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Identification of Irrigation Building in the Sangkir Garagahan Agam Regency for Agricultural Improvement

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Abstract

The increasing public demand for the quality of work provided by the government, both in physical form (buildings) and in non-physical forms (rules), is a consequence of changes in people's mindsets towards the pattern of government-community relations. Today's society is not only questioning whether or not their needs are met, but also questioning the quality of the buildings that have been carried out. Good building quality has a good impact on society. Irrigation buildings in the Sangkir Garagahan Irrigation Area were built in 2019, including primary and secondary canals that irrigate 1151 ha of rice fields located in 3 (three) nagari, namely Garagahan, Koto Tangah, and Manggopoh. This research is guided by the Irrigation Planning Standard KP-01, which is to determine the effective rainfall, and to analyze the water demand in the rice fields. Calculation of water availability using Manning's theory. By conducting a direct field survey of the Water-Using Farmers' Association and the Water Resources Service of the Bukittinggi Region, the existing condition of the canal was obtained before the construction was carried out. The intake discharge for the primary channel is 2100 liters/second, the discharge in the secondary channel for BBS V is 1300 liters/second. From the analysis of the available water discharge 8389 m3. The water discharge required for irrigation is 1795.75 m3. It is concluded that until 2027, irrigation buildings which exists still meet the water needs for rice fields.

Keywords: irrigation, channel, primary, discharge, P3A

I. Background

(Agam in figures, 2020), Agam Regency has the Sangkir Irrigation Area with a total area of 1.151 ha of Irrigated rice fields, located in Garagahan village, Kampung Tangah village, and Manggopoh village which is under the authority of the Provincial Government, through the Water Resources and Construction Development Service, located in Observer Area II UPTD Office of Water Resources and Construction Development for the Bukittinggi Region. Irrigation areas aim to support development in the agricultural sector to support the food sovereignty program which is the program of the President of the Republic of Indonesia. Village Garagahan is located in the upstream, therefore in order for the middle and downstream areas to meet water needs, Nagari Garagahan needs to maintain the availability of water to meet demand. To maintain the availability of water needs to be supported by management and infrastructure that meet the criteria for irrigation. (PP number 38, 2011), Irrigation comes from the term irrigatie in Dutch or irrigation in English. Irrigation can be interpreted as an effort made to bring water from its source for agricultural purposes, drain and distribute water through primary channels, secondary channels and tertiary channels on a regular basis and after use can also be disposed of again. (Sosrodasono et al, 2003), The irrigation system in Indonesia depends on the method of taking river water which is divided into rural irrigation and government irrigation. The distinction is based on its management. The village irrigation system is communal and does not receive assistance from the Central Government. The construction and management of all irrigation networks/channels is carried out entirely by the community. Meanwhile, irrigation systems that depend on government assistance are divided into three categories: technical, semi-technical and simple irrigation. (Permen PUPR No. 39, 1989), Technical irrigation is a water network that gets a separate water supply from the drainage network and the water supply can be measured, regulated and controlled at certain points. All buildings are permanent. The irrigated area is over 500 hectares. At the research location the type of irrigation used is technical irrigation. Irrigation networks are usually made based on a topographic map that is poured into an overview map with a scale of 1: 25000. Furthermore, from the overview map, the design is continued in a detailed overview map of a scale of 1: 5000 or 1: 2000. This detailed overview map is known among the planners as plot maps. The tertiary plots, secondary plots and primary plots are depicted on the plots. With the planning of irrigation networks/channels and plots, it is hoped that the water needs for irrigation can be met. So it is necessary to identify the buildings that were built in 2019.

