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Research Article

Monthly Water Balance Analysis at Palaran District-the Province of East Kalimantan

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Abstract

Agroclimate potential rainfall in research especially Palaran District, already to Carried out in two months. To Determine the length of growing periods Potentially, by means of monthly water balanced analysis. Rain fall in this area turn on 1450-2900 mm/year (average 2325 mm/year) with 140.5 rain day/year rain or average 12.4 days/month, have to Double Wave Rainfall Pattern (or C Rainfall pattern), in Rainfall Zone III.

Monthly water balanced analysis has surplus 439 mm/year and the length of growing seasons 365 days/year. With assumption that the danger of pest and pathogen can be overcame and good managing water irrigation, growing paddy can be done 2 or 3 times a year and upland food crops can be planted once a year.

Keywords: Water Balance; Agroclimate; Growing Season; Crops Pattern

Introduction

Climate resources are fundamental factors to consider in the development of the region, agricultural planning and water management. These resources have the diversity and dynamics are very high so unpredictable. Although statistically every region has a different climate patterns, but the extreme fluctuations that are easy-going, and often are beyond the tolerance of the plants so that their role as natural resource potential can be turned into obstacles and even threats. This would be especially felt by areas that do not have adequate irrigation facilities, so the rain is the main source of water to meet irrigation needs of agricultural lands. Thus, the existence and farming activities in these areas is very limited by the presence of rain by time and high rainfall.

The availability of water, mainly from rainfall is an important limiting factor for increase in the production of a plant. The water balance is a method that can be used to view the availability of ground water to plants at a specific time, so the water shortage for plants can be overcome or prevented e.g. by awarding the irrigation water on the number and the right time. The availability of ground water is becoming a very important thing to consider before commiting to cultivated crops. It can be concluded that the use of land that does not fit can lower productivity and quality of crop production, therefore the cropping pattern must be adjusted with the availability of ground water.

Analysis of water balance is an important tool to assess the current status and trends in water resource availability in an area over a specific period of time. Furthermore, water balance estimates streng then water management decision-making, by assessing and improving the validity of visions, scenarios and strategies. This study is the activity of collecting and utilization of climate resources in preparation for the monthly homeland to obtain information about the potential of the area and the potential growing season so that it can be used to encourage an increase in agricultural products and maximizing the potential of existing land use.

Materials and Methods

Research sites

This research was conducted by making use of climate data, especially rainfall and temperature the entire territory of the Palaran district. Palaran district is the gateway to the Samarinda City a re-

sult of the expansion of Samarinda Seberang district on 28 December 2012, its geographical position 117º0'0''-117º17'0'' EL dan 0º31'30' - 0º43'0'' Latitude.

Data collection and analysis of rainfall

The climate data used are rainfall and rainy days, evaporation, air temperature and air humidity are prepared monthly format from the district. and the Meteorological Station Temindung - Samarinda.

Analysis of water balance

Water Balance Land expressed in a form of integral equations to simplify some semblance of some researchers, so that the water balance of an area of land prepared according to the method Rules Book (Book Keeping), developed by Thornthwaite and Mather [1] in Nasir (1993), and can expressed in equation form:

R=ETA ± Δ KAT ±Li,

Where:

R = Rainfall

ETA = Actual evapotranspiration (≤ ETP)

Δ KAT = Change in soil water content

Li = Runoff (surplus and deficit depends on its value)

This land water balance analysis, calculation Evapotranspiration potential (ETP) using the formula of Thornthwaite [1] in Sosrodarsono and Takeda [2] as follows:

$$ETP\ i = 16 \times (10 \times Ti/I)^{a}$$

$$I = \sum_{i=1}^{12} (Ti/5)^{1.514}$$

$$a = 6.75 \times 10^{-7}\ I^{3} - 7.71 \times 10^{-5}\ I^{2} + 1.792 \times 10^{-2}\ I + 0.49239$$

Analysis of Growing Season

The length of the growing season can be determined based on the pattern of rainfall (monthly, monthly or weekly) by observing the beginning of the rainy season is determined that the period of the growing season are the periods when soil water content of not less than 50% of the water available Buckman and Brady (1969) in Sujalu [3].

