Chapter 1. Plantation abandonment: Implications for ecological restoration

Introduction

Millions of hectares of tropical forests have been degraded due to logging and other anthropogenic activities across the world (Lugo 1995; Primack 1990). Agriculture expansion has also been a major reason for forest clearing (Angelsen 1995; Myers 1993). However, subsequent abandonment of such cleared areas for various ecological, social, political and economic reasons has become a major contributor to secondary forest formation in the tropics in the last 40 years across Asia, Africa, and South America (Asner et al. 2009, Rudel et al. 2009). Such agricultural abandonment trend was observed in many parts of eastern North America, and Europe, since 1870, but has been a relatively recent phenomenon in South America, and in many Asian countries such as China, Nepal and India (Neilson and Pritchard 2009; Ramankutty et al. 2002; Ramankutty and Foley 1999; Alves and Skole 1996).

The estimated land abandonment is a considerably high that merits attention of ecologist, restoration specialists, land managers and others. In Amazon alone about 30% of the area are now secondary forests due to abandoning of farmlands, cattle ranches, frequent fires and drought (Houghton et al. 2000; Nepstad et al. 1999; Hartshorn and Hammel 1994). However, there may be additional land abandonment which has not been estimated. For instance in Southeast Asia, the traditional farming system called shifting cultivation over many years, has added vast stretches of open grasslands which are not recorded under degradation of forest or abandonment of cultivated lands (Hobbs and Cramer 2007). Similarly in, Vietnam about 9.7 million ha of grasslands and scrub are formed due to abandonment of farmlands or a similar kind of land use in formerly forest areas (Gilmour et al. 2000).
Secondary forests are important in the context of enhancing biodiversity and in many cases have provided refuge to local species of flora and fauna (Sayer et al. 2004; Emrich et al. 2000). It also gains importance in the context of global carbon sequestrations and enhancing the local faunal diversity (Kettle 2012; Corbin and Holl 2012; Reino et al. 2010; Rey-Benayas et al. 2010). In the Indian context, in the Western Ghats, the advantage of secondary forests, locally called as ‘sopinna betta’, has been highlighted in providing fodder for cattle and leaf-litter manure for farming (Sinu et al. 2012; Nayak et al. 2000), apart from fuel wood, timber and non-timber forest products (Singh 2004; Bhat et al. 2001). Secondary forest can also enhance the water sources for downstream agriculture production and the livelihood of farming communities (Mittleman 2001).

The recent Global Forest Resources Assessment (FRA 2011), reported that there has been an increase in forest cover in many countries such as China and other Asian countries which is attributed to active afforestation programmes in those countries (Sayer et al. 2004). A similar trend was reported by Forest Survey of India (FSI 2009), which indicates nearly 5% increase in forest cover over the preceding decade in India. However, Puyravaud et al. (2010) argues that this increase failed to discriminate natural forests from large expanses of exotic plantations, thereby obscuring the fate of the former. After subtracting the forests in India from the area covered by plantations, it showed forest cover decline by about 1.5–2.7% per year. Overall forest recovery estimates are even less certain, but a compilation of available reports suggests that at least 1.2% of the humid tropical forest biome was in some stage of long-term secondary regrowth in 2000. Nearly 70% of the regrowth reports indicate forest regeneration in hilly, upland, and mountainous environments considered marginal for large-scale agriculture and ranching (Asner et al. 2009).

**Drivers of Agricultural Abandonment**

Agricultural abandonment is a complex phenomenon, which arises from ecological-mismanagement, change in legal rights on the land, social and economic issues, apart from spread of diseases (Chetana et al. 2012; Bowen et al. 2007; Khanal and Watanab
2006; Lambin et al. 2003; Aide et al. 2000; Ramankutty and Foley 1999; Chapman and Chapman 1999). These issues will be dealt in greater detail below.

