resources from Lampung (high population density, closest to Java) to Jambi (Central Sumatra, low population density). The Tulang Bawang and Bâtang Hari watershed in Lampung and Jambi, respectively, cut though the ecological zones and provide a coherent framework for analysis. Rivers were the main human transport medium and thus formed the organizing principle of the landscape up till a few decades ago. After the development of roads the role of rivers has been reduced, but water resources as such are a major source of conflict over the use of natural resources.

The characterization of land use practices in the benchmark areas has lead to the recognition of interactions between socio-economic factors (stakeholder groups: local, spontaneous migrants, transmigrants, white-collar farmers, large scale operators) and land use patterns (see ASB-Indonesia summary reports for Phase 1 and Phase 2).

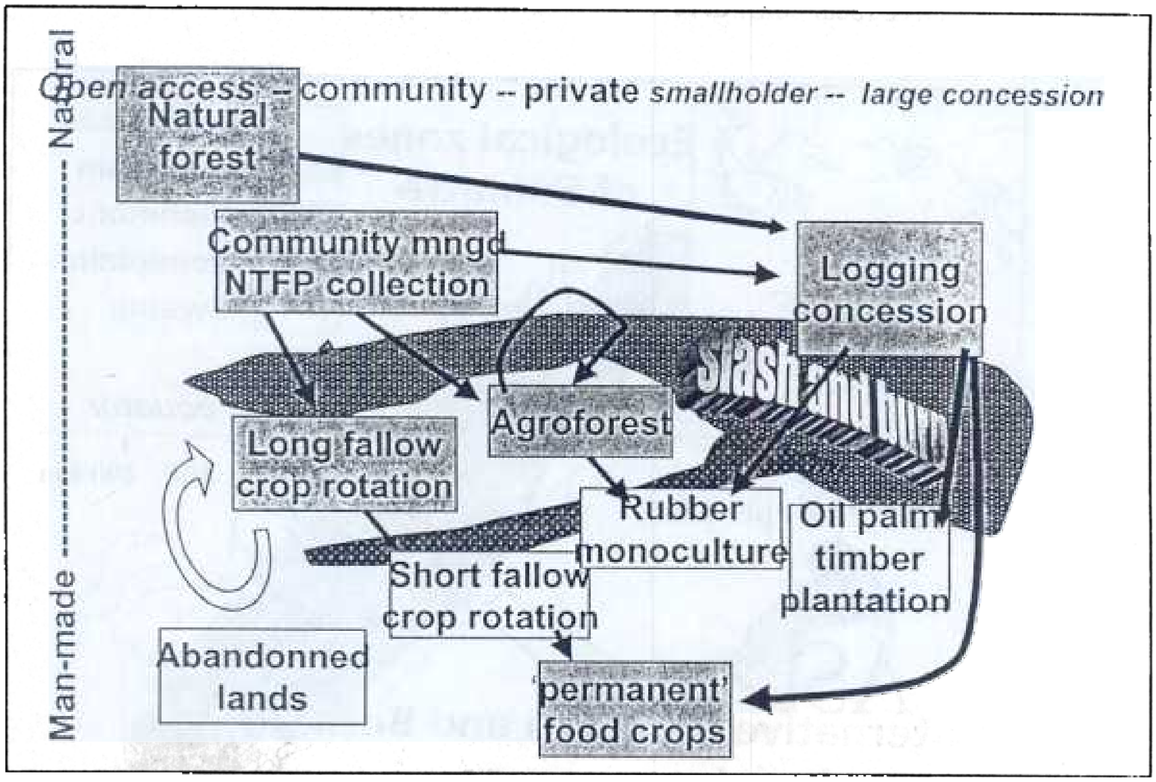

Figure 3. Tentative classification of land use systems in Sumatra on the basis of actors (human control over resource access, X axis) and degree of human control over the agro-ecosystem (Y axis)

The various land use options following forest conversion have clearly different impacts on environmental properties, including their biodiversity value. Within the main categories, such as rubber production systems, clear trade-off's exist between productivity and plant species richness, but our current knowledge establishes a broad envelope of possibilities (Fig. 4). Follow up work in the rubber agroforestry is aimed at testing the hypothesis that substantial increases in profitability (shifts to the right(can be achieved with little loss for biodiversity (shifts to lower positions in the graph).