The research objectives are:

1. Does the water flow meet irrigation needs

2. Are the primary and secondary canals built to meet irrigation water needs

II. Research Method

1. Study Area Location

The Sangkir Garagahan Irrigation Area is located in the Lubuk Basung sub-district which is 5 km from the capital of Agam Regency. The Sangkir Garagahan Irrigation Area is located in the Observation Area II UPTD of the Water Resources and Construction Development Office of the Bukittinggi Region, has an area of 1,151 Ha of irrigation rice fields. with latitude 0^0.33’4259”, longitude $100^0$05’4005’’, weir position at $0^0$20'3.77326”S,100^0 3'14.53324”E 3300 MW. As can be seen in Figure 1.

Figure 1. Location of irrigation areas and weirs

2.Materials and tools

In the form of secondary data, namely irrigation network data in the form of position and location of canals, data on the area of irrigated rice fields, and data on the number of P3A. Primary data in the form of channel length data, channel width, water height, sedimented channel area, water velocity data using buoys and the position and area of rice fields.

3.Analysis Techniques

From the visual map, obtained the irrigation area, the area of irrigation, the slope of the channel, the dimensions of the channel. All of this data will analyze the discharge of water needs for irrigation and the discharge of water availability in the Sangkir Garagahan Irrigation Area.

III. Literature review

1. Flow On Open Channel

(Thornbury, W.D., 1969), The flow of water in a channel can be in the form of open channel flow and pipe flow. The two genres are similar in many ways, but differ in one most important way. Open channel flow must have a free surface. Flow in open channels can be classified into various types depending on the criteria used Uniform Steady Flow. Steady uniform flow is a flow that has a constant depth, wet area, velocity and discharge in each section of a straight channel cross section. In addition, it has energy lines, water levels and the bottom of the channel that are parallel to each other which means they have the same slope.

2. Uniform Flow Qualification

If the flow velocity at a point does not change with time, it is called steady flow or permanent flow. Uniform flow is considered to have the following characteristics:

Depth, wet area, velocity and de-bit at each cross section in a straight channel section are constant. The energy line, the water level and the bottom of the channel are parallel to each other, meaning that the slope is the same or Sf = Sw = So = S.

Uniform flow is considered as a permanent or steady flow (steady flow). When water enters the channel slowly, the velocity decreases and therefore the resistance also decreases, and the resistance is less than gravity so that there is an acceleration in the straight section upstream. Speed and resistance will increase gradually until there is a balance between resistance and gravity.

3. Uniform Flow Rate

Open Channel Hydraulics (Chow, Ven Te), 1992, For hydraulic calculations, the average uniform flow velocity in an open channel is usually expressed by an approximation known as the uniform flow formula. Robert Manning (1989) suggests a formula:

$V= (1/n) \times R^{2/3} \times S^{1/2}$

where : V = average speed (m/s),

R= hydraulic radius (m),
S = channel slope,
n = roughness of Manning

Manning's formula is used in the uniform flow formula, where the calculation includes 6 variables, namely normal discharge Q, average flow velocity V, normal depth y, roughness coefficient n, channel slope S, geometric elements depending on the shape of the channel cross-section such as A, R. Selection of appropriate values of n for various design conditions (materials used).

4. Irrigation

Irrigation is the business of providing, regulating, and disposing of irrigation water to support agriculture whose types include surface irrigation, swamp irrigation, underground water irrigation, pump irrigation, and pond irrigation (PP No. 20 of 2006). Irrigation aims to help meet the water needs of farmers in cultivating their agricultural land so that there is no longer a shortage of water.

5. How to give water

Generally for rice plants in tertiary plots, namely by plot to plot. The steps for giving the water are as shown in Figure 2, namely: the supply channel, namely the tertiary channel and the quarter channel. Water is given to the topmost plot of rice fields or closest to the feeding channel by gravity. After the topmost rice field is full, then the water is flowed to the lower rice field. Furthermore, the water is given to the lowest plot, the water given from the canal is used repeatedly from plot to plot, and finally the water is channeled into artificial or natural sewers.