1) Ecological factors

Ecological factors leading to the abandoning of land often include decline in soil fertility and productivity due to land degradation (Hobbs and Cramer 2007). The best examples are shifting/slash-and-burn or swidden agriculture in many parts of Asian countries (Rasul and Thapa 2003; Dobby 1950). The common characteristics of this type of agricultural system are clearing a patch of vegetation by the slash-and-burn method, growing assorted varieties of crops in the cleared land for one or two seasons and then moving to a new plot of land on a rotational basis (Spencer 1966; Conklin 1957). This was practiced earlier in longer cycle of ‘jhum’ of 10-20 years, but recent shorter jhum cycle of 4-5 years repeatedly imposed on the same site, has led to large tracts of land taken over by bamboo (Ramakrishnan 1992; Raghavan 1960). These traditional farming practices are disappearing in southeast Asia (Padoch et al. 2007) and such degraded and abandoned land after loss of soil fertility are regrown with native vegetation in many parts of southeast Asia, Nepal and northeast India. However they are also prone to be infested with weeds as in most parts of northeast India/Himalayas and in other places are overgrown with broom grasses (Thysanolaena maxima) and bamboos (Dendrocalamus hamiltonii) as characteristic natural vegetation in the low-nutrient area frequented by fire (Shankar et al. 2001; Toky and Ramakrishnan 1983a, 1983b).

Abandonment of agricultural fields could also be due to overuse of fertilizer and inappropriate cultivation practices; which could lead to greater soil erosion, loss of organic matter leading to reduction in water-holding capacity, and depletion of ground water table (Gisbert et al. 2005; Lambin et al. 2003). Land abandonment may also occur due to changes in the management regime or biophysical settings which may result, for instance, in the loss of key pasture species or invasion by aggressive weed species (Grigulis et al. 2005).
Mining and landfill sites have also led to land abandonment, which may also have contributed to formation of secondary forests (van Rooyen et al. 2012). It may also result from less proximate modifications, for instance, from regional pollution problems, altered surface or groundwater hydrology regimes, or changing regional climatic conditions (Gisbert et al. 2005; Lambin et al. 2003). The Kudremukh iron ore mining area once largely covered by wet-evergreen forests and montane grasslands in south India has been abandoned because the river Bhadra was getting polluted by open cast mining (Krishnaswamy et al. 2006). The factory was subsequently shut down and mine areas abandoned (Murthy and Seshadri 2011).

2) Pandemic and crop diseases
Black Death was one of the most devastating pandemics in Europe and parts of the Mediterranean. During the period 1348–1352; about 30–60% of the population was killed and as a consequence, there was a large reduction in rural population (Yeloff and Van Geel 2007; Gottfried et al. 1983) leading to abandoned farmlands. Many plantations are also abandoned due to devastating plant diseases globally. In the recent past, Areca-nut (Areca catechu) plantations raised in the forests of central Western Ghats were severely infected by yellow leaf disease (YLD) (Purushothama et al. 2007). As a consequence, farmers abandoned the plantations and shifted to urban areas along with their families in search of alternative livelihood (pers. comu.). Irish-potato late blight disease also affected many developing countries; farmers were not able to control the disease leading to heavy losses and crop abandonment (Ortiz et al. 1999; Hardy et al. 1995).

3) Economics issues
Trends in globalisation and market liberalisation have profound effects on agricultural sectors worldwide. Technological advancement in agriculture led to loss of relevance and economic viability for traditional agricultural practices resulting in large numbers of farmlands being abandoned in Europe (van Meijl 2006). A similar trend was seen in northeast of Pokhara in Nepal, where about 46.6% of agricultural land was abandoned in 2004 due to urban migration (Khanal and Watanab 2006). In China, many rural folk migrated to the cities due to availability of new economic opportunities and better
lifestyle, leading to abandonment of many agricultural areas that subsequently led to increase in the net forest cover (Wang et al. 2012; FRA 2011). Similar trend was also observed in Rusinga Island, Kenya, where people were more attracted towards fishing industry than traditional farming, leading to large agricultural areas being abandoned due to lack of labour and profit (Conelly 1994).

