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Study of River Water Quality in Pangkajene for Irrigation Pangkep District - Indonesia

Johannes Patanduk
Civil Engineering Department, Faculty of Engineering, Hasanudddin University,
PerintisKemerdekaan Km.10, Makassar, 90245, Indonesia

ABSTRACT

The increasing of population has led to the rise of need for water irrigation and food production. However, water needs are still sensitive which in turn can cause competition and conflict. One way to deal with it is to monitor the quality and quantity of river water expected to be appropriate based on its usefulness. The river water is expected still within the limits of tolerance of water quality criteria and the appropriate utilization of large quantity of water still needs to be fulfilled. Therefore, a study of quality and quantity of Pangkajene River used for irrigation Pangkep District was conducted.The data of climatology, hydrology were collected in order to compute irrigation the water requirements, the quantity of discharge mainstay, to analyze the water balance, the water samples, to test the water samples in the laboratory, and then to analyze the results . The results indicated the Biological Oxygen Demand (BOD) of Pangkajene River had exceeded the water quality standards by grade IV Quality Standards Water Quality Regulation of South Sulawesi Governor. This is due to the effects of sewage and people around the River. So it can be advised that domestic wastewater should not be discharged directly into the river / water bodies but it must be processed first and all industrial wastewater producers are required to have an installation wastewater treatment plant (WWTP). The quantity of discharge mainstay seems to have significant fluctuation in the river of the water balance Pangkajene and water shortage in June I, II June, July I, August I, II August, September I, and September II and it is recommended for planting crops in the months with less discharge in order to reduce the occurrence of water shortages.

Keywords: *Water Quality, Water Quantity, Irrigation and River Pangkajene*

I. INTRODUCTION

Pangkajene and Islands District, SouthSulawesi, Indonesia, has a major river called Pangkajene River (32 km long with an area of 613.41km^2 watershed. The river is used as the main source of water for 8615ha irrigated rice fields.

The quality and quantity of water in the river is expected to be appropriate based on its utility as a source of irrigation water. However, it has become a major problem whether the water quality criteria are still eligible to be used or not, and the quantity of water in which the level of demand for irrigation water can sometimes become less stream flow conditions resulting in water shortages. Therefore, there must be a way to reduce its impact on agriculture. A study of the quality and quantity of the river water for irrigation in Pangkajene and Islands District was undertaken.

The next chapter presents the methods used in this study, then, Chapter 3 shows the results of the analysis, and the last chapter gives conclusions related to the research.

II. LITERATURE REVIEW

A coastal river is a natural feature and is integrated for water quality needed for living. River water is more important in life circle. (**Directory of Irrigation, 1986**).

The quality and the quantity of water resource are indicated by Debit Curvature Method for the mathematical model of the linear regression for solution. (**Oriana, 2012**).

Water quality for irrigation, habitat percolation, and effective run off were measured by evaporation and transpiration. (**Directory of Irrigation, 1986)**.

Water resources for balancing are needed for water quantity and water catchment area. We can measure the water minimization for the households and industries. (**Biringkanae, Muliawan, 2011**).

The quality control management for the quantity and quality of the water resources we need three variables: the physical model, chemical model and biological model. (**Rule of Chief Government South Sulwesi, 2010**).

III. RESEARCH METHOD

A. Debit Curvature Method

In analyzing the mainstay discharge, based on the ways in which the selection of the appropriate methods, generally based on these considerations, the data were available. Of these factors, the method of calculation used was a mainstay discharge Curvature Method Debit using the linear regression.

Curved Debit method is used with reference to the recorded data, the recorded high elevation discharge (H) and discharge (Q) obtained from the observational data in the last 10 years, starting from 2002 to 2011 on Front Air Station High Registrar (Staff Gauge) Tabo-Tabo , then the equation was the relationship between the Q-H by using the linear regression equation.

Data modeling is a common practice in the fields of science and engineering. This method is used to find the theoretical parameters that give the most appropriate relationship. The equation is expressed as follows [1]:

$$Y_i = b_0 + b_1 X_i \quad (1)$$

The equations derived from the relationship between the Q - H, plotted the value of recorded water level into the equation above, and the value of the obtained discharge. In order to predict / forecast the need for the year 2013, the model (trend) with linear regression for each month was conducted.

