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ENHANCING REFORESTATION IN DEGRADED TROPICAL PEATLANDS IN CENTRAL KALIMANTAN

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SUMMARY

Tropical peatlands of Southeast Asia are great terrestrial carbon stores and major hot spots of biodiversity. Main peat forming ecosystem is peat swamp forest (PSF). Currently peat swamp forests are converted to plantations and agriculture with breath-taking pace. Aside from conservation, active restoration is also needed on degraded areas to conserve both biodiversity and the remaining peat deposits. Our work searches practical and affordable techniques for reforestation of degraded peatlands. Our study site was clear-felled open, drained and several times burnt deep peat area in the so-called Ex-Mega Rice area in Central Kalimantan, Indonesia. We chose five native PSF tree species (*Shorea balangeran, Dyera polyphylla, Alstonia pneumatophora, Dacryodes rostrata* and *Campnosperma squamatum*) known to have potential for reforestation. Seed material acquired from local forests was grown in a field nursery. At the age of 6-11 months seedlings were planted in the field in three replicate locations characterized by differing wetness conditions. We tested three treatments: weeding (3 intensities), mounding and fertilizing, and their combinations to study the best practices to enhance seedling success. Growth and mortality of the seedlings and environmental variables (water table, temperature) were monitored for two years. Effects of treatments and environmental variables on the growth were tested with mixed-effect models and on mortality rates with Cox regression. We conclude that fertilizing had most clear positive effect both on growth and mortality in tested species whereas mounding decreased mortality but the effects on growth were ambiguous. Weeding had slight positive effect both on growth and survival in most cases. Water table position had effect both on growth and mortality but the results differed substantially between species. When labor and material costs are taken into account, our results can derive species-specific best option for reforestation scheme for these five species on degraded tropical peatlands.

Keywords: *tropical peatland, reforestation, restoration*

INTRODUCTION

Tropical peatlands of Southeast Asia are one of the great terrestrial carbon sources. Main peat forming ecosystem, peat swamp forest (PSF) has been, until recently, one of the last relatively untouched wilderness inhabiting one of the most diverse flora and fauna on the Earth. During the last decades peat swamp forests have been converted to plantations and agriculture with increasing intensity. Drainage and removal of forest cover have caused loss of biodiversity, progressive decrease in carbon stores and these damages are reinforced by fire outbreaks during dry seasons.

In the autumn 2015, prolonged and wide-spread fires in the Indonesian and Malaysian archipelago covered again large areas in Southeast Asia to thick haze. This ―worst environmental disaster of the century" (Meijaard 2015 and Monbiot 2015) brought the situation of the tropical peatlands to the international awareness. To amend the devastating situation, Indonesian government has taken measures to ban all new development in peatlands and start restoration of the drained areas (Letter of Instruction no S.661 /MenLHK-Setjen/Rokum/2015). Aside from conserving the remaining peatlands, active restoration will be needed in the degraded peatlands. In the clear-cut and several times burnt areas there is not a need only for the hydrological restoration, but also for the reforestation. This study searches for practical techniques for reforestation of these degraded tropical peatlands. This is done by testing how five native species seedlings responded to selected silvicultural practices in a planting trial on a degraded tropical peatland area. The tested practices were fertilizing, mounding and weeding. Full analysis of the results is yet to come and thus we present here the preliminary findings.

METHODS

The study was conducted in the degraded peatland in the Ex-Mega Rice area block C, in the Kalampangan zone (2°19'S 114°01'E), near Palangka Raya, Central Kalimantan. The former peat swamp forest was drained, clear-cut and it had burnt several times. The peat depth in the area was approximately 4 m. The vegetation on the area consisted of ferns, bushes and sparse small trees. The mean annual rainfall was approximately 2500 mm and the mean temperature was 26 °C (Hirano *et al.*, 2014).

We chose five native PSF species (*Shorea balangeran, Dyera polyphylla, Alstonia pneumatophora, Dacryodes rostrata* and *Campnosperma squamatum*) known to have potential for reforesting degraded peat areas. Seeds were collected from the local forests and seedlings were grown in a field nursery near the Kalampangan village. After 6-11 months in the nursery, the seedlings were planted in the start of rainy season in November 2012 in the field in three replicate locations characterized by differing wetness conditions. We used three treatments: weeding (3 intensities: no weeding, moderate weeding, total weeding), mounding (40 cm high constructed mounds filled with peat material from the site) and fertilizing (organic manure from local farms, applied once at planting), and their combinations to study the best practices to enhance seedling success. Height and mortality of the seedlings was monitored for two years. Water table was monitored with automated loggers in all three replicate locations. Soil temperature and soil properties (chemistry and physical properties) were monitored with regular measurement campaigns. For each separate species, effects of the treatments and environmental variables on the growth were tested with linear mixed-effect models and on mortality rates with Cox regression models.