In India the agricultural sector which is driven by both domestic and international economy, experienced a cascading impact on production of rubber, coffee, cardamom, and tea since 1990 (George and Joseph 2005). Many plantations were abandoned due to fluctuations in price and demand in the global market. For instance fluctuations in tea prices at the international market directly influenced the livelihoods of plantation workers and has strong linkages with social unrest within this sector (Neilson and Pritchard 2009; Banerjee et al. 2003). The abandonment of commercial plantations that sustain large human populations in biodiversity rich areas therefore poses a big challenge to meet the demands of people and biodiversity (Chetana et al. 2012).

4) Social issues
Rural depopulation is an on-going trend worldwide and as the world population increases, rural areas get urbanised (McKinney 2002; Miller and Hobbs 2002). The primary cause for migration is the availability of job opportunities, better education, health facilities, communication and road-networks, (Khanal and Watanab 2006). In south India, closing down of plantations are related to worker–owner conflicts and labour unions (Neilson and Pritchard 2009; Banerjee et al. 2003). Plantation abandonment in north east India is mainly related to welfare issues within the ‘tea tribes’, a community specialised in manual picking of tea, which imposed a human security angle in the tea gardens (Mishra et al. 2011; Gohain 2007).

5) Political instability
Tea plantation managers in Kerala, India are constantly under stress owing to demands from politically motivated unions (Neilson and Pritchard 2009; Banerjee et al. 2003). Such pressure led to loss in the agricultural sectors leading to abandonment (Banerjee et
al. 2003). In Assam civilian insecurity due to armed violence among the local communities, insurgency and militants led to abandonment of plantations (Gohain 2007; Talukdar 2007; Bhowmik 2005; Dasgupta 2004). This also had an ethnic angle to it as land-use conflicts in north east India led to many non-resident-owned plantations getting abandoned (Barbora 2002; George 1994).

6) Legal and land tenure settings

Legal and tenure rights are the driving factors in agricultural management worldwide. Farmlands that lie within the conservation prioritised area or buffer zones around wildlife habitats may be more vulnerable to abandonments due to the Protected Area (PA) Act or due to human–wildlife conflicts (Naughton-treves and Treves 2005). Similarly, in India, many conservation priority areas experienced agricultural land abandonment (Teegalapalli et al. 2010; Karanth 2007). By Indian law, when 99-year lease on the lands given for agricultural purposes in PAs and sanctuaries expires, it may lead to abandonment. In few farmlands that are within PAs, refusal of access also leads to abandonment. Further, an Act was passed to protect Ecologically Sensitive Areas (ESAs), including Ecologically Fragile Lands (EFL) act in many parts of Kerala state, making parts of many plantations defunct (Chetana et al. 2012; Neilson and Pritchard 2009).

Benefits of Abandonment

Abandoned farmland located within the forests or in close proximity provides opportunities for studying ecological restoration (Walker et al. 2007; Palmer et al. 1997) through the process of ecological succession (Rudel et al. 2009; Young et al. 2005; Bradshaw and Bekoff 2001). The field of restoration ecology has been strengthened over a century by contributions from succession ecology, assembly rules, landscape ecology, disturbance ecology, climate change, historical ecology and environmental ethics and philosophy (Higgs 1997). Further advancement in soil science and knowledge of soil seed germination has profoundly contributed towards the knowledge of plant community structure and restoration processes (Hobbs et al. 2007). Community ecological theory
played an important role in the development of restoration ecology that aimed at improving the biodiversity status locally (Palmer et al. 1997).

In ecological restoration the two important strategies of restoration are active and passive to aid the recovery of large areas of deforested and degraded tropical lands. Active restoration is where management techniques such as planting seeds or seedlings are implemented, and passive restoration is when no such action is taken except to cease environmental stressors such as agriculture or grazing (Morrison and Lindell 2011). Both the active and passive restoration has its own pros and cons. Active restoration may speed up the ecological process in highly degraded landscape, but it is expensive and skilled labour might be required. In passive restoration no investment is provided however there is a need for good natural seed sources, less human disturbance and negligible intraspecific competitions with invasive species. In many such cases a combination of active and passive needs to be worked out and a model of mixed restoration practices can be formulated. This approach involves the planting of many small, dense blocks of native trees to enhance biodiversity and provide a range of ecosystem services (Rey-Benayas et al. 2008). Such practices need to be case specific for instance in tea with a dense canopy or overgrown with invasive species a mixture of clearing, uprooting and selective planting along with historical use of the area may be productive under the model of ‘mixed ecological restoration’.