Based on the calculation of the period of the beginning of the season is the "decade (the first month of the season cropping) that rainfall > 55 mm and was followed the next decade that rainfall ≥ 55 mm". As for determining the beginning of the growing season is done by using an approach. Period Effective Precipitation, namely "14-weeks moving average of the R/PE ≥ 0.75", and the beginning of the period is the weeks that the value of R/PE ± 0.5. Preparation of planting (including processing land) can be initiated when the value of R/PE 14-week average of ≥ 0.5 [4].

Results and Discussion

Palaran District

Palaran district a town in most its area in the City of Samarinda, the capital of the province of East kalimantan, is geographically located on the Equator with a position between these areas is at an altitude of 0 - 75 m above sea level. This area includes 5 villages ie Simpang Pasir, Handil Bhakti, Bantuas, Bukuan and Rawa Makmur wich is responsible for the overall management of the area is 221.29 km^2 its 28.46% of the town.

Based on the topography, then the territory of the Palaran district almost 65.27% lies at an elevation of 0-25 m above sea level, it is generally located near the Mahakam River.

No.	The Land Use Types	Area	
		(Hectares)	(%)
01.	Mixed Garden	6,051.60	27,35
02.	Wetland	2,967.50	13.41
03.	Plantation	6,691.72	30.24
04.	Settlements	4,983.28	22.52
05.	Industries	156.96	00.71
06.	Slough/swamp area	1.53	0.01
07.	Coal mining	1,277.41	04.76
Amount		22,129.00	100,00

Table 1: The Land Use Types at the Area Studied.

Figure 1: Maps of Samarinda City.

Analysis of rainfall data

As previously mentioned, the condition of rainfall data from various monitoring stations rainfall can be collected mostly incomplete. There are stations that have rainfall data with observations penjang period with complete data condition (data from meteorological stations BMG Temindung-Samarinda) da tone also rain station which contains only observational data in the short-term period at a time is not complete.

In the analysis of precipitation data should be obtained from the rain monitoring stations as much as possible with relatively the same amount of data and derived from observations in the long term, so that some stations that have too short observation data not used in the analysis. To obtain the data series rains were adequate in the long period of the same observations, should do the following things: for data that is empty (< 4 months within 1 year) replacement (generated) by using the value of the monthly average of the station than with rainfall data in the same months of rain monitoring stations are nearby.

In the analysis to determine the distribution patterns/distribution of rainfall is sampled rainfall data WKPP Lempake, based on the results of statistical analysis X^2 test at the level of 95%, it can be seen that rainfall this area has a pattern of Normal Distribution for known value of X^2 count (= 7:01) is smaller than X2 table at the 95% confidence interval (= 14:07). So, the analysis of the possibility of rain on a certain value can be calculated by using an approach by Normal Distribution.

Mean annual rainfall received by the various regions in Pasir District ranges from 1450 mm/year up to 2900 mm/year, rainfall annual average of 2325 mm/year with the number of rainy days on average 143.5 mm/year or 190 mm/month with the average number of rain days 11.9 mm/month. Monthly rainfall is highest in May (217 mm) by the number of rainy days as much as 14.5 mm/month or an average of 15.4 mm/day, the lowest rainfall occurs in August (119 mm) by the number of rainy days as much as 10.3 mm /month or an average of 11.6 mm/day. Analysis of rainfall in monthly sub-district of Kuala Rantau langsat, over a period of 37 years (1971-2008) shows that the average rainfall monthly ranges between 31 - 92 mm (Figure 1). This shows that quantitatively conditions of precipitation in the area of research is enabling for the development of food crops (needs water plant crops and rice is 2 - 5 mm/day).

