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Title:  ECS21-0461, entitled "Tropical montane forest in South Asia: Composition, structure and dieback in relation to soils and topography"

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Abstract: We evaluated the composition, structure and dieback of a montane forest in relation to soils and physiography of an important biogeographic region that has been sparsely studied. Our objectives were to: 1. Describe the forest composition and structure; 2. Assess the current extent of dieback; and 3. Relate tree composition, structure, and dieback proneness to edaphic and physiographic measures. We enumerated all live and dead standing plants ≥ 3 cm diameter at breast height (DBH), in thirty 20×15 m2 over story plots. We measured all regeneration < 1m height in subplots, sampled soils and measures of physiography, and visually rated the proportion of crown die-back, and recorded standing dead trees.

There are six excel data files:1. HPNP\_DBH; 2. HPNP\_Environmental data; 3. HPNP\_Canpy openness data; 4. HPNP\_species list; 5. HPNP\_Vegetation data; and 6. HPNP\_Mortality data

Usage Notes:

1.HPNP\_DBH – This file comprises the diameter at breast heights of all trees greater or equal to 3cm (dbh) by species in each of 32 plots

2.HPNP\_Environmental data – This file comprises the soil nutrient contents, soil textures, and topographic variables for each of the 32 plots.

3.HPNP\_Canpy openness data – This file comprises the hemispherical data measuring canopy openness for each of the 32 plots

4. HPNP\_species list – This file comprises the species names by code

5. HPNP\_Vegetation data – This file comprises numbers of individuals of seedlings (less than 1m) by species in the 32 plots

6. HPNP\_Mortality data – This file the standing dead trees (>3cm dbh) by dbh and where possible identified to species for each plot

Research domain: Primary research domain – Biological Sciences – Plant Sciences Botany.

Keyword(s): aluminum,aspect,canopy openness,cloud forest,forest dieback, drought, heavy metals, Horton Plains National Park, iron, late secondary, lead, metallurgy, succession

Methods:

*Study site*

Our study was conducted in the tropical montane cloud forests at Horton Plains National Park (HPNP), situated in the Nuwaraeliya District of the central province of Sri Lanka (6’ 47o N to 6’ 50o N and 80’46o E to 80’51o E). The condition and successional development of the forest would be considered primary, undisturbed forest with no known impact by humans from timber or fuelwood harvest, livestock grazing or collection of non-timber forest products. The park is managed under the jurisdiction of the Department of Wildlife Conservation, Sri Lanka. It is situated on the highest plateau land of Sri Lanka and is characterized by undulating valleys and rolling hills (Fig. 1). The Park extends over an area of 3160 ha.

Mean annual temperature of HPNP is 15o C ([DWC, 2007](#_ENREF_15)), with an annual precipitation of 2150 mm ([DWC, 2007](#_ENREF_15)), and a minimum monthly precipitation of 100 mm ([Bruijnzeel and Scatena, 2011](#_ENREF_5)). Southwest monsoons bring more rains to the study site during May-July, than northeast monsoons (October-November) with drier inter-monsoonal periods in August and January to March (DWC, 2007). Frequent mist occurs during early afternoons and may continue throughout the whole night, especially during the southwest monsoon period. Cloud deposition contributes significantly to total precipitation especially during the southwest monsoon when gale-strength winds can also occur ([DWC, 2007](#_ENREF_15)).

Most of the park area is covered withtropical montane cloud forests (70.4 %) at elevations between 2100 m to 2300 m. Grasslands defined by tall tussock grass (18.4 %) and carpet grasses (2 %) occupy most of the remaining lower slopes and hollows of the park (see Fig. 2). In addition, some riparian areas comprise dwarf bamboo, *Arundinaria densifolia* ([Ediriweera *et al.*, 2008](#_ENREF_16)). When forest die-back was first noticed to actually start remains unknown but it was first reported in 1970s (Perera, 1978) and has been observed to continue over time, largely reported in the non-peer reviewed gray literature (Werner, 1988; Mahaliyanage *et al*., 1999; Ediriweera *et al*., 2008; Chandrajith *et al*., 2009; Kotinkaduwa *et al*. 2011).

*Vegetation sampling and analysis*

Thirty plots for the study were chosen randomly on a 1:50,000 map of HPNP with the aid of Hawth's Tools in ArcGIS software. One restriction imposed by the National Park Service was that all plots had to be placed within 200 m of a trail to enable access and to prevent any new trail being created within areas deemed wilderness. Plots were selected in forest between the 2100 m to 2300 m altitudinal range. This range represented where the forest was present across the undulating park plateau. For each 20 m×15 m plot we measured all live and standing dead woody plants in which the diameter at breast height (DBH) ≥ 3 cm was tagged and enumerated between December 2016 and December 2017. Where plants were of uncertain taxonomy, voucher specimens were collected and verified by comparing with samples from the National Herbarium of the Royal Botanical Garden, Peradeniya. Crowns of each tagged tree was observed using Nikon® binoculars. Dieback status was recorded as described by a die-back scale (McLaughlin *et al*., 1992) with some modifications (**Error! Reference source not found.**a). Bark damage (both signs of browse and fraying) from sambar deer (*Rusa unicolor*) was visually estimated on all trees and shrubs (DBH≥3 cm) using a generated scale (See Table 1b).

Seedlings < 1 m in height were enumerated in two, 2 m × 2 m quadrats that were established in each overstory plot. Based on the characteristics of cotyledons and other morphological features, seedlings were identified to the species level where possible or at least to genus.

A compass and clinometer was used to record the aspect and the slope of each plot. An altimeter was used to record altitude to the nearest meter. Canopy openness was calculated for each plot by taking hemispherical photographs using Nikon Coolpix 5400® digital camera fixed into the FC-E9 fisheye converter lens®. Photographs were captured from the plot center at 1.3 m above the ground surface during relatively uniform overcast skies. Soils were collected from at least three randomly located places within each plot for the first 15 cm of mineral top soil immediately beneath the organic horizon. Samples for each plot were mixed together to make a single composite sample. Soil samples were then air dried and sieved < 2mm to remove stones. Soil pH was measured with H2O extraction. Cation exchange capacity (CEC), conductivity, phosphorus (P), magnesium (Mg), potassium (K), calcium (Ca) nitrogen (N), carbon (C), iron (Fe), Aluminum (Al) and a variety of micro-nutrients and metals (manganese (Mn); nickel (Ni); sodium (Na); lead (Pb)) were determined at Uva Wellassa University and the soil laboratory of the Coconut Research Institute of Sri Lanka. Available nutrients and organic carbon were extracted to 1 M (mol/L) ammonium acetate buffered to pH 7 by using Kjeldahl digest according to Walkley and Black (1934).

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