

UNIVERSITI TEKNOLOGI MALAYSIA

BORANG PENGESAHAN STATUS TESIS ♦

JUDUL: COMPARISON OF EVAPOTRANSPIRATION MODELS
FOR A TROPICAL FOREST CATCHMENT
 SESI PENGAJIAN: 2005 / 2006

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CHAPTER 1

INTRODUCTION

The term evapotranspiration is the combination processes of evaporation from soil, open-water, vegetations and wet canopy and transpiration from plants. It is usually abbreviated as ET. It describes the transfer process of water to the atmosphere as water vapour. Evaporation is a process where water evaporates from any source of moist surface to the air and it will proceed until the air is saturated with moisture. Free-water evaporation is only a part of process that contributes water to the atmosphere. Living vegetation is continuously transferring water from the ground to the atmosphere through a process called transpiration.

A large number of studies related to ET have been conducted ranging from individual plants, soil samples and even the entire watersheds to estimate a kind of potential ET (PET) from climatic and land use data and convert this to the actual ET (AET) (Linsley,1998). Unfortunately, this parameter is very difficult to be measured directly in the field.

The multiple effects of climate change have led to the difficulty to predict how much the water is actually evaporated to the atmosphere as water vapour. Thus, in order to ensure that the occurrence of ET has good interrelationships and keep balancing with other processes in the hydrological cycle, an in-depth knowledge of all the terms of the water balance is essential. From here, it cannot be denied that ET has become one of the most important aspects of water balance.

1.1 Background of Study

The term evapotranspiration, ET comes from the combination of the prefix “evapo” (for soil evaporation) with the word transpiration. ET is the second largest hydrologic component of the water budget after the precipitation. According to Sun (2005), ET makes up 64% of the total rainfall on global scale and followed by runoff which is produced by the remaining 36% of the rainfall. Approximately 75% of the annual precipitation over the North American continent is returned to the atmosphere in gaseous form (Gray, 1970). Similarly, results from the Loweo Catchment in the Yangambi Forest Reserve in Zaire showed that ET accounted for 63 % of the rainfall in the basin with rainfall of 1500mm (Oyebande, 1988).

Evaporation normally takes place from open water, soil, vegetation and wet canopy whereas transpiration is contributed by the natural growing plants. Evaporation from bare ground may be intense but the vaporized moisture can be rapidly decline without new rainfall. This kind of evaporation is a short term phenomena. In contrast, a dense tropical forest, mostly occupied by deep-rooted trees can continue to transpire water from deeper soil layers (Oyebande, 1988). Lomee, (1961) found that there is available soil moisture at 4.2 m depth below the forest in Java and in the Congo Basin, soil moisture is still available between 1.23 m and 1.51 m under forest ground. Thus, it implies that forest serves as an important source of water vapour since it transpires water in larger quantities compare to other types of vegetation.

Forests cover approximately one-third of the land surface of the earth and approximately 10% of the entire surface of the globe (Baumgartner,1979). Generally, the tropical forests occur in three regions: the Latin American, African and Indo-Malayan region (Oyebande, 1988). Most of the tropical rain forests consist of some unique characteristics such as low albedo, high rates of evapotranspiration, high nutrient cycling and large water holding capacity of soils (Carlos,1990).

The assessment of ET has been widely studied and applied in Japan due to its important role in water management. Two thirds of Japan is still covered by forest, and 41% of it is plantation forest (Japan FAO Association, 1997). Timber industry was a major contributor to Japan economic growth. However, since imported timbers are available at lower price, the monetary value of local timber in Japan is no longer maintained at good market selling price. On the other hand, it is necessary for the government to provide stable water supply to meet the social demand. This phenomenon initiated the government to change the industry pattern from timber production to soil and water conservation. Therefore, reassessment of forest management practices in Japan is essential to determine the most excellent way to ensure sufficient and stable water supply. In order to implement the new policy successfully, ET has become the primary parameter to be considered since it has the superior capability in water conservation management. An ET research has been conducted at Hitachi Ohta Experimental Watershed which is located on the Pacific coast of eastern Japan. The research indirectly implies that ET may become a very useful aspect which can be looked into in dealing with water conservation matter (Murakami, 2000).

In the Amazon forest, deforestation has been found to impose deep impact on ET. Deforestation is described as a large-scale conversion of tropical forests into pastures or annual crops. Several resources estimate deforestation rates for the Brazilian Amazonia are between 30000 and 45000 km² per year under rapid progress (Fearnside, 1989). If the deforestation is to be continued at this rate, the Amazonian tropical forest will disappear within 50 to 100 years. The removal of forests will lead to changes in the regional climate. ET might be reduced due to the less radiative energy at the canopy level since grass presents a higher albedo than forest (Clark et al., 1989). Moreover, ET is expected to reduce due to the deficit of soil moisture at the rooting zone primarily during the dry season.

Management of forest is much less intensive than management of agricultural crops. Therefore, forest will be more directly influenced by the variations of climate. Although during the last decade a large number of studies have been conducted, it is still difficult to quantify ET from such a complex forest ecosystem.

1.2 OBJECTIVES OF STUDY

1. To estimate the evapotranspiration (ET) from a tropical rain forests catchments using selected evapotranspiration models.
2. To compare the predicted evapotranspiration (ET) with the observed value which is water balance method.

1.3 SCOPES OF STUDY

This study use secondary data from forest which is Bukit Tarek Forest Reserved in Selangor, Peninsular Malaysia. This dissertation consists of five distinct chapters, each covering a specific topic:

- **Chapter 1:**

A brief introduction of ET process will be given. Some related issues, researches, studies or articles on ET in other countries are discussed. Objectives of the study are determined and lastly the general scopes from the beginning of the study until the completion of the thesis are stated.

- **Chapter 2:**

A literature review based on the findings and information obtained from various sources of reading materials such as journals, related reference books, articles and reports of studies or research. Literature review consists of the forest hydrological cycle, concepts of forest evapotranspiration, factors affecting forest evapotranspiration and methods of forest evapotranspiration measurement.

- **Chapter 3:**

Approach and methodology of this study is discussed in this chapter. Firstly, site description and data sources are briefly discussed. Then it is followed by the discussion on the selected empirical models. The selection of the empirical model is based on the availability of climatic and land use data obtained from the Forest Research Institute Malaysia (FRIM).

- **Chapter 4:**

This chapter begins with data analysis and followed by the calculations of ET rates. Observed results are then compared with the predicted result to evaluate the accuracy of each model. Relevant graphs are plotted if necessary in order to present the results in more unambiguous manner. Finally, this chapter discusses results of both observed and predicted ET.

- **Chapter 5:**

Conclusion is drawn in the last chapter. The most accurate method in determining the ET of the study is defined.