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Restoring working forests in human dominated landscapes of tropical South Asia: An introduction

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ABSTRACT

The resource issues around restoring human dominated landscapes in tropical South Asia are complex and can be divided into topics concerning forest fragmentation and restoration. Issues that focus on effects of forest fragmentation include studies that show declines in forest structure and standing carbon stocks within forest fragments as compared to contiguous forest; changes in bird composition and flock density in relation to land use – especially between forests, the forest buffer zones and agricultural lands (tea, coffee); and the potential origins of many sacred groves as forest fragments and their future roles as cultural, social and ecological centers of reforestation within deforested landscapes. Studies that focus on restoration have demonstrated the benefits of plantations as mechanisms to establish second growth forests and native species plantings for both economic and conservation purposes; the incorporation of indigenous plants that produce non-timber forest products in forest restoration programs; and the control of fire, soil preparation and protection from herbivory as treatments that can facilitate natural forest regeneration in montane grasslands.

1. Introduction

Tropical forests provide a variety of goods and services to humanity, including the maintenance of biodiversity, carbon sequestration, watershed protection, timber and non-timber forest products and open space recreation (Myers 1988; Chopra 1993; Godoy and Bawa, 1993; Balmford et al., 2002; MEA 2003; Ricketts et al., 2004; Wong and Yu, 2005; Foley et al., 2007; Dasgupta, 2010; Rands et al., 2010; Gamfeldt et al., 2013). Tropical South Asia comprises India and Sri Lanka. Tropical South Asia has high population density, and ancient cultures and land use histories. It was one of the first regions in the tropics that underwent large land clearance of forests (Goldewijk, 2001) for agriculture during the colonial era under the British from 1850 to 1950 mainly due to land conversion for plantation crops. This continued in the post-colonial era from 1950 to 1970 primarily for development (Vincent, 1883; Wimaladharma, 1977; Flint, 1994; Wickramagamage, 1998; Kurosaki, 2009; Näsström and Mattsson, 2011). Forest conversion therefore started over 150 years ago and, unlike many regions, progressed at lower rates of deforestation for a longer period (Kurosaki, 2009; Näsström and Mattsson, 2011). Many studies within the region have highlighted the damaging effects on biodiversity and other forest values because of land use policies that favored extensive forest conversion to commercial tree and shrub crops such as tea, rubber and coffee, or a few favored timber species (Flint, 1994; Dixon et al., 1994; Wickramagamage, 1998).

In the last thirty years, scientists and policy makers have recognized the important role that tropical forests play in maintaining biodiversity and therefore providing a multitude of ecosystem services (Balmford et al., 2002; Gibson et al., 2011), sequestering carbon (Brown and Lugo, 1982; Phillips et al., 1998; Lewis et al., 2009), and providing clean surface water supplies for downstream irrigated agriculture and drinking water (Pringle, 2001; Foley et al., 2005). The Intergovernmental Panel on Climate Change has proposed reforestation of tropical abandoned agricultural land and pastures as a strategy to increase carbon sequestration and help mitigate anthropogenic carbon emissions (Ding et al., 2001). Through reforestation ecosystems are able to recover function and biodiversity and serve as potential sinks for atmospheric carbon by storage in both plant

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biomass and soil organic matter (Lamb et al., 2005). In addition, reforestation has long been recognized for its potential to reduce erosion locally and to impact hydrological cycles (Eshleman, 2004; Ellison et al., 2012).

Plantation forestry has played a major role in the reforestation history of South Asia. It has a complex history of trial and error, dominated by monoculture plantations of exotic species such as *Eucalyptus, Acacia* and *Pinus*. The globalization of *Eucalyptus* increased with planting and success rates in the tropics from 1960 to 1990 (FAO, 1985; Saxena et al., 1993; Bennett 2010). However, criticism of planting *Eucalypts* was vocal in the 1980s during the intense period of planting in India and Thailand (Bennett, 2010). At the same time, a mix of state, government, industrial cooperation, small holder land ownership and community- based reforestation programs were implemented within degraded forest areas and shrub and grasslands that were previously covered by forests, resulting in further experimentation with *Eucalyptus* as well as other exotics such as *Acacia* and *Pinus* species (Rai, 1999; Pomeroy et al., 2003; Ramachandra et al., 2004). Although exotic species may greatly out produce native tress species, especially under short rotations (Nath et al., 1990), exotic plantations in some cases had detrimental effects on hydrology for adjacent agriculture, and provided only single values – timber for the State (Kumar et al., 2003). Small-holders and subsistence farmers do not like the exotic plantations chiefly because none could be used for their benefit (FAO, 1985). Further, they have been assumed to have low conservation value (Lamb, 1998; Chazdon, 2008). In recent years, however, efforts have increased to better understand the processes that govern restoration of tropical degraded land (see. *e.g.* Yirdaw, 2001; Parrotta and Knowles, 2002; Vincent and Davies, 2003; Sharam et al., 2006; Slocum et al., 2006; Goodale et al., 2012; Salek and Vylupek, 2012) and exotic timber plantations are recognized as one potential approach (Lamb, 1998; Ashton et al., 1998; Lamb et al., 2005; Wishnie et al., 2007).

