



**UNIVERSITI PUTRA MALAYSIA**

**DEVELOPMENT OF SIMPLE EQUATIONS TO ESTIMATE  
NET RAINFALL UNDER CLOSED TREE CANOPIES**

**CHONG SIAM YEE**

**FP 2012 54**

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ESTIMATE NET RAINFALL UNDER CLOSED  
TREE CANOPIES**



**CHONG SIAM YEE**

**MASTER OF SCIENCE**

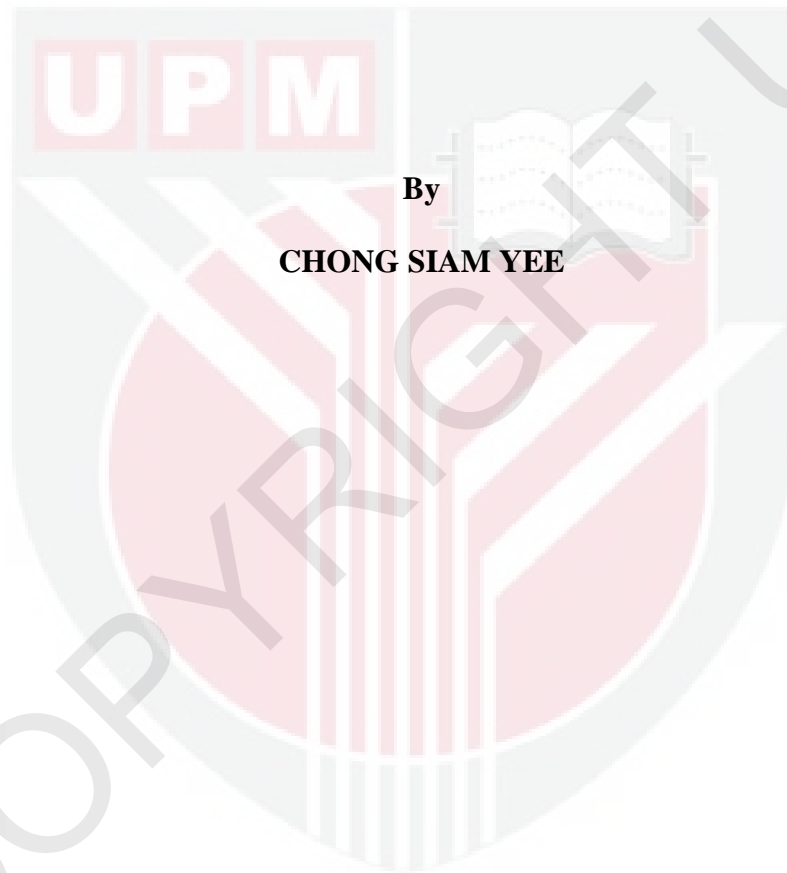
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**By**

**CHONG SIAM YEE**



**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,  
in Fulfilment of the Requirements for the Degree of Master of Science**

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**DEDICATION**

**SPECIAL DEDICATION TO MY BELOVED PARENTS AND SIBLINGS**



Abstract of thesis presented to the Senate of Universiti Putra Malaysia  
in fulfilment of the requirement for the degree of Master of Science

**DEVELOPMENT OF SIMPLE EQUATIONS TO ESTIMATE NET  
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By

**CHONG SIAM YEE**

**December 2012**

**Chairman: Christopher Teh Boon Sung, PhD**

**Faculty: Agriculture**

Many interception models have been developed. These models, however, are complex, data-demanding, and often usable only for a specific vegetation type. The focus of this study was to develop and validate a two- and a three-coefficient equation for full canopies for oil palm, rubber, and pine trees. Throughfall and stemflow data from seven past studies were used to determine the best-fit coefficients for the two equations. The three-coefficient equation was  $P_n = P_g \times \exp[-(0.3443 - (P_g / (58.9748 + P_g)) \times 0.1639)]$  and the two-coefficient equation was  $P_n = 0.7724 \times P_g - 0.5845$  ( $R^2 = 0.91$ ), where  $P_n$  and  $P_g$  are net and gross rainfall, respectively. To validate these two equations, field data were collected. Rain gauges were used for rainfall measurement and recorded in five minutes interval by data loggers. Ten rain gauges were used for throughfall measurement and arranged along the North-South direction with a 10-m interval. Three sampled trees were selected randomly for stemflow measurement and one rain gauge was installed at a nearby open area. Two error indexes were used as a goodness-of-fit measure, namely: index of agreement and normalized mean absolute error. Results showed that both the two-

and three-coefficient equations performed nearly equally well. The equations predicted net rainfall with errors between 12 to 23% (ranked as “Fair” to “Good” in terms of overall equation accuracy) and with an index of agreement of more than 90%. Results showed that these two equations can be used with fairly accurate estimations of throughfall and net rainfall, and, to a lesser degree, stemflow. The estimation errors were most probably because the canopy and rainfall characteristics were not taken into account in the two equations.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

