CHAPTER 1

Introduction

1.1 Overview of forest resources in the Philippines

The Philippines is one of the few countries in the world which was originally and thoroughly covered by rain forest (Schulte, 2002). It is considered as one of the mega diverse countries in the world in terms of its large share of endemic flora and fauna however, it is now on the list of biodiversity hotspots (Myers et al. 2000). The replacement of natural forests to various unproductive lands worsens the country´s condition in terms of massive forest loss. In fact, the decline of its old growth forest cover from 70% to 7% in less than a century is considered as one of the most severe in the world (Heaney, 1998). Countrywide, Philippines has only three percent primary forest cover remaining, with very few of these forests found in the lowlands (ESSC, 1999; Myers et al., 2000). Forest cover loss was attributed to intensive logging (both illegal and legal), upland migration and agricultural expansion; and unsustainable practices such as shifting cultivation (Heaney, 1998; Pulhin et al. 2006). These activities have created 13M hectares of open grassland areas and 5.2 M hectares of this figure need immediate rehabilitation (FAO, 2005) (see Figures).

Protection of the remaining forest cover and the adoption of necessary schemes for the rehabilitation of huge barren land in the country have been put forward. In fact, reforestation efforts in the country have started one hundred years ago (since 1910) through various projects initiated by the government (Pulhin et al. 2006). However, success in terms of the area coverage by rehabilitation efforts was poorly seen on the ground (Esteban, 2003). In addition, a huge gap between the rate of reforestation and deforestation with a ratio of 1:23 hectares, favouring the latter was evident (FAO, 2005). Lack of technical expertise to rehabilitate the land and poor species-site matching are among the many constraints identified in most of the reforestation in the country (Pulhin et al. 2006, Carandang and Cardenas, 1991).

Conversion of many natural forests in the Philippines through shifting cultivation leaving large areas of open grasslands and degraded land. (Middle and last photos were taken by J. Quimio).

1.2 Reforestation strategies in the Philippines

The situations mentioned earlier had brought the government to lead various programs that could rehabilitate the country's degraded forest lands. One of the biggest forest restoration activities in the Philippines happened during the period of 1987 to 1995 through National Forestation Program which targeted to reforest 1.4 M hectares (Magno, 1994). Another project was reforestation through an organized communities and also known as Community-Based Forest Management. Communities were contracted by the government to reforest and have occupancy over the lands that they have developed (Pulhin et al. 2006). This approach is one of the most promising strategies to reforest large areas that promote sustainable forest management not only in the Philippines, but also to some other southeast Asian countries (Shulte, 2002).

However, a limited number of species are being used in reforestation. These species particularly come from the genera *Pinus*, *Eucalyptus* and *Acacia* (Lamb et.al 2005). In the Philippines alone, about 80% of the established plantations were planted with *Gmelina arborea, Swietenia macrophylla, Acacia auriculiformis, Acacia mangium* and *Eucalyptus* species (Pulhin et al. 2006). These species were introduced to the country and favoured by most farmers due to the availability of resources and established methods on how to grow them successfully in the field. Studies have shown that areas planted in a monoculture approach are less good in terms of their productivity and ecological gains compare to mixed-species stands (Erskine et al. 2006). In fact, many traditional plantations have supplied goods but have made minor contributions to the restoration of the ecological functions and biodiversity (Lamb et.al. 2005).

1.3 Rainforestation approach to reforestation

In the tropics, recent approaches to reforestation emphasize the establishment of native species in mixed stands (Lamb et al. 2005, Montagnini et. al 1995). Stands planted with mixture of indigenous species perform well in terms of biomass productivity and carbon sequestration than pure stands (Redondo-Brenes and Montagnini, 2006). In the mid-90s a farming technology called "rainforestation" on the island of Leyte, the Philippines was envisioned. The working hypothesis in the creation of rainforestation was "The closer a farming system in the humid tropics is to a natural rainforest ecosystem, the more sustainable it is" (Margraf and Milan, 1996). In addition to its goal, rainforestation will serve as a buffer to remaining protected areas by planting species that are native in areas such as public degraded forest lands, in other tenurial instruments including Community-based Forest Management, ancestral domain sites and protected areas. It aims to restore degraded areas and farms planted with old coconut stands through a highly diverse and economically future-oriented and sustainable tree farm (Margraf and Milan 1996). The proposed planting scheme to rainforestation establishment was to initially plant native pioneers at a close distance of 2m x 2m and planting of shade tolerant species in the second year. Shade tolerant species are composed on highly values timber tree species in the Philippines, mostly belong to Dipterocarpaceae family. Planting of fruit trees were also suggested in the second year (Margraf and Milan, 1996). The scheme aims to restore one million hectares of rainforests by year 2020 using tree species native to a particular forest in the area (Rainforestation Primer, 2007).

1.4 Significance of the study

Land restoration in the tropics in the form of reforestation is commonly objected due to high evapotranspiration rates of the created stands which could lead to decrease in stream flows and ground water recharge (Bruijnzeel, 1997). In many cases of reforestation in the Philippines, empirical evidence is scarce on how these efforts affect the water and soil properties (Chokkalingam et al. 2006). Recent study in reforestation in Leyte revealed a significant variation in the water use depending on the species, tree size and biomass (Dierick and Hölscher, 2009).Their results suggested that species selection plays an important role in the control of water consumption in reforestation. Similar studies addressing more appropriate tree species selection and species mixtures are currently underway (Wishnie et al., 2007; Potvin and Dutilleul, 2009). An assessment of the functional diversity in such mixed stands for example on the basis of leaf traits appears relevant.

Characterization of reforestation species through their leaf traits and other related physiological parameters is crucial for the assessment of the systems´ecological functioning. Leaf traits lead to understanding the functional leaf ecology of species (Castro-Diez, et. al. 2000) and to predicting plant performance though their growth and survival (Poorter and Bongers 2006; Martinez-Garza et.al 2005) especially when planted to an early-successional environment like in most areas needing immediate restoration.

In this study, investigation was done on the leaf water conductance of the most common species used in reforestation in Leyte. Stomatal conductance (g_s) is a significant physiological parameter which provides the capacity of the species in terms of its rate of water turn over through its leaves. It is closely associated with the CO_2 assimilation rate (Farquhar and Sharkey, 1982). Juhrbandt et al. (2004) compiled a list of the maximal stomatal conductance (g_{smax}) rates of various tree species belonging to early and late successional groups from humid tropical forests. To my knowledge, this study is a pioneering work with respect to this topic in a reforestation setting in the Philippines. It is deemed necessary and timely to assess the relationship of these parameters to species which co-exists in a new course of restoring previously degraded areas. Results could serve as a baseline data for further research activities related to reforestation and forest management, in broadening the pool of species with known stomatal conductance rates and leaf traits and to recommend species combination to attain specific goal to restoration.

1.5 Research objectives

The general objective of this research was to assess rainforestation as a scheme to reforest degraded sites, in terms of the functional diversity of the co-occurring species. Specific objectives were outlined as follows:

(1) to assess the species-specific variation of leaf traits and in particular of maximal leaf stomatal conductance (g_{smax})

(2) to search for relationships between g_{smax} and tree variables i.e. tree architecture, leaf morphological and chemical traits

(3) to group species according to their distinct foliar traits.