Agricultural Transitions at Dryland and Tropical Forest Margins: Actors, Scales and Trade-offs

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INTRODUCTION

Concerns about land-use/cover change emerged in the research agenda on global environmental change several decades ago with the realization that land surface processes influence climate. In the mid-1970s, it was recognised that land-cover change, especially in drylands, modifies surface albedo and thus surface-atmosphere energy exchanges, with an impact on regional climate. In the early 1980s, humid forest zones were highlighted as sources and sinks of carbon, which underscored the impact of land-use/cover change on the global climate via the carbon cycle (Lambin et al., 2003; Palm et al., 2005). Be it dryland or humid forest ecosystems, they constitute global agricultural frontier zones which hold a large, if not the last, source of potentially cultivable land for agricultural use. Given the large variety of ecosystems and land use histories involved in these zones, universal assessments and policies to guide the design of future land use patterns must necessarily fail. To achieve sustainable agricultural management, any policy intervention has to be regionally specific, and sometimes even adapted to local particularities of 'real world' pathways of land change, involving trade-offs between economic gains and conservation (Tomich et al., 2005). Therefore, understanding the main driving forces, key actors and processes of agricultural change and land use patterns is vital to improve assessments of the long-term change occurring in rural lands at the global agricultural frontiers. Two meta-analytical databases are used in this chapter to explore the variety of key actors influencing land use transitions at the forest (Geist and Lambin, 2001; 2002) and dryland margins (Geist and Lambin, 2004; Geist, 2005). In addition, a matrix, developed through the Alternatives to Slash-and-Burn (ASB) Programme, is put forward as a method for assessing the trade-offs and to draw implications for land use policies (Tomich et al., 2005; Palm et al., 2005).

In the first part of the chapter, results of a region-by-region analysis of causative factors of land-use/cover change are presented, disaggregated by broad geographical regions such as continents, or subsets of continents. By doing so, we

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adhere to the notion that no 'one-size-fits-all' approach is adequate to explain the complex phenomenon of agricultural trajectories in tropical forest and dryland regions. This is due to the high variability in time and space exhibited by biophysical environments, socio-economic activities, and cultural contexts that are associated with land use change. In fact, the pathways of deforestation and desertification are nearly as diverse as the histories, cultures, and ecosystems of the regions themselves. Nonetheless, there is no irreducible complexity inherent to it, and a few dominant 'stories' can be identified which explain the succession of causes and events leading to land change, despite of their substantial variation by regions (Lambin and Geist, 2003a).

Understanding the pathways of land change is crucial for designing appropriate policy interventions. To achieve sustainable management of humid forest and dryland ecosystems, interventions need to address the region-specific causes of land-use/cover change. Proximate causes generally operate at the local level (of individual farms, households, or communities), while underlying causes may originate from the regional (districts, provinces, or country) or even global levels, with complex interplays between different levels of organization. Underlying causes are often exogenous to the local communities managing land and are thus often uncontrollable by these communities. Only some local-scale factors are endogenous to decision makers (Lambin and Geist, 2003b). Thus the second part of this chapter considers variable interactions and important interacting hierarchical scales.

If land use patterns at the last remaining agricultural frontiers are to be sustainable, i.e., balancing the legitimate interests of development and equally legitimate global concerns over the environmental consequences of land cover change, trade-offs need to be considered between what is to be sustained, and what is to be developed. From the viewpoint of managing agricultural transitions, there must be an incentive structure introduced for various actors operating at different scales influencing negotiations about outcomes that suit the various interests involved. The ASB matrix (Tomich et al., 1998, 2005; Palm et al., 2005) provides an approach to assess the degree of trade-offs (and complementarities) global environmental objectives served by rain forest conservation and national and local objectives, often involving conversion of natural forest to other uses and to identify innovative policies and institutions needed to reconcile ecosystems and human well-being at the local level. The ASB matrix is also a powerful tool for looking at specific trade-offs between provisioning and regulating services in various tropical ecosystems under human uses, i.e., losses of certain ecosystem functions of global importance such as carbon stocks, affecting central functions of the climate system, *versus* provision of food, fiber and feed services for local livelihoods as well as national economic development. The matrix also provides a basis for policymakers and stakeholders to assess trade-offs across land use systems regarding development options and ecosystem services. Principally, the ASB matrix could be applied to other ecoregions and land use systems outside the humid tropics. Therefore, the final part of the chapter presents examples of indicators of environmental and developmental objectives for a selection of ASB benchmark sites.