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Review

More than just trees: Assessing reforestation success in tropical developing countries

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A B S T R A C T

Rural communities in many parts of the tropics are dependent of forests for their livelihoods and for environmental services. Forest resources in the tropics have declined rapidly over the past century and therefore many developing countries in the tropics have reforestation programs. Although reforestation is a long-term process with long-term benefits, existing evaluations of the success of these programs tends to focus on short-term establishment success indicators. This paper presents a review of reforestation assessment that highlights the need to not only consider short-term establishment success, but also longer-term growth and maturation success, environmental success and socio-economic success. In addition, we argue that reforestation assessment should not be based on success indicators alone, but should incorporate the drivers of success, which encompasses an array of biophysical, socio-economic, institutional and project characteristics. This is needed in order to understand the reasons why reforestation projects succeed or fail and therefore to design more successful projects in future. The paper presents a conceptual model for reforestation success assessment that links key groups of success indicators and drivers. This conceptual model provides the basis for a more comprehensive evaluation of reforestation success and the basis for the development of predictive systems-based assessment models. These models will be needed to better guide reforestation project planning and policy design and therefore assist rural communities in tropical developing countries to alleviate poverty and achieve a better quality of life.

1. Introduction

The United Nations Food and Agriculture Organisation (FAO) estimates that more than 1.6 billion people worldwide depend on forests for their livelihood, including 60 million indigenous people who are almost wholly dependent on forests and with 350 million people living within or adjacent to dense forests depended on them for subsistence and income (FAO, 2001). In developing countries specifically, The World Bank have estimated that forest resources directly contribute to the livelihoods of 90 percent of the 1.2 billion people living in extreme poverty and indirectly support agriculture and food supplies of nearly half the population of the developing world (World Bank, 2004). Figures of similar magnitude have also been reported by the FAO (2001) with estimates of 1.2 billion people in developing countries reliant on agroforestry farming systems for food and to generate income.

In rural areas of the humid tropics, it is estimated that 500 million people depend on a mixture of agricultural and forest resources to maintain their livelihoods (Maginnis and Jackson, 2002). Therefore, rural communities in tropical developing countries rely heavily on the extraction of timber and non-timber resources from forests, and often on the conversion of forests to agriculture and other uses as well. Forest ecosystem services such as water purification and crop pollination (by providing a habitat for pollinating insects, birds and mammals) likewise play a key role in supporting rural livelihoods (IUCN, 2007).

The loss of tropical forest resources on which millions of rural people depend has been rapid over the past century. An estimated 350 million hectares of tropical forests have been deforested and a further 500 million hectares of secondary and primary topical forests have been degraded (ITTO, 2002). Despite the traditional heavy dependence of rural communities on tropical forests, tree cover no longer dominates many tropical forest landscapes. In some areas, the current land-use configuration has led to a dramatic and detrimental decline in the availability of forest goods and services (Maginnis and Jackson, 2002). In such degraded landscapes, agricultural production tends to suffer, local shortages of timber and fuelwood occur, household income falls, and biological diversity declines. Often, the effects of landscape degradation are felt

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downstream due to an increase in silt loads and a decline in water quality (Maginnis and Jackson, 2002).

Reforestation can help reverse some of the more severe impacts of forest loss and degradation on rural communities in the tropics by providing secure access for local people to a range of forest products, including fuelwood and non-timber forest products; improved hydrological regulation and nutrient cycling; providing more diverse and better connected habitats, thus supporting more biological diversity; and options to increase the resilience and adaptability of existing agricultural systems (Maginnis and Jackson, 2002).

On a global scale, reforestation in the tropics is considered an important means of climate change mitigation (Canadell and Raupach, 2008). Palm et al. (2005) estimate that 300 million to 1 billion hectares of land is available for reforestation in the humid tropics and that given the area of land available, reforestation in the humid tropics alone would sequester 27 to 90 billion tonnes of carbon. Afforestation and reforestation are common forestry activities included in trading schemes for carbon sequestration offsets. Successful reforestation projects must result in established stands to qualify as an offset. Forest biomes store as much as 10 times more carbon in their vegetation than do non-forest biomes, usually at least for decades, and for centuries in some ecosystems (Saundry, 2009).