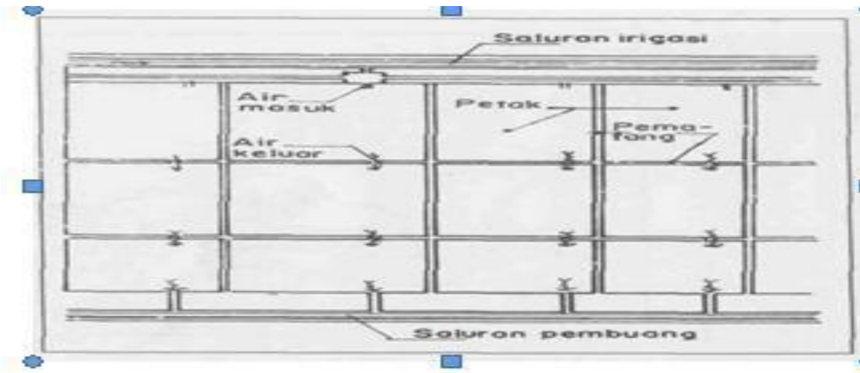

Figure 2. How to give water

6. Irrigation Channel

Groundwater irrigation canals are part of the groundwater irrigation network which starts after the intake/pump building until the land is irrigated (PP No. 20 of 2006). Irrigation channels in this study are divided into: - Primary Channel

The primary channel is the channel that carries water from the main network to the secondary channel and to the tertiary plots to be irrigated. Tertiary plots are a collection of quaternary plots, each quaternary plot has an area of approximately 8 to 15 ha. While the tertiary plots have an area of 50 to 150 ha. Secondary Channel

Secondary canal is a channel that carries water from the primary channel to the tertiary plots served by the secondary channel.

The research is guided by the Irrigation Planning Standards section of the Irrigation Network section KP-01, (2013), where irrigation canals are divided into (Figure 3):

- Primary canals are channels that carry water from the main network to secondary channels and to irrigated tertiary plots. The primary channel is also known as the main channel. This channel ends at the building for the latter.

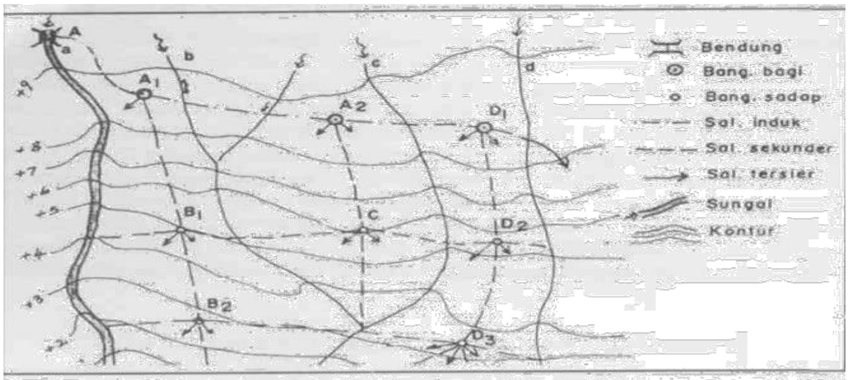

Figure 3. Irrigation channel

Irrigation channel are part of the groundwater irrigation network which starts after the intake/pump building to the irrigated land (PP No. 20 of 2006).

7. Maximum Speed Allowed

The maximum allowable speed is the maximum (average) flow velocity that will not cause erosion/scouring of the channel surface. The following speeds are recommended for use can be seen in table 1 below.