B. Irrigation Water Needs

The rate of percolation was very much dependent on the properties of the soil. In clay soil with good processing characteristics, percolation rate was 1-3 mm / day. Evaporation was the change of water to steam. Penman method was used to determine the amount of evaporation, whereby evaporation (Ea), the saturated vapor pressure at the mean temperature (e), the actual vapor pressure (ea), Wind Speed (u). The relationship between the variables are shown as follows [2]:

$$Ea = 0{,}35(e-e_a)(0{,}5+0{,}54u) \quad (2)$$

Transpiration is a process of water vapor leaving the plant body. The water requirement of plants is influenced by the factors of percolation, evaporation, transpiration which were then calculated as evapotranspiration. Free water evaporation (Epan), reference crop Evapotranspiration (Eto), crop Evapotranspiration (Etc), slope of the saturated vapor pressure curve (Δ), psychrometer coefficient (γ), corrected Penman (Kp), crop coefficient (Kc), latent heat evaporation (L), temperature (t). The relationship between variables is shown as follows:

$$E_{pan} = \frac{10\left[\frac{R\Delta}{L}\right] + \gamma Ea}{\Delta + \gamma} \quad (3)$$

$$Et_o = K_p \cdot E_{pan} \quad (4)$$

$$Et_c = K_c \cdot Et_o \quad (5)$$

The amount of water requirements for land preparation depends on the amount of the soil saturation, duration of treatment, evaporation and percolation. The amount of water requirement for paddy cultivation time could be calculated by using the method developed by Van de Goordan Zilstra, including the need water for processing (IR), a replacement water requirement of water loss due to evaporation and percolation in fields already saturated (M), magnitude wasted water evaporation (Eo), Percolation (P), Lamatillage (T), water requirement for saturation(S), and Numbers exponent (e =2.7182). The relationship between the variables are shown as follows[6]:

$$IR = \frac{Me^k}{\left(e^4 - 1\right)} \quad (6)$$

The water requirement for crops is the need for saturation and not required because of the flooding. The effective rainfall is the amount of rainfall that falls on an area of agriculture that can be only partially utilized / absorbed by the plants to meet the needs during infancy. Before determining the value of the effective rainfall, first it was necessary to determine the value of the mean rainfall using Thiessen Polygon Method, that is Thiessen polygon average rainfall (R), the total area of influence of a station limited line polygons (A1.. An), and the High rainfall station (R1..Rn). The relationship between the variables are shown as follows [7]:

$$R = \frac{A_1.R_1 + A_2.R_2 + ... + A_n.R_n}{A_{total}} \quad (7)$$

After determining the average rainfall, then the mainstay rainfall (R80). Forrice, and rainfall (R50) for the following crops was determined:

a) For Rice

$$R_{80} = \frac{N}{5} + 1 \quad (8)$$

b) For Corps

$$R_{50} = \frac{N}{2} + 1 \quad (9)$$

The effective rainfall (Reff) is calculated using the formula:

a) For Rice

$$R_{eff} = 0{,}7 \text{ x } \frac{R_{80}}{15} \quad (10)$$

b) For Corps

$$R_{eff} = 0{,}7 \text{ x } \frac{R_{50}}{15} \quad (11)$$

The replacement of the water layer was performed 2 times: each 50 mm (3.3 mm / day for 15 days) early in the first and second months of planting. The irrigation efficiency is the ratio of the discharge rate of irrigation water used to debit the amount of irrigation water that flowed and expressed in percent (%).

Losses can be due to the evaporation of irrigation, seepage from drains or other purposes. In planning the total amount of irrigation efficiency from the water loss in the primary to tertiary canal was 65%.

The Crop Water Requirement is the amount of water needs required by plants for growth. This included the crop water requirement (NFR), crop consumptive use (Etc), effective rainfall (Reff), Percolation (P), and the replacement of the water layer (WLR). The relationship between variables is shown as follows:

a) For Rice,

$$NFR = Et_c + P - R_{eff} + WLR \qquad (12)$$

b) For Corps

$$NFR = Et_c + P - R_{eff} \qquad (13)$$

The need for taking the required amount of water needs to door collection. Needs net (net) in the rice water (NFR), the overall irrigation efficiency (E), and the coefficient converting mm / day to l / sec / ha (8.64). The relationship between the variables are shown as follows [14]:

$$DR = \frac{NFR}{E \times 8{,}64} \qquad (14)$$

Cropping pattern is a layout plan for the area irrigated cropping. It is useful to establish the pattern of utilization of irrigation water which is available for plant production gain as much as possible in agriculture. Planning cropping pattern done by calculating the value of evapotranspiration, percolation, donations effective rainfall, water demand astillage, replacement of a layer of water, consumptive needs of plants, and the total efficiency of the irrigation canals. Of cropping patterns were obtained value of irrigation water requirement for each ha is used in planning the multiplier coefficients of the total area of the land planted.Water balance is a balance between the availability of water to the water needs of all irrigated land. The water balance can be seen when the water shortage or water excess occurs for one year, and we can determine the ability of the service for the overall irrigation in the available irrigated land.