**PEMBANGUNAN PERSAMAAN UNTUK MENGANGGAR HUJAN BERSIH  
DI BAWAH KANOPI POKOK TERTUTUP**

Oleh

**CHONG SIAM YEE**

**December 2012**

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Terdapat banyak model hujan yang telah dibangunkan. Kebanyakan model melibatkan banyak parameter, kompleks dan hanya boleh digunakan untuk jenis tumbuh-tumbuhan tertentu. Tumpuan kajian ini adalah untuk membangun dan mengesah persamaan dua dan tiga pekali hujan bersih (hujan bersih = hujan berkesan - aliran terus - aliran batang) bagi pokok kelapa sawit, getah and pain yang kanopinya hampir tutup atau tutup sepenuhnya. Data aliran terus dan aliran batang dari tujuh kajian sebelumnya diguna untuk penyuaian pekali kedua-dua persamaan ini. Persama tiga pekali ialah  $P_n = P_g \times \exp [-(0.3443 - (P_g / (58.9748 + P_g)) \times 0.1639)]$  dan persamaan dua pekali ialah  $P_n = 0.7724 P_g - 0.5845$  ( $R^2 = 0.91$ ), dimana  $P_n$  dan  $P_g$  masing-masing ialah hujan bersih dan hujan berkesan. Untuk mengesahkan kedua-dua persamaan ini, kajian ladang dijalankan. Tolok hujan digunakan untuk menyukat air hujan dan dicatatkan selang lima minit oleh data logger. Sepuluh buah tolok hujan digunakan untuk menyukat aliran terus dan disusun mengikut arah Utara-Selatan dengan selang jarak 10 m. Tiga pohon pokok dipilih secara rawak untuk sukat aliran batang dan sebuah tolok hujan diletakan di kawasan



lapang yang berhampiran. Terdapat dua indeks ralat digunakan bagi kedua-dua persamaan ini, iaitu *index of agreement* dan *normalized mean absolute error*. Hasil kajian ini menunjukkan bahawa persamaan dua dan tiga pekali menunjukkan keputusan yang hampir sama. Kedua-dua persamaan ini mempunyai *normalized mean absolute error* sebanyak 12 kepada 23% (kelas kejituan antara “Sederhana” dan “Baik”) dengan *index of agreement* melebihi 90%. Keputusan menunjukkan kedua-dua persamaan ini boleh digunakan dalam menganggar aliran terus dan hujan bersih dengan agak tepat dan kurang tepat untuk aliran batang. Ralat penganggaran persamaan mungkin disebabkan ciri-ciri kanopi dan hujan tidak diambil kira dalam kedua-dua persamaan ini.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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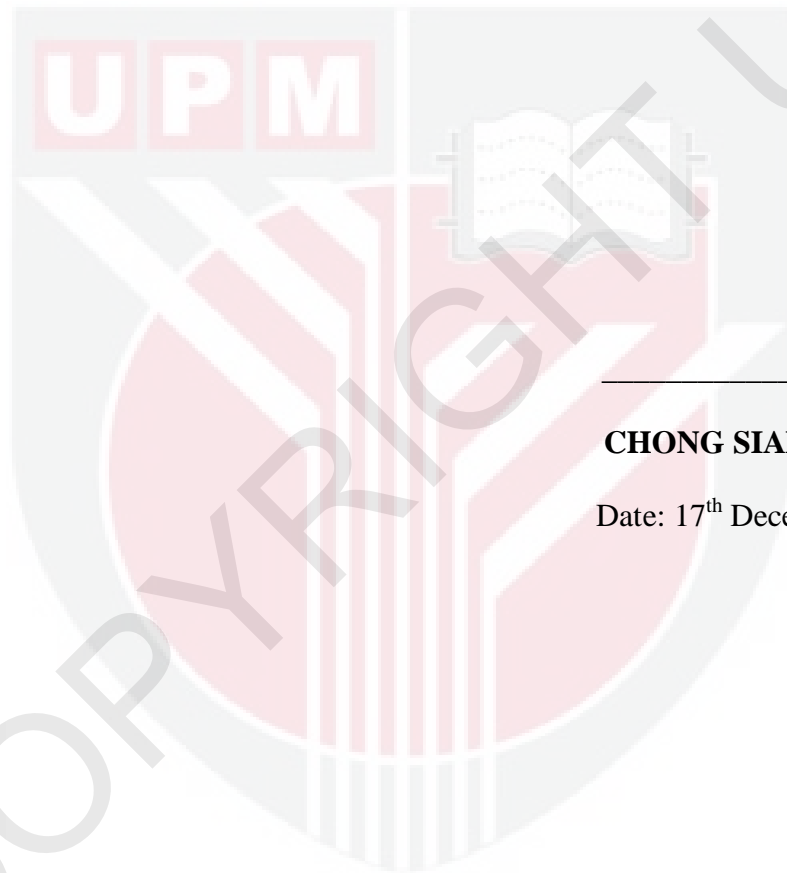
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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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**CHONG SIAM YEE**

Date: 17<sup>th</sup> December 2012

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