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INDICATIONS OF COMPACTION IN RELATION TO SUBSIDENCE ON PEATLANDS USED FOR *ACCACIA CRASSICARPA* PLANTATION IN INDONESIA

Darmawan; Department of Soil Science and Land Resources, Faculty of Agriculture, Bogor Agricultural University; Darmaga Campus, 16880, Bogor, Indonesia, +62-0251-8629357, darmawan_soil@yahoo.com
Dwi Putro.Tejo Baskoro and Budi Nugroho; Department of Soil Science and Land Resources, Faculty of Agriculture, Bogor Agricultural University

SUMMARY

Land subsidence will always take place when peatlands are drained. The subsidence is often used in predicting Carbon emission from the lands. One year subsidence monitoring as well as measurement of bulk density and size fractions of the organic materials was carried out at several sites of peatlands in Sumatra used for *Accacia crassicarpa* plantation. The subsidence rate during the year was found to be uncertain since the land surfaces were found to alternately rise and down. Peat materials above the water table are dominated by fine fractions that in general corresponded with higher bulk density but the higher bulk density is difficult to be straightforwardly interpreted as an indication of compaction, because it depends on the historical change of the peatlands.

Keywords: Emission, Compaction, Subsidence, Peatlands

INTRODUCTION

Conversion of tropical peatlands to agriculture as well as to plantation forest in Indonesia has become a great environmental issue with respect to carbon emission to the atmosphere. There are many publications presenting data of the emission obtained from mathematical estimates that use subsidence as a key parameter. Considering that subsidence involves consolidation, compaction, decomposition (Andriesse,1988) and burning of land materials, it is of great importance to fully understand how far the subsidence would happen. Understanding process and rate of the subsidence will give much help in understanding contribution of peat material decomposition to the subsidence and hence will be a good base in understanding process of the emission.

Measurement of compaction is not an easy work (Kool *et al.*, 2006). Compaction is theoretically believed to correlate with increasing bulk density (BD), therefore measuring BD of peat layer is often done for this purpose. On the other hand compaction likely correlates with size of organic material fractions of peat, in that the finest the fraction the highest the compaction would happen.

This research aimed to measuring subsidence of different circumstances of *A. cracicarpa* plantation on peatlands with respect to peat depth and history of landuse in Sumatra and to depth-wisely observing BD as well as fractioning size of organic material.

MATERIAL AND METHODS

This research was carried out at three locations in Sumatra Island, Indonesia. First location is in Riau Province, within an *A. cracicarpa* plantation area directly converted 8-10 years ago from pristine peatland forest in deep peat. Second location is in Jambi Province also within an *A. cracicarpa* plantation on a moderate peat depth which area was previously logged. The third is located in South Sumatra Province, on shallow peat depth which area is denuded and has been subjected to repeated burnings and over drained from the surrounding.

Subsidence was monitored at three plots in the first location including one plot within the neighboring pristine peatland forest, at one plot in the second location with an additional plot within a remaining adjacent logged-over area, and two plots in the third location. The monitoring was run for a year at 1- weekly interval. At all plots, the peat surface level was measured using perforated PVC tube as poles inserted vertically through the peat and anchored in the underlying mineral sediment. Using this perforated PVC water table was monitored as well.

Measurement of BD was done at plots of the subsidence monitoring in the first location and at one plot in the second and the third locations. The BD samples were collected from the sides of pits using top-down open metal box with 10 cm x 10 cm x 10 cm dimension. Sampling was done depth-wisely down to around water table. Same samples were collected for separately fractionating size of organic particles into sizes of <106μ , 106μ – 1000μ , 1000μ – 2000μ , 2000μ – 5000μ , > 5000μ by soaking the samples with 0.1 M Sodium pyrophosphate and followed by sequential wet sieving using respective size of sieves.

RESULTS AND DISCUSSION

Fig. 1 shows that subsidence rates of the *A. crassicarpa* plantations on the deep peat over a year was unclear. The plot of the 9 years plantation shows a subsidence of about 2 cm after a year. In the contrary the plot of the 6 years plantation shows a rising surface level instead of subsidence. Rising and lowering surface level alternately happen and is found for all the measurement plots, including that of the pristine forest. Among parameters considered to have correlation with this alternate process, it seems that the soil (peat) moisture content is the only parameter shows a significant correlation. The correlation is even quite clear for the pristine forest plot. One possible explanation of this correlation is that the increasing and decreasing soil moisture content to a considerable extent made the peat material to swell and shrink respectively.