Fluctuations in rainfall patterns describe the average monthly rainfall in a year, which is obtained by comparing the value of the average rainfall of the month with the average value of the intensity of rainfall, while the average rainfall intensity in question is dividing the annual cumulative rainfall at 12. Thus, obtained information District, Greeting categorized as Dual Pattern or Pattern Bimodel (Double wave) with the notation C (Figure 1). Conditions rainfall patterns illustrate that within a year this region has two periods of high rainfall (April-June and October-December) and two periods of low rainfall (February-March and July-September). And when referring to the classification Oldeman (1975), which is primarily intended for rice cultivation, the area experienced two periods of wet months with rainfall > 200 mm / month.

Soil water balance monthly

The results of the analysis of the physical properties of soil (dry land) until the effective rooting depth of 60 cm showed soil water content (in% by volume) at a rate of cumulative field capacity (KL) ranges from 27% - 34.2%, and at the level of permanent wilting point (TLP) ranging from 4.2% - 6.9%. This condition shows high recesses soil water content cumulative average up kedalama 60 cm at a rate KL of 148 mm, at a rate of TLP by 30 mm, thus the rate of Capacity Save Groundwater (Water Holding Capacity, WHC) by 118 mm and use referral of Richard and Richard (1975) in Pramudia and Estiningtyas (1996) content of Soil available Ait Optimum (Optimum KAT) to a depth of 60 cm by 59 mm (Table 1).

On the table shows that R (rainfall) cumulative monthly is always greater than the value of the ETP, these conditions also shows that the magnitude of ETA will always be equal to the value of ETP, these conditions also shows that the magnitude Eta will always be equal to the value of ETP, This condition shows that the soil water content in Sub Palaran both on dry land (and especially) in wetlands (paddy) is always able to meet the water needs of commodities including rice paddy fields cultivated throughout the growing period managed life. It also shows the actual status of ground water is always at the field capacity limit, but always there is a surplus, and there is no depletion of groundwater or APWL.

In dry conditions, the State of the balance of water in the monthly the research areas are have not experiencing water deficit. However, when linked to the availability of water for plants that dotted the decline between the capacity Permanent wilting point and airy, then the soil water conditions It is still above the condition of permanent wilting point. That means for the development of food

Month:	R (mm)	ETP (mm)	R-ETP (mm)	APWL (mm)	KAT (mm)	KAT Δ (mm)	ETA (mm)	Def. (mm)	Surpl. (mm)
January	195	119	76	0	148	0	119	0	76
February	145	118	27	0	148	0	118	0	27
March	168	127	41	0	148	0	127	0	41
April	138	124	14	0	148	0	124	0	14
May	217	113	14	0	148	0	113	0	14
June	189	113	76	0	148	0	113	0	76
July	131	120	11	0	148	0	120	0	11
August	119	119	0	0	148	0	119	0	0
September	127	124	3	0	148	0	124	0	3
October	155	113	42	0	148	0	113	0	42
November	165	112	53	0	148	0	112	0	53
December	204	122	82	0	148	0	122	0	82
Σ	1953	1514	439	0	-	0	1514	0	439

Table 2: Cumulative Monthly Water Balance.

Notes: R=Rainfall: ETP =Potential evapotranspiration; APWL= Accumulation Potential Water Loss; KAT=Content of Groundwater; ΔKAT=Changes in Soil Water Content; ETA=Actual evapotranspiration; Def.=Deficit; Surpl= Surplus.

crops, then on the dry season condition of research area can be planted along the years, but suggested planting food crops on the worst deficit condition to do the giving water for the plants so that the expected results are more optimal.

Based on the above data, Palaran District for the long years have surplus water as much as 439 mm/year. So it can be said that the farmland in the district requires the creation of more dams or procurement of drainage network. Therefore, these data can be used as a basis for planning and management of various activities, such as making a water dam (for water storage and distribution), which serves as a network of irrigation and the possibility of natural water utilization for a variety of other activities (Rao and Bhaskara. 2015; Mardawilis., *et al*, 2011).

And the provision of means of irrigation and drainage network that must consider the capacity that potentially flow will always occur in this region. At the same time, to examine the condition of water balance of this area, especially the surplus water (rain) owned this area, it is a potential and enable the development of irrigation farming land.