RESULTS

Based on the preliminary findings, *Shorea balangeran* was had the best results both in growth and survival, followed by *Dacryodes rostrata* with more modest results for the three remaining species (Figure 1).

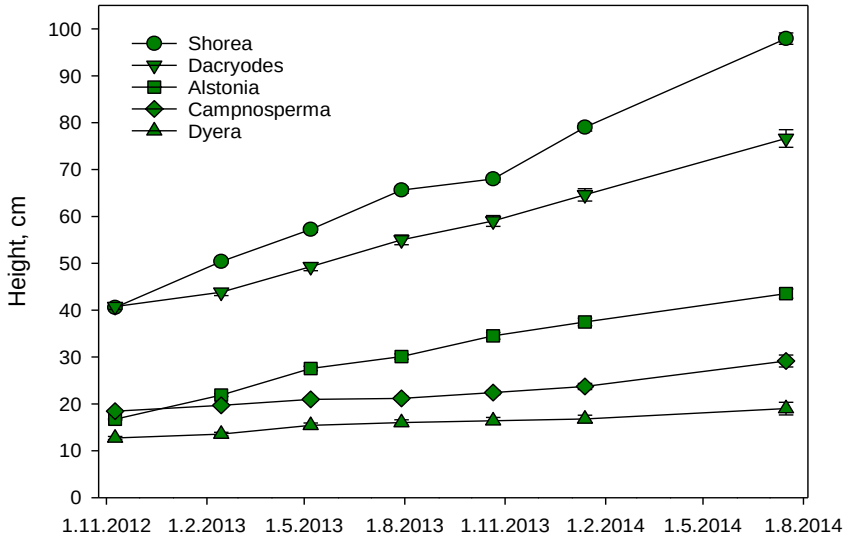

Figure 1: Height of the species without any treatments during the first 1.5 years after planting

Fertilizing had most clear positive effect both on growth and survival in tested species (Figure 2). Mounding decreased mortality in most cases but the effects on growth were mixed. Weeding had slight positive effect both on growth and survival in most cases. Water table position had effect both on growth and mortality but the results differed substantially between species. Two years after planting in October 2014 all the sites were caught by fire and most of the seedlings were killed and the measurements had to be terminated.

DISCUSSION

Drained, clear-cut and several times burnt tropical peatlands are extremely harsh environments for any vegetation. After removal of trees, repeated fires and heavy rainfall eroding the surface peat, the nutrient pool especially in deep peat areas, such as in Kalampangan zone in this study, is practically non-existing (Könönen *et al.*, 2015). The water table change between wet and dry seasons can be up to 2 meters. Flooding can rise 50 cm above the soil surface in places in wet season whereas the water table can be 1.5 m deep in the dry season. This sets high demands for both flood and drought tolerance of the plants. Based on our findings, species like *Shorea balangeran*

and *Dacryodes rostrata* may well be able to overcome these conditions and establish viable stands over time. Fertilizing as a one-time investment seems to have clear positive effect on the onset of stand establishment and should thus be considered. Mounding is a labor intensive and more costly technique and even if it might reduce the mortality in the early stages, based on this study we cannot anticipate if it would enhance future success of the seedling or not. Weeding needs to be done several times and is also labor intensive. Based on the somewhat contradicting results depending on the species and sites, we may suggest that the shelter provided by the existing vegetation (mostly ferns) may in some cases be beneficial, as well as the decrease of the competition and increased light availability achieved by weeding. When labor and material costs are taken into account, comparing the results of these techniques can derive species-specific best option for reforestation scheme on degraded tropical peatlands.

Figure 2: Moderate weeding and fertilized *Shorea balangeran* 1.5 years after planting

CONCLUSION

Even in the very harsh conditions in the deep peat areas, with right species and techniques, the reforestation of degraded tropical peatlands can be successful. Nevertheless, the main concern should be in securing the stands from burning, which in turn needs local commitment for responsible use of fire. The chance for success can further be enhanced with hydrological restoration, where permanently elevated ground water table can reduce the susceptibility for fires.

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