Crop water requirement calculations of Longan (Dimorcapus longan L.) in Nawungan Orchard, Selopamioro Village, Imogiri Sub-District, Bantul, D.I. Yogyakarta

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Abstract. This research was aimed to measure actual evapotranspiration, to determine of water requirement and crop coefficient (Kc) of longan (Dimorcapus longan Lour.) was cultivated in Longan Nawungan orchard, Selopamioro Village, Imogiri Sub-district. Plot scale of water balance was applied to determine ETa, with input components were rainfall and irrigation, while output were ETa, water storage (ΔSM), and surface runoff (SRO). Components of runoff was measured using tank and the moisture content was measured using gravimetry method. Automatic weather station was installed in Nawungan orchard to record rainfall, wind speed, air humidity, and intensity of solar radiation. Later, the climatic data were used to calculate the reference evapotranspiration (ETo) using Penman-Monteith method. Due to agroforestry and mix cropping system, longan trees were cultivated among seasonal crops and other trees, then the dual crop coefficient (Kc) was preferred. During February-Maret 2019, the value of rainfall and surface runoff were 640 mm during observation period and 0.08 mm, respectively. The reference evapotranspiration (ETo) and actual evapotranspiration (ETa) were 5.76 mm/day and 7.90 mm/day, respectively. The crop coefficient of longan in the site study area was 0.30.

1. Introduction

Dimocarpus longan Lour. known locally Longan is one of the crops with good prospects, can be seen from the needs of the fruit in Indonesia reached 29 thousand tons in 2012 [1]. Longan (Dimocarpus longan Lour.) is not native to Indonesia, but originated from China, so the plants belonging subtropics [2]. Longan in Indonesia has been quite a long time and there are several varieties cultivated among others: local longan, Pingpong, and Diamond River of Vietnam, Itoh from Thailand and Malaysia. In Indonesia, Longan is commonly found in Java in several districts, including Ambarawa, Magelang, Temanggung, Wonogiri in Central Java, and Tumpang in East Java [3]. Longan is able to bind water so well that crop water needs are met. Meeting the needs of the crop water use in precision farming system. Precision agriculture is an integrated farming system based on information and production, to increase efficiency, productivity and profitability of agricultural production from upstream to downstream sustainable, site-specific as well as minimizes the undesirable effects on the environment [4]. Precision approach to water supply timely and volume on horticultural crops is done taking into account the specific conditions of the land, soil moisture, soil type, and the planting period [5].
Irrigation is the provision and regulation of water to support agriculture that kind include surface irrigation, underground irrigation and irrigation pumps. The purpose irrigation drain water is regularly needed by plants when the soil moisture supply is not sufficient to support the growth of plants, so the plants can grow optimally. Irrigation scheduling important role in water management objectives effectively and efficiently in the process of agricultural production. Irrigation is one factor affecting the crop water needs. In addition, the climatic conditions and crop coefficient be other factors in determining crop water requirement [6].

Crop water requirement is the amount of water that plants need to form a network of plants, evaporated, percolation and soil tillage. Real water needs for agriculture business area includes evapotranspiration (ET), amount of water required for operation specifically as clearing land and water replacement, and loss during use [7]. With the value of evapotranspiration can be seen the value of crop coefficient (Kc). Kc is generally used to estimate the value of the ETc in a way be used as a multiplier of the value of potential evapotranspiration (ETo). In Longan crop, crop coefficient (Kc) there was not a valid information especially in Indonesia. In the Food and Agriculture Organization (FAO) has information related crop coefficient (Kc) of each species of plant in the world. Longan is not yet registered for the plant crop coefficient (Kc) for both tropical and subtropical countries. So from that need for research in finding a crop coefficient (Kc) Longan plant.