The water balance in the study area was analyzed through estimation of available water resources in the study area. Although the study area which the major water sources from rainfall-runoff through small streams, reservoirs and retention ponds were sufficient to cover water demand. So, the condition of the water balance in the region will greatly affect the downstream region, especially the city of Samarinda. Potential water balance in the form of surplus water will be more a threat to the capital of the province, because if not managed properly it will generate a flood and sediment material were carried through the process that results in erosion runoff.

Analysis Long planting season

By knowing the status of a regional water balance, it can be known directly cropping potential of the land. In principle, the potential of a land to be cultivated with various kinds of commodities related to the beginning and duration of the season cropping, cropping intensity, the type of commodity, cultivation techniques and crop yield potential is concerned [5]. Potential planting period is determined by the availability of groundwater obtained from ground water balance calculation. Under the given constraints FAO (1978) and Reddy (1983) concerning the determination of the growing season or planting season using the approach of the ratio between rainfall (CH) and potential evapotranspiration (ETP), in table 3 shows that the ratio CH/ETP turns always > 0.75 for the entire period measured, then this area.

Month	1	2	3	4	5	6	7	8	9	10	11	12
R	195	145	168	138	217	189	131	119	127	155	165	204
ETP	119	118	127	124	113	113	120	119	124	113	112	122
R/ETP	1.63	1.23	1.32	1.11	1.92	1.67	1.15	1.00	1.02	1.37	1.47	1.67

Table 3: Ratio R/ETP Calculation.

A growing season is the period of the year when crops and other plants grow successfully. The length of a growing season varies from place to place. Most crops need a growing season of at least 90 days. Similarly, to examine relationships between second crops planting date and precipitation, we separated second crops-growing regions into those for which planting dates are likely to be governed by the seasonality of precipitation ('precipitation-limited' regions) and those for which planting dates are unlikely to be governed by the seasonality of precipitation (Figure 1a). We considered a second crops growing region to be precipitation-limited if there is some day when precipitation is less than half of PET (using average monthly precipitation interpolated to daily values, and daily computed values of PET, as described above) intensification of efforts particularly agricultural land is determined by the balance of availability and agricultural water needs. For a region that has a balance of availability and agricultural water needs positive, then predicted the area would have a chance of an increase in the index growing.

Alternative water resources utilization and efficiency of distribution of water is also known to increase the index growing. With the use of the balance of water, then it can be done identification of potential availability of water and the water needs of crops at different planting patterns in scenarios of land irrigated and non-irrigated and can group status of the balance of availability and the needs of agricultural water for each area or region irrigation of the rice fields so that it can be made an inventory of areas which can be improved index growing. The data can also be used to regulate the planting schedule as well as schedule the awarding of irrigation on farmland so that crop production can be maintained.

The cropping pattern means the proportion of area under various crops at a point of time or regional allocation of land among different crops. Information obtained can be used as a reference for the policy makers in the field of agriculture in the determine the pattern of cropping and planting time. Possible to have a year-round growing season or 365 days so as to allow penglolaan 3 paddy rice planting season, with a record of limiting factors due to insect pests and diseases can be tackled. According the results of calculations and analysis, some important information that can be taken to the technical operational interests in the field is that in which occurs the water surplus in a row. To do the making of drainage channel/disposal in order to drain off the excess water, especially if the soil conditions do not support for the occurrence of rapid infiltration and surplus period lasts for a period which is long enough (6 months). Whereas for the period the deficit did not happen so that for the sake of cultivation is very possible, because ground water is always available in the circumstances. In June it is highly recommended to be cautious in conducting the activities of the planting of let alone grow rooted short, supply/water should be awarding intensive on the month [6-18].

Conclusion

1. In normal conditions this area has never experienced water deficit on the contrary has a surplus of water as much as 847 mm/year with the length of the growing season for 365 days or a year.
2. Although the State of the balance of water experience the deficit, however, is still on the boundary of the water available to the plant, then it can be inferred that in the area of research can be done planting food crops along the years with the production of inputs (irrigation) in dry conditions.

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