Worldwide, integrated approaches, although unlikely to achieve complete restoration, are now favored. These approaches range from using native species, landscape design, targeting site matching in species selection, using species mixtures, silvicultural management for greater productivity, to fostering understory diversity (see. *e.g.* Ashton et al., 1997a; Menalled et al., 1998; Miyawaki, 1999; Mark, 2007; Benayas et al., 2008; Chazdon, 2008; Cole et al. 2010; Park et al., 2010; Richards and Schmidt 2010). In using any of these approaches for reforestation and land restoration in South Asia, and in particular the Western Ghats and Sri Lanka, there has been a shift towards integrating native tree species (Raman et al., 2009; Nagaraja et al., 2011; Chetana and Ganesh, 2012). In fact, native species are now often promoted as being more ecologically and socially sustainable than exotic species for a series of reasons. First, recent studies have highlighted the importance of native trees for agricultural communities, emphasizing the goods and services that these trees provide to local farmers (Walters, 1997; Aguilar and Condit, 2001; DeClerck et al., 2006; Garen et al., 2009). Second, much work has been done on the recovery of second growth forest as a way of combating forest fragmentation and in the development of corridors for ecosystem restoration for local communities (Chazdon, 2003, 2008).

Given these trends, the goal of this special issue in Forest Ecology and Management is to review the scientific data and experiences of more than twenty-five years of research relating to the ecology and management of native tree species and second growth forests in order to inform reforestation and land restoration activities in the tropical South Asian region. The papers within this special issue cover largely ecological and silvicultural topics of reforestation and restoration. The issue is dedicated to Professors Savithri and Nimal Gunatilleke of the University of Peradeniya, Sri Lanka. Building on the rich tradition of village home garden woodlands in their nation, Sri Lanka, they with their students have applied continuing research, into the landscape ecology and historical biogeography of its rich wet zone flora, in path breaking experiments on forest restoration in the context of the contemporary village economy (Gunatilleke et al., 1995; Ashton et al., 1997a; Ashton et al., 1997b; Gunatilleke et al., 2004; Tennakoon et al., 2005; Gunaratne et al., 2010; Gunaratne et al., 2011).

2. The papers in the special issue: organization and content

This special issue comprises six papers. They cover topics around tropical forest restoration that range from ecological aspects of native species reforestation, effects of land use on birds flocks and diversity, estimates of carbon in relation to forest fragmentation and underlying drivers of forest diversity in sacred forests.

In the first paper, Gunaratne and colleagues provided a synthesis of their work investigating the ecological barriers to tropical montane forest succession on anthropogenic grasslands (Gunaratne et al., 2014). Their findings suggest that forest regeneration on grasslands is impeded by limited seed dispersal, herbivory of seedlings that do establish and fire. Planting studies show that tree seedlings do better when grasses are removed and herbivores are excluded. *Macaranga indica* and *Symplocos cochinchinense* are two early successional pioneers that are potential nurse trees; planted on grasslands, they facilitate other tree regeneration beneath their canopy. Other potential techniques that they suggest include the creation of fire breaks, and scarification and exposure of mineral soil of grassland adjacent to forest patches. In the second paper, Mark Ashton and colleagues describe the use of pine plantations as a technique, both to secure the natural recruitment of native tree regeneration beneath the pine canopy and to facilitate the plantings of native trees (Ashton et al., 2014a). They provide a case for restoration for both conservation and utilitarian values, and make a strong economic case for the economic restoration of native species in the everwet regions of South Asia in comparison to the intensive cultivation of tea.

Rural communities have traditionally valued forests for a diversity of products and services, with timber serving a minor role. The demand for 'non-timber forest products' (NTFPs) must change from subsistence to monetary values, given the development of the region, if they are to be included in future values harvested from the forest. In the third paper, Ashton and colleagues review the use and cultivation of exemplar non-timber forest plants that yield a mix of products comprising resins, latexes, sugars, medicines, fibers, fruits and nuts (Ashton et al., 2014b). The paper provides ways of incorporating NTFP's into restoration plantings. In particular, the major species identified to have future commercial values in plantation systems include *Aegle marmelos*, *Calamus* spp., *Caryota urens*, *Coscinium fenestratum*, *Diospyros melanoxylon*, *Elettaria cardamomum*, *Gyrinops walla*, *Phyllanthus emblica*, *Santalum album*, and *Vateria* spp.

Forest fragments are thought to store a disproportionate amount of some of the remaining terrestrial carbon in degraded and deforested landscapes. Anand et al. (2014) evaluate the change in tree allometry and forest structure in forest fragments of the Western Ghats. They compared above-ground carbon stocks in evergreen forest fragments to stocks in relatively undisturbed, contiguous forests. Their results suggest forest