Fig. 2 and 3 show that subsidence rates of the *A. crassicarpa* plantations on the shallower peat over a year were slightly higher than that of the deep peat. However, between the plots there are significant variations. The lowest extent of subsidence in the deep peat is likely due to a steady water table that is kept around 50-80 cm below the surface. A sharp fall of the surface is detected at the plot of newly started plantation from a condition of an over drained and burnt peatland. The drop happen just follow significant lowering of the water table (Fig. .3 a). This anomaly is hard to explain but it may be attributed to a sharp increase in decaying process of wood remnants below the surface by termites during the low water table period.

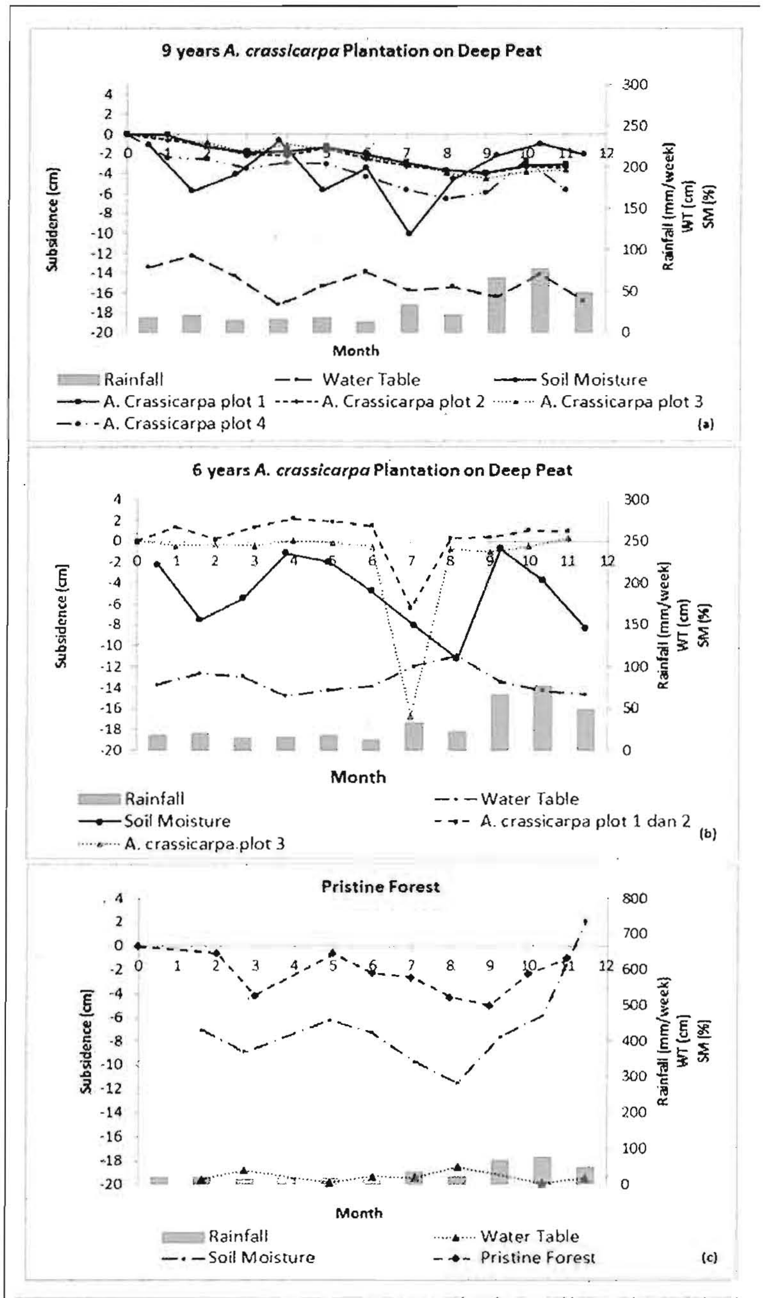

Figure 1. One year subsidence monitoring on *A. crassicarpa* planted deep peat and of adjacent pristine forest.

