Mapping peat soil moisture under oil palm plantation and tropical forest in Sarawak

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SUMMARY

Water table conditions in drained peatlands affect peat decomposition, fluvial carbon and greenhouse gas emissions, and plant growth in oil palm plantations. This study illustrates the spatial heterogeneity of soil moisture profiles in cultivated tropical peat under oil palm plantation and uncultivated secondary forest, using maps. At a study plot under each land use the geographical coordinates of sampling points, tree locations and other features were recorded. Peat soil samples were taken at depths of 0–50 cm, 50–100 cm, 100–150 cm and 150–200 cm, and their moisture contents were determined. Overall, soil moisture content was higher in secondary forest than in oil palm plantation due to land management activities such as drainage and peat compaction in the latter. Significant differences were observed between the topsoil (0–50 cm) and deeper soil layers under both land uses. Soil moisture maps of the study plots interpolated using geographical information system (GIS) software were used to visualise the spatial distributions of moisture content in soil layers at different depths (0–50 cm, 50–100 cm, 100–150 cm, 150–200 cm). Moisture content in the 0–50 cm soil layer appeared to be inversely related to elevation, but the correlation was not statistically significant. On the other hand, there was a significant positive correlation between soil moisture content and the diameters of oil palm trunks. Palm trees with negative growth of trunk diameter were mostly located in subplots which were relatively dry and/or located near drains. The results of this study indicate that soil moisture mapping using GIS could be a useful tool in improving the management of peatland to promote oil palm growth.

KEY WORDS: Geographical Information System, GIS, map, tropical peatland

INTRODUCTION

Peat consists of partially decomposed organic materials which have accumulated primarily due to waterlogged and anoxic conditions in the soil (Page & Baird 2016, Tubiello *et al.* 2016). It is found on every continent and across tropical, temperate, boreal and (sub)arctic regions. Tropical peatlands make up 90–170 million hectares (Mha) of the 186–423 Mha of peatlands throughout the world (Gumbricht *et al.* 2017, Xu *et al*. 2018) and are located mainly in South America, Central Africa and South East Asia. Most of the peatlands in South East Asia are found in Malaysia and Indonesia (Hooijer *et al*. 2012, Veloo *et al.* 2015) and they cover 8 % (2.7 Mha) of the total land area of Malaysia (Mutalib *et al*. 1991, Abat *et al*. 2012). A large proportion of these peatlands have been cleared and converted for agricultural development to grow plants including oil palm (*Elaeis guineensis* Jacq.), sago palm (*Metroxylon sagu* Rottb.) and pulpwood trees (Purwanto *et al*. 2002, Miettinen *et al.* 2012, Carlson *et al*. 2015).

Peat is formed when the accumulation rate of organic material exceeds its decomposition rate in an oxygen deficient environment (Hoyt *et al.* 2019). Undisturbed peatlands often function as carbon (C) sinks with capacity to store organic matter in flooded conditions characterised by low redox potential, where only relatively slow anaerobic decomposition of organic matter - resulting in C-loss in the form of methane (CH_4) - can occur (Cobb *et al*. 2017, Manning *et al*. 2019). When the peatland is converted for agricultural use, permanent lowering of the water table through drainage is required to create an aerated zone suitable for the growth of crop roots. This simultaneously raises the soil redox potential, increasing oxygen availability and enhancing the release of C from organic matter decomposition