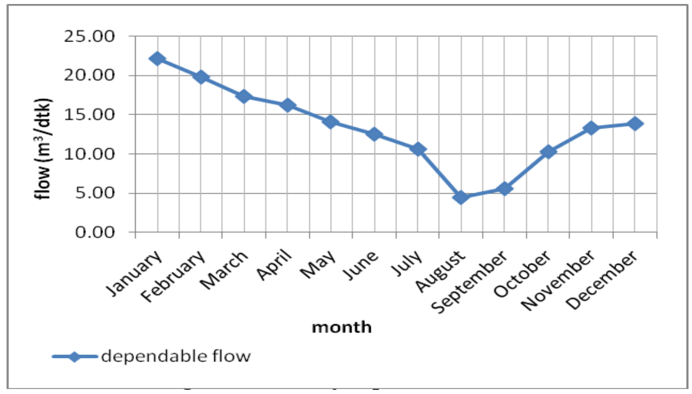
C. Irrigation Water Quality

Pangkajene River water quality checks were carried out by taking samples of the water in the irrigation weir Tabo-Tabo on August 6, 2012 and then the laboratory water quality test was performed at the Environmental Health and Engineering Center for Disease Control (BTKLPP) Class 1 Makassar. Then it was adjusted to the Investigation Air Quality Standards Regulations quality of South Sulawesi Governor No. 69 of 2010 Class IV for the use of irrigation.

THE ANALYSIS OF THE RESULTS

D. Quantity Dependable Flow

The results of the calculation of the quantity of river discharge dependable flow Pangkajene using the arc discharge method can be seen in Figure 1.



In Figure1, the line above is the mainstay of Pangkajene river discharge quantity. Based on these lines, it can be seen that the fluctuation of the water in Pangkajene river happens to be quite significant, i.e. in the rainy season it has a great flow, while in the dry season it has a very small discharge.

E. Existing Cropping Pattern Water Balance

The calculation is done by comparing the water balance between the needs of the irrigation water for the entire 8615ha of irrigation water sourced from Pangkajene river services with the available river discharge mainstay in Pangkajene. The graph of water balance between the needs of the existing irrigation cropping pattern in Pangkep district with Pangkajene river discharge mainstay can be seen in Figure2.

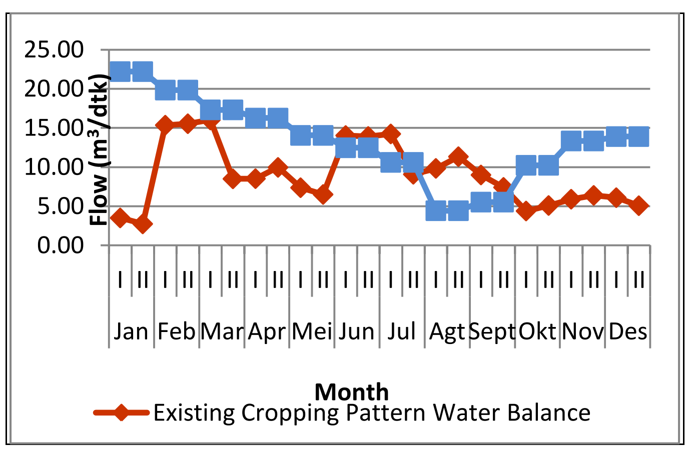


Figure 2.ExistingCroppingPatternWaterBalance

Based on Figure2 above, we can see the comparison between the line of Pangkajene river discharge mainstay to outline the need for irrigation water in Pangkep cropping district. From the discharge mainstay it was known that the significant fluctuations in the debit of Pangkajene river during the rainy season which tend to be large even far above the needs of the irrigation water, but in the dry season the debits became less. From the comparison of the discharge mainstay and major irrigation water demand on the chart we will also be aware that there is a shortage of water as much as 7 times of that in June I, II June, July I, August I, II August, September I, II and September.

F. WaterbalanceCroppingPatternOptimization

The water balance irrigation cropping pattern optimization was conducted by comparing the results between the water needs of the cropping pattern optimization results with the discharge mainstay in Pangkajene River. The optimization is an effort to water management plan to be used efficiently in order to identify the best solution in the decision of a problem. The optimization is applied on the basis of a solution to the shortage of water caused a significant fluctuation in the dry season. The parameters used to perform the optimization is to apply the Crop planting pattern in the shortage of water. The graph of water balance between irrigation needs cropping pattern optimization results with Pangkajene river discharge mainstay can be seen in Figure3.