Restoring ecosystems not only increases biodiversity but improves defunct watershed functions and stabilises soil (Sayer 2001; Zaizhi 2000; Ramakrishnan and Kushwaha 2000; Lamb and Tomlinson 1994). This is especially important within protected areas, where the primary factor is ecosystem restoration and conservation, rather than commercial production (Chokkalingam et al. 2001). In forested ecosystems soil erosion is prevented, and soil moisture retained due to the growth of successional species (Brown and Lugo 1990). The study from Attapadi Hills Restoration Programme in parts of Nilgiris, south India have shown that by enhancing active restoration, soil fertility and moisture improved in the degraded habitats (Ravi 2013). Such restored secondary forests are also used as foraging grounds by many birds and mammals (Chapman and Chapman
A case study from Arunachal Pradesh showed that Hornbills which nest in the primary forest visit the secondary forest for foraging due to the availability of fruiting plants in high density and also due to the high frequency of fruiting (Datta 1998). Faunal diversity was also higher in secondary forest than in the primary forest due to greater resource availability (McShea et al. 2009).

From the economic point of view, such land restoration programmes may benefit the communities, who are depending on them for their livelihoods (Rey-Benayas et al. 2008). The studies from Anamalai rainforest restoration programme showed by actively involving local communities alternative livelihoods can be generated through restoration activities and monitoring (Mudappa and Raman 2010; Raman et al. 2009). Similar active restoration effort by selectively clearing abandoned Caribbean pine plantation in Sri-Lanka to restore rainforest species, involved local communities for restoration activities (Ashton et al. 1997). Similar efforts were made in grass dominated areas at Knuckles Forest Reserve in Sri-Lankan (Gunaratne et al. 2011). In deforested bauxite mining site in Brazilian Amazon, active restoration of native species provided local communities livelihood opportunities (Parrotta and Knowles 2001). Such restored secondary forests can provide leaf litter, fuel wood, non-timber forest products (NTFP) such as honey, medicinal plants, and lichens, which can decrease the dependency of people on natural forests for their livelihoods (Biswal 2009; Setty et al. 2001). All this follows from the recent paradigm shift in restoration science that indicates that it’s not just the science and technology required for the practitioners, but the need to incorporate many disciplinary sciences along with consideration of historical, social, cultural and environmental ethics, and philosophy (Rey-Benayas et al. 2008; Higgs 1997).

Agricultural abandonment is a global phenomenon, which may be short-term or permanent depending upon the factors driving the abandonment. The benefits accruing from abandonment may therefore depend on these factors. The review by Rudel et al. (2009) highlighted that increasing urbanisation and rural depopulation can increase forest cover in the uplands in the tropics (Rudel et al. 2009; Wright and Muller-Landau 2006). There is potential to enhance forest cover in such abandoned agricultural lands, by
encouraging people with the concept of payment of ecosystem services such as carbon credits or through international agreements to control greenhouse emissions such as REDD (reducing emissions from deforestation and degradation) or REDD+, which provides a potentially powerful mechanism for supporting ecological restoration of tropical forests in developing countries. The Green India Mission of the Government of India is another option for restoration which is promoted to combat climate change on natural ecosystems of the country and targets a holistic approach to greening which will strive to restore forests in abandoned areas, enhance degraded forests and also support livelihoods for communities dependent on biomass and non-timber forest produce (GIM 2011; Mathew 2011). In all these cases prior understanding of the ecological and socioeconomic context of a particular region is however essential to make it sustainable (Kettle 2012).