Table 1. Maximum speed allowed

Material	Maximum Speed Pair (m/s)
Stone	2
Concrete	3

8. Discharge Measurement Method

As a reference in measuring the flow of rivers and open channels that are not affected by backflow or lava flows, which are still accommodated in river channels or open channels, by measuring the flow velocity using a surface buoy, with the aim of obtaining rough data on river and open channel discharges. River/open channel discharge is the volume of water flowing through a cross-section of an open river/channel per unit time. The measuring equipment used in this method are: Wet cross section measuring instrument, must comply with SNI 03-2414-1991 (Measurement Method for River and Open Channel Discharge). Surface flow measurement equipment must use a surface float. The water level measuring instrument must comply with SNI 03-2414-1991 (Method of Measuring River and Open Channel Discharge). Irrigation water needs for each area of rice fields, Sosrodarsono, (2003), KP 01 (2013). The need for irrigation water is calculated by the formula: NFR = (Etc + P + WLR + LP – Re) / Eff (2)

Carrier network efficiency = 70 % . Tertiary network efficiency = 90%. Operational efficiency = 80 %. So the project efficiency becomes = 0.70 x 0.90 x 0.80 = 0.5.

9. Effective Rainfall

Sutopo, (2002), Asdak, (2010), Effective rainfall is rainfall that can be directly used by plants for their growth. This effective rainfall depends on the intensity of rain, the needs of plants and the ability to store water from the land at that time. Effective rainfall is determined based on rainfall stations located at the irrigation location and is calculated

based on (KP 01)

Re = 0.70 x R 80 (3)

R80 = n/5+1 (4)

IV. Metodolgy

1. Time and place

The research was conducted in 2021. The Sangkir Garagahan Irrigation Area is located in the Lubuk Basung sub-district which is 5 km from the capital of Agam Regency, it has an agricultural area of 1,031 Ha which is fed by the Irrigation Area. The Sangkir Garagahan Irrigation Area is located in the Observation Area II of the Water Resources and Construction Development Office of the Bukittinggi Region.The weir irrigates the rice fields in Garagahan with a standard area of 1151 ha, and irrigates the functional area in the primary canal in the Garagahan area of 496 ha. The intake discharge is 2.100 liters/second.

2. Research Implementation Method

- Secondary Data: Collecting data from the project party at the Department of Water Resources Management and Construction Development of West Sumatra Province, in the form of data secondary in the form of a primary canal irrigation network scheme, the area of rice fields and the size of the discharge from the weir is the intake discharge of 2.100 liters/second. The need for primary line 150 liters/second. Loss of water in the primary channel is 650 liters/second, and the water discharge for BBS V is 1.300 liters/second which is flowed through the secondary channel.

- Primary data, namely data obtained directly in the field, such as the dimensions of the canal, the area of rice fields, and interviews with the P3A, namely from the results of measurements in the field, the dimensions of the primary channel width are 3 m and the water level is 1,10 m. This water discharge irrigates 496 ha of rice fields in a 2.542 m long channel.

3. Research Stages

a. Collecting data in the form of area of primary canal irrigated rice fields in DI Garagahan.
b. Study of literature and field data
c. Analysis of demand discharge in DI Garagahan.
d. Cross section of the primary channel at DI Gragahan
e. Discharge accommodated in the primary channel

f. Reporting and publication

V. Results and Discussion

A. Measurement Results

From the results of identification in the field, the condition of the dam on the part of the building was broken which resulted in water loss of 650 liters/second in its drainage. In addition it was identified that:

a. The flow of water to the rice fields is smooth
b. There are still many canals that have a high sediment level as seen in Building Divide 2 (BG2).
c. The location of the primary channel looks cleaner
d. Channels look more well-maintained
e. No more grass growing along the channel
f. When it rains in a state of high rain intensity, the water recedes more quickly

