ESTIMATING DBH OF COMMERCIAL TREES FROM STUMP MEASUREMENTS IN MALINAU, EAST KALIMANTAN

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Changes in the system of forest harvest have potentially important implications for the future extent and quality of natural forest resources. Throughout the Malinau district in East Kalimantan there is intensive harvesting of timber from natural forest. It is important for planners and managers in such regions to be able to estimate quantities and proportions of wood volume or tree biomass extraction from particular forest stands over a certain time period. One way of calculating harvest removals is to estimate volume/biomass from cut stumps. To estimate biomass extractions, if quantitative relationships between stump measurements and reference diameter of trees have not been established previously, measurements made on stumps will be limited to the use of analytical techniques that involve counts and frequencies. Pre-existing variables such as basal area, volume or aboveground biomass cannot be estimated from stump measurements in such cases. Tree diameters at some reference stem height are necessary for computing important tree variables such as basal area, volume and aboveground biomass (Chhetri & Fowler 1996). Diameter at breast height (dbh) is the most commonly used reference diameter and it is measured at 1.37 m above the ground in the USA and Canada, and 1.30 m in countries using metric system (Köhl 1993).

Studies predicting dbh from stump height measurements are numerous (Bylin 1982), but none had been conducted in the Malinau district. This paper will present prediction models for (1) commercial dipterocarps, (2) commercial non-dipterocarps, and (3) a general model for all commercial trees in the Malinau district.

The objective of this study was to develop a relationship between stump height and dbh in order to predict dbh from diameter at estimated stump height (dsh) for those species being harvested. The data used in this study was collected from three separate concession holders, namely, Intracawood Manufacturing, Malinau Jayasakti and Wanabakti in the Malinau district, East Kalimantan. The forest type is predominantly primary lowland and submontane forest, dominated by dipterocarps. The elevation range is between 100 and 200 m asl. The data for this paper forms part of a larger study investigating harvest management, and will later be used to estimate biomass removal.

Diameter and stump height were measured using a diameter tape to the nearest centimetre. Stump height was measured from the ground to the basal position on the main stem where the tree was cut. Analysis of stump height data (170 samples) established the mean stump height for the study area, 111 cm (Table 1). This figure was then used to measure dsh and dbh for a total 800 trees. The number of samples in each group ranged from 194 for Meranti Merah to single individuals (Table 2). The samples have been grouped by trade name (Kebler 2000) and divided into dipterocarp and non-dipterocarp groups. Groups having less than 15 individuals each were pooled together as one. General linear model equations in SYSTAT version 6.0 statistical software were used to develop relationships between dbh and dsh. The coefficients for determining dbh ranged between 0.96 and 0.99 (Table 3). These values and the low standard deviation results of the estimates indicate that these models should have a high degree of accuracy in predicting dbh.

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Table 1 Statistical descriptions for selected parameters of stumps

Description /location	INT	MJS	WNB	ALL
Number of samples	50	70	50	170
Diameter inside bark (cm)				
Minimum	35	40	30	30
Maximum	150	150	115	150
Mean	77	76	61	72
Standard deviation	23.1	22.1	20.2	22.7
Height (cm)				
Minimum	70	66	70	66
Maximum	170	170	160	170
Mean	113	110	110	111
Standard deviation	35.0	21.4	22.3	22.9

Note: INT = Intracawood Manufacturing, MJS = Malinau Jayasakti , WNB = Wanabakti

Table 2 Number of samples (total percentages), dbh and dsh means and ranges

Family /trade name	No. samples	Per cent	Dbh (cm)		Dsh (cm)	
			Mean	Range	Mean	Range
Dipterocarp						
Bengkirai	17	2.1	54	21–94	55	22–96
Keruing	187	23.4	42	17–114	43	18–120
Meranti kuning	81	10.1	41	19–99	42	19–103
Meranti merah	196	24.5	43	18–125	44	18–130
Meranti putih	141	17.6	42	16–101	43	17–105
Tengkawang	56	7.0	50	23–108	52	23–112
Others	15	1.9	40	23–73	42	24–73
All dipterocarps	693	86.6	43	16–125	44	17–130
Non-dipterocarp						
Dara-dara	18	2.3	35	25–56	35	25–51
Nyatoh	16	2.0	40	21–55	40	21–56
Ulin	22	2.7	41	21–92	42	21–94
Others	51	6.4	46	19–101	47	20–102
All non-dipterocarps	107	13.4	42	19–101	43	20–102
All family	800	100	43	16–125	44	17–130

It should be noted, however, that the mean stump height for this study is higher than those reported by Bylin (1982) and Chhetri and Fowler (1996). There are a number of possible reasons for this: (1) Tall buttress roots; a large proportion of the sampled trees had tall buttress roots. It was found that chainsaw operators cut higher up the trunk in order to avoid them. (2) Uneven topography in the study site. We found that trees were cut higher up the trunk on steep sided slopes. (3) Illegal logging activities may also contribute; people participating in such activities tend to be less interested in systematic harvesting at regular heights (Chhetri & Fowler 1996). (4) The data for this study was collected from cut blocks along roads and skid trails. Stumps along the road tended to be taller as they were cut to clear land or to be used for building material rather than for timber.

Table 3 Coefficients (b_0 and b_1), standard error (SE) and multiple R squared (R^2) of predicting dbh from dsh (Dbh = $b_0 + b_1 \times$ dsh)

Family/trade name	No. samples	b_0	b_1	SE	R^2
Dipterocarp					
Bengkirai	17	0.753	0.955	1.770	0.994
Keruing	187	0.745	0.960	0.822	0.997
Meranti kuning	81	0.802	0.959	0.914	0.997
Meranti merah	196	0.482	0.968	0.868	0.998
Meranti putih	141	0.559	0.965	0.793	0.997
Tengkawang	56	0.500	0.969	0.762	0.989
Others	15	- 0.761	0.999	0.621	0.988
All dipterocarps	693	0.581	0.964	0.867	0.997
Non-dipterocarp					
Dara-dara	18	0.802	0.955	0.670	0.993
Nyatoh	16	- 0.318	0.988	0.482	0.998
Ulin	22	- 0.138	0.973	0.758	0.997
Others	51	0.140	0.973	0.769	0.998
All non-dipterocarps	107	0.068	0.975	0.718	0.998
All family	800	0.518	0.966	0.850	0.998

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