**Tea plantations and Biodiversity**

Tea plantations in India are located in the global hotspots of biodiversity in Western Ghats and northeast India (Myers *et al.* 2000; Myers 1990,1988). They also harbour many species which are rare, threatened and endangered such as the Lion-tailed macaque, Nilgiri langur, Brown palm civet, etc., apart from large carnivores such as tiger and herbivores such as elephant and Indian gaur that use the tea landscapes to move from one forest to another (Kumar *et al.* 2011).

**Brief history of tea and the tea crisis**

Globally, tea (*Camellia sinensis*) is produced across Asia, Africa, and South America, though it was originally found in the hills of southern China (Hicks 2001). The major producers of tea in the world are China, India, Kenya, and Sri-Lanka (FAO 2008; Parker 2003). Total area under tea cultivation is about 0.579 million ha, which globally contributes to 21% of global tea production (FAO 2008). These countries are mostly developing economies with rich labour resources (van der Wal 2008). India is the second largest tea producer after China, followed by Kenya and Sri Lanka (FAO 2008). The major demand for tea comes from the Russian Federation, UK, USA, Pakistan, Japan,
Saudi Arabia and Germany (Parker 2003). In 1852, India successfully established tea plantations in the hills of Darjeeling in North East India following much later in 1854 James Finlay and Company experimented with tea cultivation in Western Ghats at Munnar, Kerala and Coonoor in Nilgiris, Tamil Nadu (Joseph 2002; Swaminathan et al. 1990). Subsequently, many more plantations have been established in other parts of the hills by clearing high biodiversity areas. South India alone has about 0.12 million ha of land under tea cultivation (Indian Tea Board 2012).

In the 1990s, following the collapse of the Soviet Union (USSR), India lost its major tea market (George and Joseph 2005). As a consequence of this slump, large quantity of surplus tea was flowing into the domestic market, which in turn affected many small growers (Banerjee et al. 2003). They were not able to compete with large growers as the price was very low. Many small-scale plantations started growing other economic crops while the rest were abandoned (Neilson and Pritchard 2009; CEC 2002). The tea industry is a labour-intensive sector, which directly employs over one million workers and provides income generation options for another 10 million people (Deepika 2008; Bora and Deka 1999). The slump in the market led to unemployment and its associated livelihood issues within Indian tea plantations. Tea growers in other tea growing countries such as China, Sri-Lanka and Kenya were buffered by low cost of production due to incentives provided by their respective governments (Ridwan et al. 1997), which was not the case in India.

Plantations which are facing economic crises could be revived by encouraging them to procure fair trade (Renard 2003), and eco-friendly certifications, which are well-known practices for many agricultural commodities, including tea and coffee that are located in biodiversity rich regions (Mistiaen 2010). Additionally, they can be helped by fixing reasonable state–central agricultural taxes and export duties (George and Joseph 2005).
Tea plantations and native species restoration

Large-scale agriculture farming sectors such as coffee or tea are suffering due to the shortage of labourers and many plantations becoming defunct and abandoned. However, there is no reliable record on tea plantation abandonment; because many small plantations are not registered with the tea board and many were converted into rubber, spice, and coconut plantations in southern Kerala (Pers. Obs.). In Trivandrum district of Kerala about 55% of tea plantations were abandoned between 2001 and 2007 (Chetana et al. 2012). These accounted to about 10,499 ha (about 39 plantations) (Neilson and Pritchard, 2009). In the Western Ghats, many of the plantations lie abandoned due to being situated inside protected areas (Chetana et al. 2012) or are under the 99-year lease, mostly given away by the British administration in India that are likely to expire soon. Such plantations often occupy large area within the Protected areas (Chetana and Ganesh 2012; Ali and Pai 2001).

Many abandoned lands potentially regrow into secondary forests aided by forest seed sources (Holl et al. 2000). Such lands have shown that colonisation by native species is strongly driven by seed sources and microsite suitability (Verdu and Garcia-Fayos 1996). In the Neo-tropics, post-agricultural land abandonment has been studied extensively and many have highlighted that understanding site-specific ecological process is essential for conservation and management (Costa et al. 2012; Jamoneau et al. 2012; Cramer and Hobbs 2007; Holl et al. 2000; Aide and Cavelier 1994; Neptstad et al. 1991).