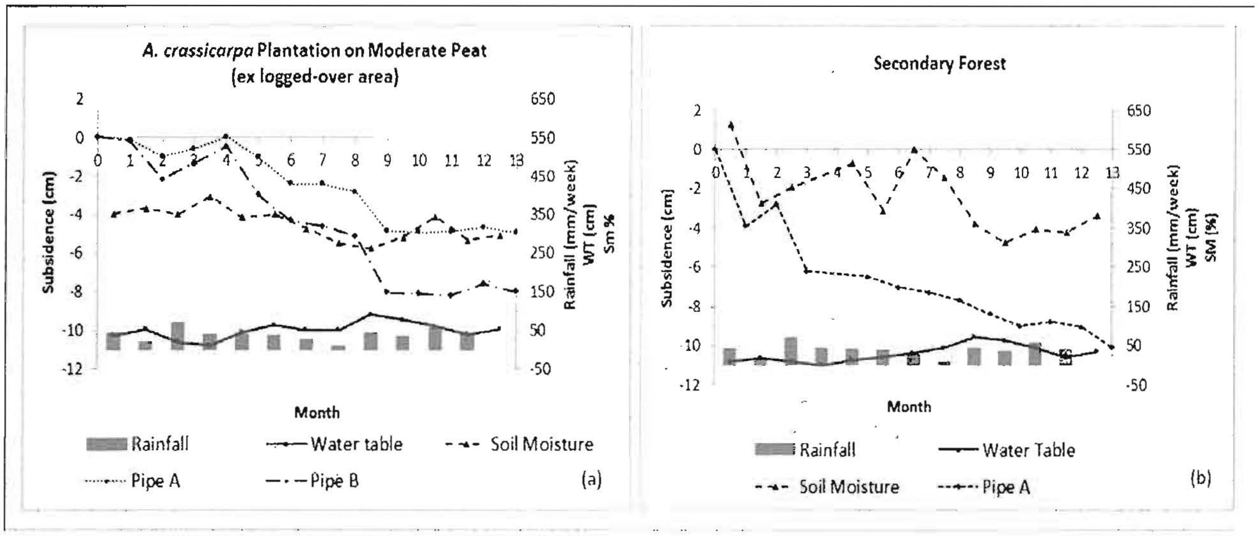

Figure 2. One year subsidence monitoring on *A. crassicarpa* planted moderate peat and of adjacent secondary forest (ex logged-over area).