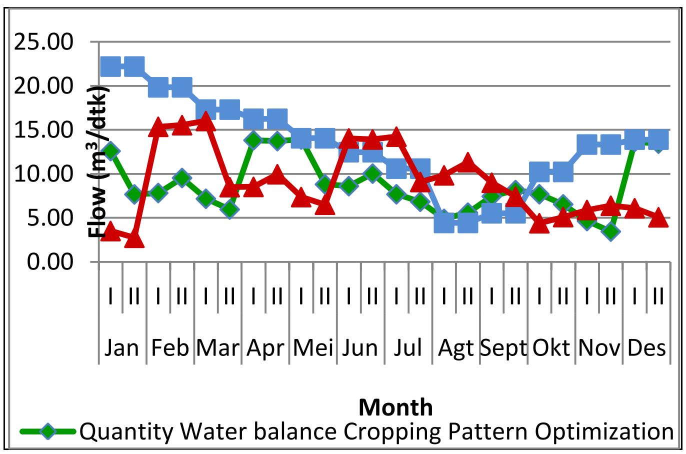


Figure 3.Water balance Cropping Pattern Optimization

Based on Figure 3, it can be seen that the results of the optimization of the Crop planting can reduce the need for irrigation water. So the occurrences of water shortages, since the water shortages had occurred 7 times (JuneI, II June, July I, August I, II August, September I, II, and September) should be reduced to 4 times (August I, II August, September I, and September II). This was done by changing the schedule of the cropping patterns, that is, instead of planting rice in the first planting in July II, the rice planting was held in May II and the early planting crops was done in August when the river had less discharge. When the shortage of water last for a long time, it is recommended that the provision of water be applied in rotation. Since the use of cropping pattern proved to optimize the use of water more effectively, the water shortage could be reduced, and consequently the agricultural production of Pangkep District could be directly increased.

G. Water Irrigation Quality

Based on the test results of the water samples, the river water does not qualify the criteria of the water quality standard Class IV South Sulawesi Governor Regulation No. 69of 2010. It could not meet the irrigation water source inspection of the Biological Oxygen Demand (BOD) or the Biological Oxygen Needs. The analysis of the amount of oxygen needed by the aerobic bacteria to decompose (oxidize) covered almost all of the dissolved organic substances and some of the organic substances suspended in water. The high values of the required BOD limits the effects of pollution from the sewage and the industrial population which were found around Pangkajene River. Therefore, the domestic waste water should not be discharged into the river/water bodies before it had been processed first and all industries producing waste water were required to have a waste water treatment plant.

CONCLUSION AND DISCUSSION

The quantity of Pangkajene river discharge based on the results of the analysis of the mainstay showed a significant fluctuation of the water balance and the water shortage in June I, II June, July I, August I, II August, September I, II and September and it was advised to plant crops in the months when the river had less discharge in order to reduce the occurrence of water shortages, while during the months when the water supply was still inadequate, the water delivery was made in rotation / rotation and thus, the optimization of planting rice for two cropping periods was performed in the months of January, February, March and from the months of May, June, July in order to increase the area of land planted.

Pangkajene River based on the results of water quality, showed that the value of the Biological Oxygen Demand (BOD) had exceeded the threshold class IV water quality standards as required by the Quality Standards Water Quality Regulation of South Sulawesi Governor No. 69 in 2010, which described the effects of pollution from the sewage and the industrial people who settled around Pangkajene River. Therefore, it was advised that the domestic waste water should not be discharged directly into the river / water bodies before it was first processed and that all industrial wastewater producers were required to have an installation of the wastewater treatment plant.

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Johannes Patandukwas born in Toraja, South Sulawesi Province, Indonesia on November12nd, 1948. He obtained Bachelor degree at Hasanuddin University, Indonesia, in 1980, in the field of Civil Engineering.He achieved Master degree on Regional Planning & Development, and Doctorate degree on Civil Engineering Field at the same university in 1989 and 2012, respectively.

He has become a lecturer at the Civil Engineering Department of Engineering Faculty of Hasanuddin University since 1977. His major teaching is related to water engineering and management. In addition, he has become an expert in many water engineering projects in Indonesia.

Dr. Johannes Patanduk is the Senior Member and Committee of Indonesia Association on Hydraulic Expert of South Sulawesi Province branch. He has presented many papers in many national academic meetings in Indonesia, as well as in international symposia or conferences.