2. Methodology
The study was conducted in the area of Nawungan Orchard, Selopamioro Village, Imogiri, Bantul, which began November 2018 to March 2019. This study consisted of three phases, preparation, field data collection, and data processing. The determination of the parameters in this study using the basic guidelines of the book Food and Agriculture Organization (FAO) 56 and principles of the water balance. Methods of data collection, observation and identification of agro-climatic water balance, laboratory testing and documentation. Rainfall data from the last 10 available from the Institute for Water Resources Management (BPSDA) DIY, Barongan climate station, which is the closest climate station of the village Selopamioro. Garden microclimate data were collected by Automatic Weather Stations (AWS), levels of soil moisture was measured by taking soil samples in undisturbed around the plant roots longan using ring sampler, percolation was measured by using a double ring infiltrometer, and Surface Runoff (SRO) is measured by isolating the land, then placed the container in the form of a series of pipes and bucket. Data processing method using descriptive analysis of qualitative and quantitative through, evapotranspiration by the method of Penman-Monteith and water balance, Unit Land (SUL) obtained by overlaying map includes a map of the study area, a contour map, map of soil type and land use maps. Kc value calculated longan longan dual between plants and peanut planting in the garden because the system uses the technique of intercropping.

3. Results and Discussion
3.1. Research area
Selopamioro village located in Imogiri, Bantul, Yogyakarta (DIY). Selopamioro village has an area of 22.75 km² and is bordered by Sriharjo; Imogiri in the north, bordering Gunung Kidul regency in the south, border with the Village Mangunan; Dlingo sub-district in the east, and border with the Village Seloharjo; Pundong west. Geographically, the village is located at the position Selopamioro -7.951495° S / 110.392040° E [8]. Location of the study presented in Figure 1.
Longan orchards have a mean minimum temperature of 23°C, mean maximum air temperature of 32°C, the average wind speed 0.25 m.s\(^{-1}\), and an average of 90% RH. These conditions suit the requirements grow crops according to FAO, which is the optimum temperature 25-32°C, maximum wind speed of 0.85 m/s and a minimum of 40% RH. Plant Longan can be planted in areas with an annual rainfall between 1,000-3,000 mm by the number of dry months (<60 mm) as much as 3-6 months [3] so that the precipitation is in the Nawungan Orchard suitable for plant growth Longan. Longan block in the Orchard Nawungan have an average height of each tree ± 2-4 meters with a slope of 15-40° and has an area of 4,789 m\(^2\). Longan population which can be grown in the Orchard Nawungan as many as 52 trees. Based on the survey, Longan plants in the Orchard Nawungan grow well. At Longan block planted crops also a distraction, such as peanuts, peppers, and paddy. Planting of distraction depends farmers land owners. At the time of data collection, land planted with peanuts begin to grow (Figure 2). Land planted with red chili toward the harvest period (Figure 3) while land planted to paddy is at mid-season phase (Figure 4).

**Figure 1.** Administrative Map of Selopamioro

**Figure 2.** Longan block intercropping peanut plant
Longan in the Nawungan Orchard grown on soil type Mediterranean or Regosol. Mediterranean soil is limestone soil type of the result of weathering limestone (limestone). Mediterranean soil color tends to reddish brown and less fertile, suitable for planting crops, teak, tobacco, and cashew nuts. This land is spread on subhumid region, karst topography and volcanic slopes with an altitude below 400 m, which is in Nusa Tenggara, Maluku, and Central Java [9]. These soils are not in accordance with the plant Longan, Longan can cropped such as soil type Andosol, Vertisol, Lateral, or laterit [3]. The soil texture in the form of clay blocks classified Longan (clay) are presented in Table 1. Based on Table 1, the highest percentage of clay fraction and sand fraction is lowest. The land of the Mediterranean / Alfisol textured clay or clay loam, with some of the physical characteristics, namely the depth of solum moderate to shallow (90-200 cm), the structure of blocky angular, and has a neutral pH to slightly alkaline [10]. Identification of the soil texture on a Longan block accordance with the general nature of the land of the Mediterranean.

**Table 1. Classification of soil texture**

| Area          | Dust (%) | Clay (%) | Sand (%) | Classification |
|---------------|----------|----------|----------|----------------|
| On the slopes | 32.79    | 55.80    | 11.40    | clay           |
| Central slopes| 24.77    | 57.87    | 17.36    | clay           |
| Down slope    | 36.40    | 47.53    | 16.07    | clay           |