The overall consequence of tea plantation abandonment can be complex, but no study has been carried out. There is a lack of empirical information on the ecological process that occurs when tea plantations are abandoned. Most ecological studies on colonisation of abandoned areas are restricted to tree plantations and only a few to shrub monocultures such as coffee (Komar 2006; Williams-Guillén et al. 2006; Arellano et al. 2005; Pineda et al. 2005; Armbrecht et al. 2004; Ricketts et al. 2001). Unlike coffee and cardamom, tea (Camellia sinensis) is a tree species maintained as shrub with a dense continuous short canopy. Though no ecological studies exist in overgrown tea plantations in India,
the study from Sri Lankan where grass dominated abandoned tea plantations showed that dispersal limitation is the primary constraint to forest succession while management of fire regimes, vertebrate herbivory and competition from the dominant grasses influenced the abundance and composition of emergent tree seedlings (Gunaratne et al. 2010).

The importance of dispersal and the kind of seeds that get dispersed in tea plantations is relatively unknown. Such studies are urgently needed to help understand what species can colonise abandoned plantations and what factors (e.g., forest proximity, frugivore activity and others) can influence seed input from the management perspective. Moreover tea plantations unlike tree plantations are trees maintained as shrubs with a dense canopy that is difficult to penetrate and inhospitable to many light demanding seedlings (Swaine and Whitmore 1988). This can affect regeneration of native species and offers opportunities for understanding succession processes in such intermediate habitats (Chetana and Ganesh 2012; Gunaratne et al. 2010). The study from Anamalai hills recorded that seedling survival was higher in sites with complete weed removal as against partial removal along planting lines and higher in open meadow and under shade than in sites that earlier had dense weed invasion (Raman et al. 2009). Sudden abandonment of land after years of agricultural activity can often facilitate proliferation of invasive species in the absence of any interventions and it could suppress native species regeneration (Ticktin et al. 2012; Sundaram and Hiremath 2012; Raman et al. 2009). Such information is critical in the management of abandoned plantations for forest managers and restoration practitioner’s.

History of study area and broad outline of the thesis

The ecological process of colonisation of abandoned tea plantations which is currently unknown, and the social perceptions on abandonment and its consequence on biodiversity restoration are the major focus of my thesis. I did this study in the forests and tea plantations of the Agasthyamalai Biosphere Reserve (8° 8′–9° 10′ N and 76° 52′ –77° 34′ E), southern Western Ghats. Agasthyamalai supports large contiguous forests along the eastern and western slopes and harbours five protected areas; Kalakad Mundanthurai
Tiger Reserve (KMTR (895 km$^2$) and Kanyakumari Wildlife Sanctuary (502.86 km$^2$) in Tamil Nadu, Neyyar (128 km$^2$), Peppara (53 km$^2$) and Shendurni (171 km$^2$) wildlife sanctuaries in Kerala (Velmani 2002; Ramesh et al. 1997; Figure 1.1). In addition there are several pockets of reserve forests on the eastern and western slopes of Agasthyamalai.

The entire Agasthyamalai landscape is an undulating hilly terrain with high peaks, and numerous deep valleys. The altitude of Agasthyamalai ranges from 100 m in the foothills and rises up to 1869 m Agasthyar peak. Large part of eastern slopes of Agasthyamalai is in the rain shadow area and covered by dry deciduous and scrub forests in the lower slopes. At higher altitudes which receive rainfall from both the monsoon, the forests are more moist, evergreen and wet-evergreen with grasslands and shola forests. The lower eastern slope also supports pockets of dry evergreen forests, a unique forest type in low rainfall area. The western slope of Agasthyamalai is covered with moist deciduous forests in the lower altitude and evergreen forests with grasslands and shola forests in the higher altitudes.

