Field measurement of transpiration from a mango tree

Saitama University	Member of JSCE	AYE AYE THANT
Saitama University	Member of JSCE	KUNIO WATANABE
Thammasat University		KHANCHAI CHAICHAN
Thammasat University		KRITTIYA LERTOPOCASOMBAT
Saitama University	Member of JSCE	KYI MYINT THWIN

Abstract

Total transpiration from a big tree is an important information for evaluating the pollutant migration in shallow ground, runoff phenomenon in mountainous area, water demand in irrigation and so forth. A new technique for estimating the total transpiration from a tree is proposed in this paper with some results of field measurement carried out in the campus of the Thammasat University, Thailand.

1. Introduction

Pollutants in shallow underground are essentially migrating by the water movement induced by the evapo-transpiration and the gravitational force. Unsaturated ground water flow is commonly dominating in shallow underground. The evapo-transpiration rate from bare soil and plants must be precisely estimated for analyzing the migration. Also, the transpiration is an essential information in any irrigation plan. However, the technique for the direct measurement of transpiration from a tree is not established yet. In this study, the total transpiration from a mango tree of which height is around 5 m, was estimated by using the two-sensor type evaporation meter.

2. Technique proposed and used in field

The technique and procedure proposed in this study are schematically shown in Fig.1. Transpiration from many leaves of a tree is measured by using the two-sensor type evaporation meter and the average transpiration value (Atr) is estimated. Then, the total area of leaves is estimated by the following procedure. At first, a steel bar is standing vertically at many locations under the tree and number of leaves intersecting the bar is measured. Then the average number of leaves (N1) covering one point is calculated. When the projected area of tree (Ar) is estimated, total area of leaves can be expressed as N1. The total transpiration from a tree (Ttr) can be simply calculated by the following equation;

$$Ttr = Atr \,.\, N1.\, Ar \quad -- \quad (1)$$

In general, transpiration is occuring from the backside of leaf except for special trees. When the transpiration is occuring from both front and backsides of leaf, total transpiration is the double of Ttr in equation (1).

3. Field measurement and the results

A transpiration measurement campaign was carried out during 12:00-14:00 in 16 April 2000 at a yard of the Rangsit Campus of the Thammasat University, Thailand. A mango tree of which height is about 5 m was selected for the measurement. Prior to the measurement, it was observed that transpiration occurred only on the backside of leaf. Figure 2 illustrated the projected area of the tree. The total area (Ar) was about 8.6 m^2. The numbers of leaves intercepting a vertical steel bar were measured at different 19 points. The average number of leaves (N1) was 5.9. 24 leaves were selected for the measurement. Wind was carefully protected with covering leaves by a transparent plastic sheet. Figure 3 displays the transpiration distribution obtained. The distribution is scattered because the transpiration from leaves was much influenced by the age of leaf and the radiation condition. The average transpiration was about 70 mg/m2/s under sunshine condition. On the other hand, the average transpiration in shadow area was about 20 mg/m2/s. Those influences must be studied in detail. Although those problems still remained, the average transpiration rate was roughly calculated as 48.12 $mg/m^2/s$. With inputting those values into equation (1), the total transpiration from this mango tree can be estimated as 2.44 g/s (8.78 l/hour) or 1.00 mm/hour. These values are thought to be reasonable under the natural condition. It was found that the measurement procedure is simple and highly practical.

Key words: two-sensor type evaporation meter, transpiration and field measurement
Address: Geo-sphere Research Institute of Saitama University, Graduate School of Science and Engineering, Saitama University. 255, Shimo-okubo, Urawa-shi, Saitama ken. 338-8570 Japan.

4. Conclusion and future problems

A practical method how to estimate the transpiration from a tree in field can be proposed. However, there remain some problems. As the transpiration is affected by the radiation condition and the age of leaf, so that more reliable technique how to estimate the average transpiration from leaves must be studied. Effect of wind on the measurement must be also evaluated. These problems will be studied in near future.

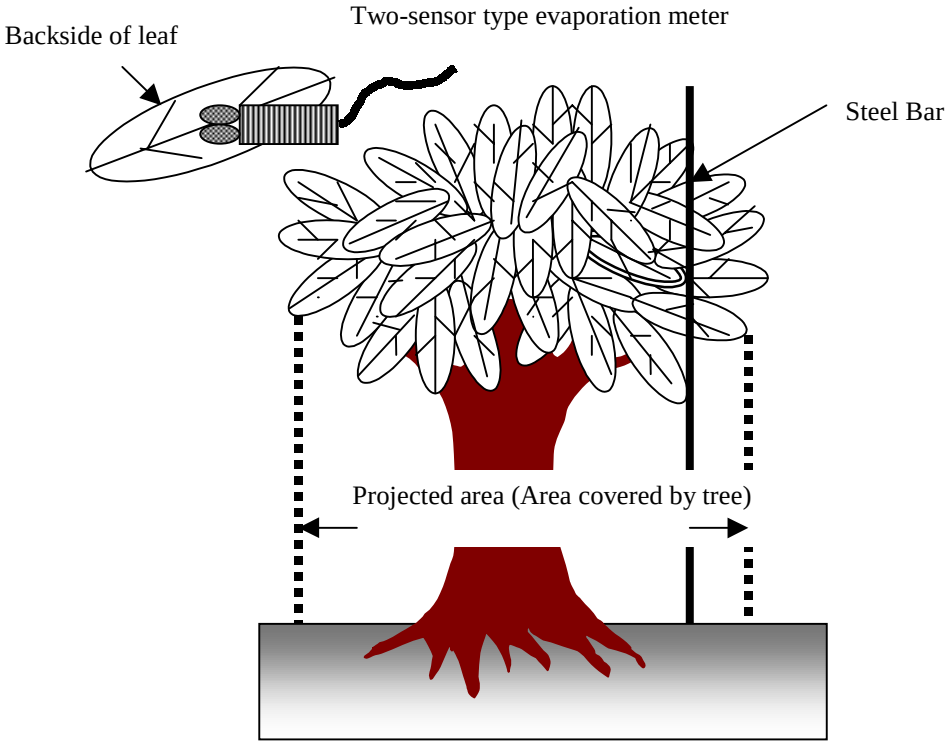

Figure 1 Schematic presentation of the transpiration measurement

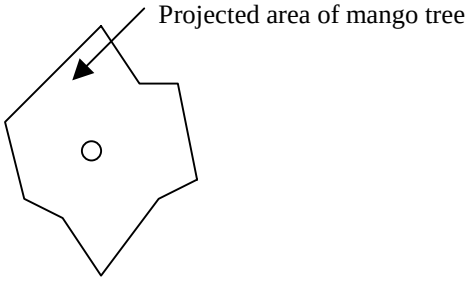

Figure 2 Projected area of a mango tree

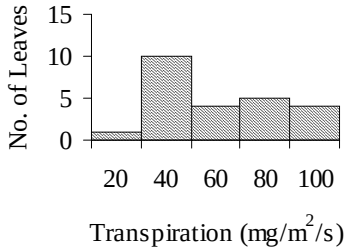

Figure 3 Transpiration distribution

Reference
1) Watanabe, K.et.al; Evapotranspiration measurements in the Thammasat University Rangist Campus, Tentative Report 1999.
2) Kyi Myint Thwin. et.al; Transpiration measurement from plant leaf by using two-sensor type evaporation meter