Source: Maharani, 2019

3.2. Water balance

3.2.1. Runoff surface. Rainfall occurred in Longan orchard obtained data from Automatic Weather Station (AWS) installed in the garden Longan. Surface runoff is part of the precipitation flows over the ground surface, occurs when rainfall exceeds the rate of infiltration. Values of surface runoff that occurs at the study site ranged from 0.015 to 0.128 mm / day. Surface runoff is obtained by installing eraser tool on the slopes of the top, middle and bottom to accommodate into the tank. Based on Figure 5, it is known that the greater the value of surface rainfall runoff that occur will be greater. Rainfall has an influence on the size of the surface flow. When rainfall is <5 mm there will be no surface runoff.
3.2.2. Water storage. Water storage in soil occurs due to the influence of the amount of rainfall. Based on Figure 6, an increase in moisture content due to the amount of rainfall that occurred. It also happens to surface runoff despite occur very little due to the soil types ahan Mediterranean / Alfisol. The land of the Mediterranean / Alfisol textured clay (clay) or clay dust (clay loam), with some of the physical characteristics, namely the depth of solum moderate to shallow (90-200 cm), the structure of blocky angular, and has a neutral pH to slightly alkaline [10]. With clay texture easy absorb water but when large rain occurs, the land will become saturated. Saturated soil can not store water in the soil resulting in decreased when the soil is no longer able to accommodate the water contained in the soil and the water becomes runoff.

3.3. Crop water requirement
3.3.1. Reference evapotranspiration. Based on Figure 7, it can be seen that the value of the reference evapotranspiration (ETo) fluctuate with time. ETo value that occurred ranged from 4.86 to 6.15 mm/day. The highest ETo value occurred on March 3, 2019 amounted to 6.15 mm/day and the lowest occurred on February 26, 2019 amounted to 4.86 mm/day. In February, the average value of ETo is happening in the amount of 5.78 mm/day, in March of 5.73 mm/day and an average value ETo during observation is
equal 5.76 mm/day. The value ET\textsubscript{o} influenced microclimate such as radiation, temperature, humidity and wind.

![Graph of ETo against time](image)

**Figure 7.** ETo against time

3.3.2. Actual evapotranspiration. In Figure 4.8 shows the graph of the relationship between ETA against time. ETA highest value occurred on March 2, 2019 at 10.02 mm / day lows occurred on March 5, 2019 of 5.50 mm / day based on Figure 4.8. The actual evapotranspiration value ETA average of 7.90 mm / day. The main factor in its favor is the value of moisture content and rainfall or irrigation. Because of these factors that can determine the value of actual evapotranspiration of the water balance equation. In addition, the water storage in the soil is influenced by the thickness of rainfall there surface percolation and runoff. In this study, percolation is used at 2.5 mm / day as a reference.

![Graph of ETa against time](image)

**Figure 8.** ETa against time

3.4. Crop coefficient (Kc)
Figure 9. The graph Kc Peanut, Rice and Longan against time

Peanuts are annuals with different Kc value corresponded to the age of the plant. At the beginning of the planting season Kc value will increase rapidly as the age of peanuts until it reaches a maximum point and decreased when approaching harvest. Peanut plants in the block Longan has entered middle age and at the end of the observation largely harvested peanuts. Based on Figure 4.9, Kc peanuts have the same pattern with the existing theory. In addition, the highest value of Kc peanuts 1.13 on February 21, 2019 and average value of Kc peanuts by 0.87. Another thing with rice, rice is a seasonal crop. Rice plant has an area of 705 m². Rice plants in the block Longan are at mid-age phase of the rice plant. Based on Figure 4.11, Kc fluctuated depending on climatic conditions. Kc value on all treatments are generally relatively low in the initial phase of the season and the crop development. This value is then increased in the mid-season phase and reaches a maximum value at the end of the phase. In the last phase (late season), the Kc value declined again. Kc same fluctuation pattern also occurred in other studies (Sofiyuddin et al., 2012). The highest rice Kc value of 0.26 on February 21, 2019 and average value of 0.20.

Longan is a subtropical plants that grow well in tropical climates and is a relatively new crop. Based on FAO No 56 of 1990, the value of Kc for fruit trees with plant height 2-4 meters value ranges between 0.40 to 0.75. This value is the Kc value fruit crops are generally grown in sub-tropical regions. In Figure 9, the value of Kc Longan in the Orchard Nawungan fluctuate over time. Longan Kc highest value of 0.39 on February 21, 2019 and average value of 0.30. Kc value obtained during the observation can be used as a reference for the planned provision of irrigation water to the plant Longan.

4. Conclusion
Reference evapotranspiration (ET₀) the study area was 5.74 mm / day, the actual crop water requirement (ETₐ) of the study area was 7.98 mm / day and Kc of longan was 0.301.

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