Agasthyamalai being located in the southern Western Ghats receives both south-west and north-east monsoon rains. However, the western slopes receive the south west monsoon rains and the eastern slope receives the north east monsoon. Some regions in the crest of Agasthyamalai range receive both the monsoons. The total annual rainfall exceeds 5000 mm in the higher slopes and the number of rainy months extends to about 10 months in the entire Agasthyamalai range (Varghese and Balasubramanyan 1999). With more than 2000 km$^2$ in area, the whole mountain range acts as a large catchment for many perennial rivers such as Thamiraparani, Manimuthar, Pachayar, Kodayar, Kodumudiyar, Nambiar, Neyyar, Kulathupuzha and Shendurni, which originate in this range. Several small and large dams have been built across these rivers to generate power and irrigate fields (Ali and Pai 2001; Henry et al. 1984).

The largely inaccessible reaches of Agasthyamalai still support undisturbed wet evergreen and Shola forests. It is one of the species-rich areas within the Western Ghats with over 150 localised endemics in addition to many Western Ghats endemics (Ramesh et al. 1997;
Collins et al. 1991; Henry et al. 1984) and is also an important speciation centre (Nayar 1996). This part of the Western Ghats shares many plant species in common with Sri Lankan forests (Nayar 1996; Henry et al. 1984; Subramanyam and Nayar 1974). It is home to many rare animal species including the highly endangered lion-tailed macaque (Macaca silenus), Nilgiri langur (Semnopithecus johnii) and the tiger (Panthera tigris).

Forests of Agasthyamalai have been extensively exploited over the last two centuries for raising plantations and timber and soft wood extraction (Velmani 2002; Gopalakrishnan 1995; Kadakshamani 1976; Iyer 1905). In the past, small and large plantations were established in the entire Agasthyamalai forests. Initially, the plantation crops were coffee, cardamom, clove, orange, etc. Cinchona was also tried as a plantation crop in some pockets. On the western slopes, large swathes of forests, mostly of moist deciduous type, were cleared to raise rubber, and pockets of evergreen forests were selectively logged to raise cardamom and clove. Later, evergreen forests were cleared and planted with tea. As part of forestry practices, teak and eucalyptus along with various softwood tree species were planted to yield timber, fuel wood, softwood, and pulp sources from the Agasthyamalai. Reed bamboos (Ochlandra sp.,) were also extensively harvested to manufacture paper in the entire Agasthyamalai range (Ganesan 2001). Though the slopes at the lower elevation were exploited for timber and various other forest resources in the past, the higher reaches that support the wet evergreen forests, large areas were converted to tea and eucalyptus plantations in the early 1900s. Many of the smaller plantations were abandoned over the later part of the last century due to expiry of the lease period. These plantations had crops such as cardamom, clove and orange. Except few tea plantations such as Bombay Burma Trading Company, most of the plantations have been abandoned during the same period in the entire Agasthyamalai range due to various reasons including labour issues, the Wildlife protection act, vagaries in tea prices globally and others.
Figure 1.1. Map of the Agasthyamalai region. Dark shaded areas represent tea plantations within and outside the protected areas. Not all sampled plantations are indicated in the map.

The social, economic and legal issues pertaining to worker welfare in tea plantations has been dealt in several studies earlier (Neilson and Pritchard 2009; Banerjee et al. 2003) but emphases on the drivers for abandonment of tea plantations has not received adequate attention. My research therefore focuses more on the ecological aspect of native species restoration and the social perceptions on abandonment.

The main objective of my study is to understand the ecological process of native species’ colonisation in abandoned tea plantations. Specifically, the focus is on identifying the
critical factors associated with the establishment of native plant species in abandoned areas surrounded by forests. In addition to these ecological issues, I also aim to expand my understanding of the socioeconomic and tenure issues associated with plantation abandonment and the perception of stakeholders on abandonment. Following are the broad objectives dealt as separate chapters in the thesis.

1. What are the major ecological factors that deter or facilitate natural colonisation of native forest species within abandoned tea plantations?

2. What are the ecological interventions that can be made to catalyse natural colonisation by native species within abandoned tea plantations?

3. What are the legal, social, and economic drivers that can help or negate natural forest restoration in tea plantations?

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