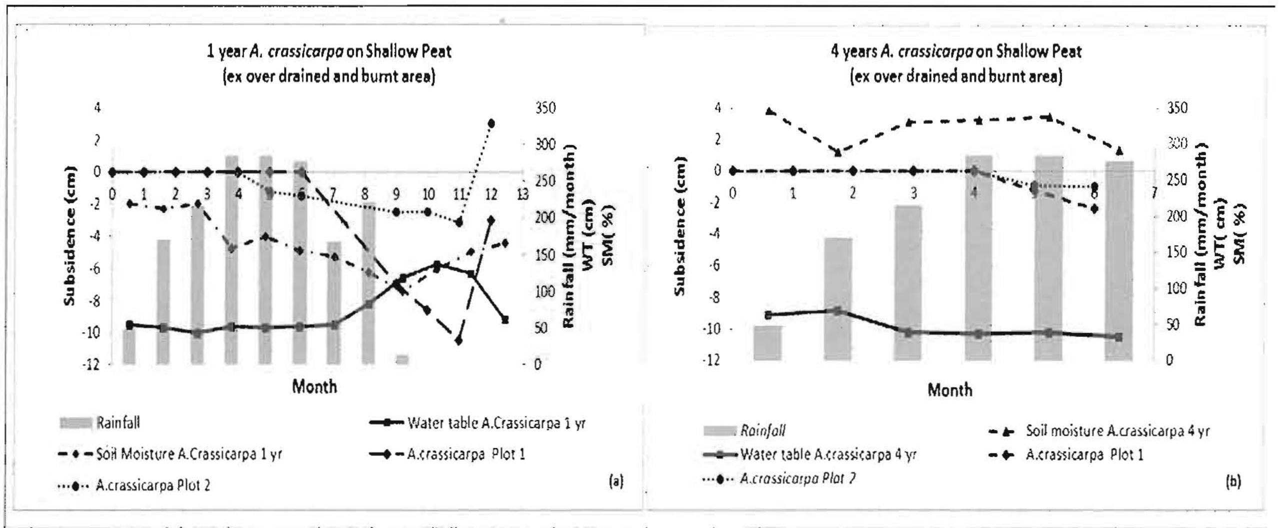

Figure 3. One year subsidence monitoring on *A. crassicarpa* planted shallow peat (ex over drained and burnt area).

The alternate rising and lowering of the surface level is also detected in Fig. 2 and 3. This fact brings a difficulty in correlating the extent of subsidence over a period with the controlling factors including the decomposition.

Results of depth BD measurement and fractionation of the peat particle size are presented in Fig 4 and 5. In general, the data show that BD values of the upper parts are higher than those of the lower parts. Similar trend is found for the particle size. Fig. 4 and 5, however, show that values of BD does not necessarily correspond with the particle size of the respective depth, in that there were found that in some cases BD values differ significantly between depths having similar particle size distribution and also that similar BD values were found at depths with differing particle size distribution.