To preserve the livelihoods of rural communities in the tropics, and for global climate change mitigation, it is clear that reforestation is necessary. Governments and international aid agencies commit substantial resources in tropical countries to restore forests (Iyyer, 2009). Despite substantial expenditure on reforestation, little information exists to indicate the success of reforestation projects in achieving ecological or socio-economic benefits. Unfortunately, many existing reforestation projects have partially or completely failed because the trees planted have not survived or have been rapidly destroyed by the same pressures that have caused forest loss and degradation in the first place. Dudley et al. (2005:4) stated that, "Anyone working regularly in the tropics becomes accustomed to finding abandoned tree nurseries, often with their donor organisations' signboards still in place, the paint gradually peeling away". Even when planted trees have survived to maturity, they have not necessarily been welcomed by local communities. One example is the widespread controversy over reforestation with exotic monocultures of eucalyptus in the tropics (Carrere and Lohmann, 1996).

Ensuring long-term success is one of the greatest challenges facing many reforestation initiatives in developing countries. However, most evaluations of reforestation success have been narrowly focused on reaching planting area targets. Few evaluations have measured the environmental or socio-economic success of reforestation projects. In addition, little is known about what influences the success of reforestation projects and in what situations reforestation projects succeed or fail. More holistic, integrated approaches to assessing reforestation success are needed.

In this paper, we develop a conceptual framework for evaluating and planning reforestation projects in tropical developing countries that incorporates both the biophysical and socio-economic indicators of success, and also the drivers of success. This paper focuses on assessing projects funded externally by government and non-government organisations (NGOs). There are also many trees planted by ordinary people for their own reasons (i.e. based on their personal 'conceptual frameworks') but these private initiatives are beyond the scope of this review. In this paper, the success indicators (performance measures) that have been applied in the tropics and internationally are reviewed first, and then related to the key biophysical, environmental and socio-economic drivers that affect success. Next a conceptual model that integrates the indicators and drivers of reforestation success as the basis for reforestation planning and success assessment is presented.

2. What is meant by reforestation success?

Reforestation is the process by which trees are returned to areas from which they have been previously cleared. Reforestation can take many forms, ranging from establishing timber plantations of fast-growing exotic species through to attempting to recreate the original forest type and structure using native species. In whatever form it takes, reforestation is a long-term endeavour. For example, it has been estimated that full recovery of the composition and structure typical of 'an intact' rainforest (starting from cleared land or highly degraded forest) would take at least 50 years in the tropics and 100 years or more in the extra-tropical zones (Hopkins, 1990; Mansourian et al., 2005a). Reforestation projects typically progress through two main stages: an initial 'establishment' phase and a long-term 'building' phase (Kanowski and Catterall, 2007). Reforestation success can therefore be viewed as a continuum from the successful establishment of the initial planting through to maturation and realisation of the full environmental and socio-economic benefits of the forest (Reay and Norton, 1999). This means that the measures of success will differ at different stages in a reforestation project. Undertaking assessments at an early stage of a reforestation project can only indicate likely future success (Reay and Norton, 1999). As the forest matures more information is required to make judgements about environmental and socio-economic success (King and Keeland, 1999; Reay and Norton, 1999).

Knowing the objectives of reforestation is important for assessing success (Aronson et al., 1993; Brown and Lugo, 1994; Hobbs and Harris, 2001). To evaluate previous reforestation actions, both initial and current reforestation objectives need to be considered because objectives defined when the project was conceived may not necessarily match current environmental and social demands. Reforestation objectives are fundamentally valued-based (Davis and Slobodkin, 2004) and have traditionally been focused on wood production, erosion prevention and water flow management. In recent decades, the objectives have shifted towards socio-economic benefits, ecosystems goods and services, recreation and wildlife conservation (Vallauri et al., 2002).

According to the CIFOR Rehab Team (2003), the objectives of reforestation projects are to enhance productivity, livelihood, and environmental service benefits. In general, the objectives of reforestation projects are divided into physical and non-physical. Physical objectives are usually aimed at increasing forest and land cover, increasing timber production, protecting watersheds and conserving biodiversity; while the non-physical objectives are usually to increase community incomes, create livelihood opportunities, empower local communities, secure community access to land and to raise environmental awareness and education (Chokkalingam et al., 2006a; Nawir et al., 2007).

Given that reforestation is a process that has multiple objectives, a comprehensive assessment of reforestation success should cover the main stages of reforestation (from establishment to forest maturation) and the main physical and non-physical objectives.

3. Potential indicators of reforestation success

A large number of qualitative and quantitative indicators have been either reported or proposed in the literature for the assessment of reforestation success. The more common indicators are now reviewed.