B. Speed and Discharge on Channel

From field data, flow velocity measurements were carried out in the primary channel, using a float in the form of a table tennis ball and with a distance of 100 meters, the velocity that occurred in the field obtained an average primary channel discharge of 0,045 m3/second. Primary Channel with the name of the building for (tapping, supplementation, control) buildings from BBS 1, BBS2, BBS3, BBS4, and BBS 5 with a total length of 2.542 meters. For the channel that has sediment, it is in the BG 2 channel. In BG 2, the monthly water discharge becomes 20,057 m3/second. The maximum average discharge is at 5.300 m3/second. According to Irrigation Planning Standards: KP-03 (1986) that the maximum speed (Table 1), for concrete channels is 3 meters/second. From field measurements on primary canals, the average water level is 1,10 meters and the guard height (W) is 0,60 meters. The width of the primary channel in the shape of a rectangle is 3 meters. Channel grade (S) = 0,005. From the calculation results, the wet cross-sectional area (A) = 3,30 m2, the wet surface circumference of the channel (P) = 5,2 m, hydraulic radius (R) = 0,63 m, with a manning roughness coefficient (n) in the form of a concrete channel of 0,013. The channel velocity (V) can be calculated by the manning formula, V = (1/n) x R2/3 x S1/2

V = 1/0,013 x (0,63)2/3 x (0,005)1/2
V = 76,92 x 0,74 x 0,054 = 3,07 m/sec

obtained V = 3,07 m/second. (meets Irrigation Planning Standards: KP-03), 1986
Discharge on the primary channel: Q = V x A
Q = 3,07 x 3,30 = 10,13 m^3/sec

With a channel length of 2542 m and a water height of 1,10 meters and a width of 3 m, the available water discharge in the primary canal = 2542 x 3 x 1,10 m^3 = 8389 m.

- Evapotranspiration

Etc = ETo x Kc ETc = ETo x 0.9
ETc = 108,88 x 0,9 = 97,99 mm
W = 6 mm/day = 365 x 6 = 2190 mm
Re 5 = 0,8 x 100,87 = 80.7 mm
Eff = 0,9

According to KP 01 (2013), water needs in the rainy season and dry season are 1,50 liters/second/ha. NFR = (Etc + P – Re) / Eff

NFR 2027 = (97,99 + 2190 – 80,7) /0,9 = 2452,54 mm/ha

- Nagari Garagahan: Primary channel:

The water requirement for rice fields is 2542,54 mm/ha
Discharge of water needed by rice fields = 496 x 2452,54/1000 = 1217 m3.
The available water discharge in the primary canal = 2542 m x 3 m x 1.10 m = 8389 m3.
The need and availability of water every second
For a rice field area of 496 ha:

The water requirement per second is = 496 ha x 1,50 l/second/ha = 0,75 m3/second.

Availability of water in the primary channel every second = 10.13 m3/second.

- Nagari Kampung Tangah: Secondary channel: The area of rice fields that need water = 136 ha.

The water requirement for rice fields is 2542,54 mm/ha

Discharge of water needed by rice fields = 136 x 2452,54/1000 = 333,5 m3. The need and availability of water every second

For a rice field area of 136 ha:

Water requirement per second is = 136 ha x 1.50 l/second/ha = 0.20 m3/second

- Nagari Manggopoh: Secondary channel.

Area of rice fields that need water = 100 ha
Discharge of water needed by rice fields = 100 x 2452.54/1000 = 245.25 m3.
The need and availability of water every second

For 100 ha of paddy fields:
The water requirement per second is = 100 ha x 1,50 l/second/ha = 0,15 m3/second.
Water requirement for irrigation = 1217 + 333,5 + 245,25 = 1795,75 m3
Availability of water 8389 m3

VI. Conclusion and Suggestions

6.1. Conclusion

From the analysis of the water demand and the availability of water in the primary and secondary canals, it was found that the water discharge required by the rice fields was 1795.75 m^3, the available water flow was 8389 m^3. The available debit is greater than the required debit. It is concluded that until 2027, irrigation buildings built in 2019 still meet the water needs for rice fields.

6.2. Suggestion

In order for the stability of the need and availability of water for irrigation to continue running well, an agreement between farmers and the PSDA service is needed to maintain irrigation buildings, water sources and use water according to their designation, namely to meet irrigation water needs in the Sangkir Garagahan irrigation area.

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