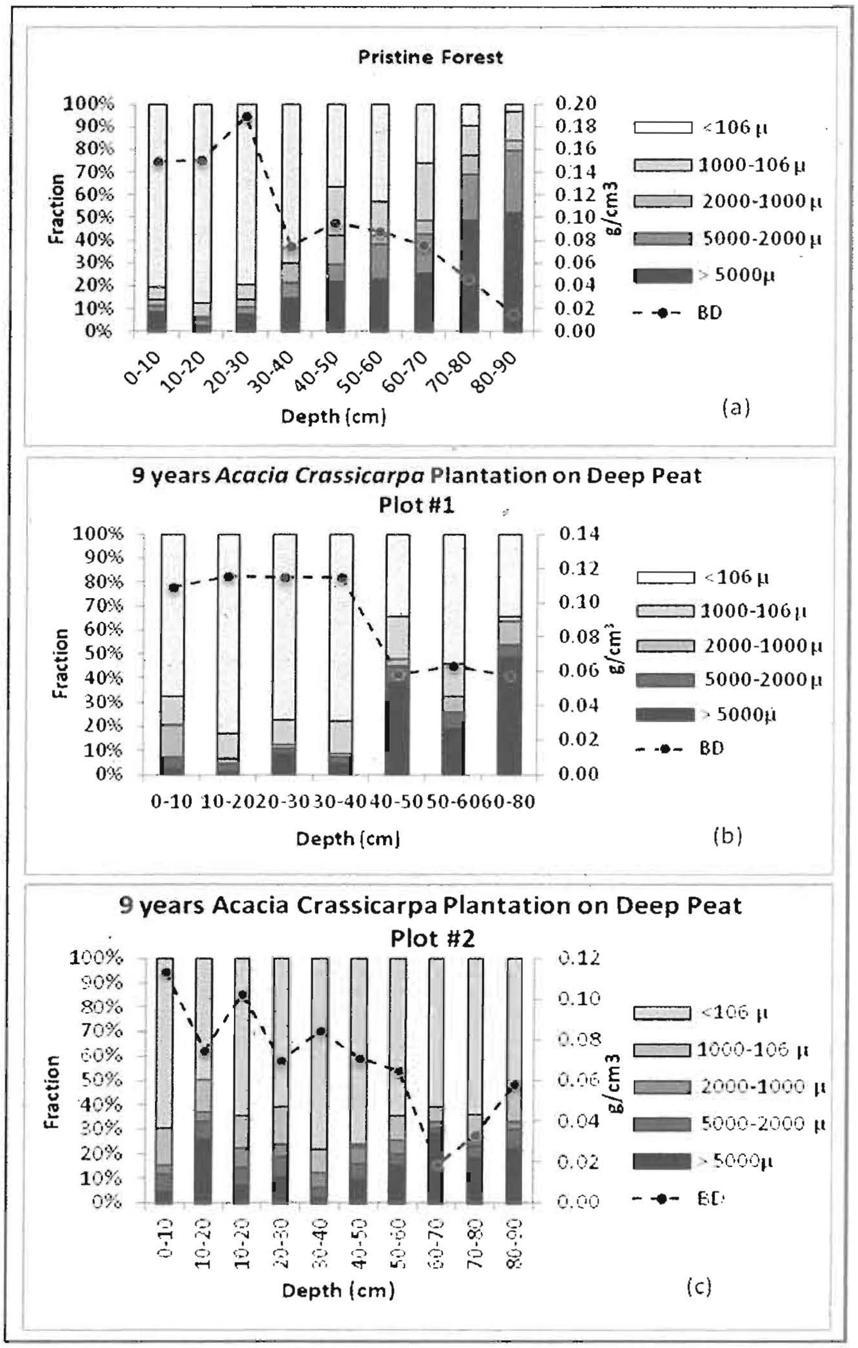

Figure 4. Bulk density and particle size fraction of *A. crassicarpa* planted deep peat and of adjacent pristine forest.

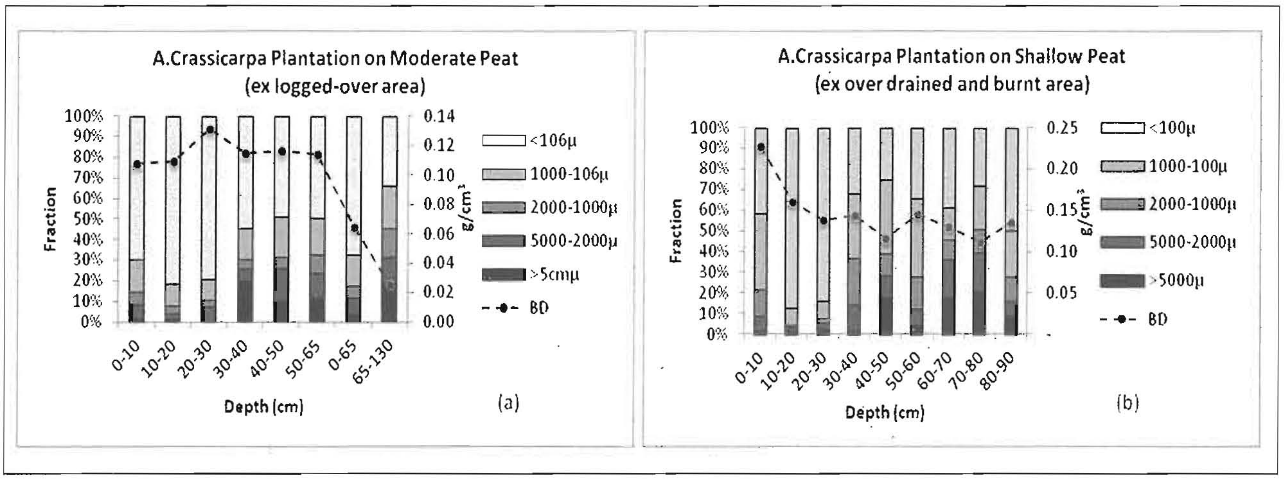

Figure 5. Bulk density and particle size fraction of *A. crassicarpa* planted moderate and shallow peat.

Fig. 4 shows that BD values of the upper parts of the pristine forest plot are about 0.16-0.20 g cm^{-3} that is higher than that of the plots of the *A. crassicarpa*. The reason is unclear but strongly indicates that interpretation of BD values of peatlands with respect to compaction cannot be straightforward but need to check for historical disturbance or change to the lands. The use of mathematical formulation such as shown in Hooijer *et al.* (2011) to calculate compaction using difference of BD values between the upper and the lower parts would, therefore, be uncertain.

CONCLUSION

The subsidence rate during the year was found to be uncertain since the land surfaces was found to alternately rise and down.

Peat materials above the water table are dominated by fine fractions that in general corresponded with higher bulk density but the higher bulk density is difficult to be straightforwardly interpreted as an indication of compaction, because it depend on the historical change of the peatlands.

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