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Dry Land Irrigation In Kandar, Tanimbar Islands Regency.

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Abstract. Dry land is one of the agro-ecosystems that has great potential. From the wide potential of dry lands in Indonesia (especially in Tanimbar Island Regency, Maluku Province), it is classified as quite high, but there are problems with water availability and socio-economic. One of the potential irrigation areas in Kandar sub-district because it does not yet have an appropriate irrigation system, and because of the limited rainfall in Kandar makes it a suitable place for an irrigation in the dry land. To analyze the proper irrigation network in the Kandar irrigation area, primary and secondary data were collected. From the data collected then analyzed, we obtained water balance in the Kandar irrigation area with two cropping patterns, namely: Corn-Peanut-Nutmeg and Corn-Corn-Peanuts experienced surplus from January-June and deficit in July-December. From the irrigation area of 1101.23 ha, the area is divided into 5 plots in accordance with the standard. After that, an overall water requirement of 0.616 l/sec is calculated, which means Weslyeta Irrigation System is sufficient for irrigation. Then we calculate the dimensions of the required canal and building dimensions, and we obtained the length of the primary canal is 3383m and the length of the secondary canal is 3053m.

1. Introduction

Dry land is one of the agro-ecosystems that has great potential for agriculture, both crops, food, horticulture (vegetables and fruits) and annual crops. Limited water in dry land means farming cannot be done throughout the year, with a cropping index (IP) of less than 1.50. The cause is fluctuating rain distribution and patterns, both spatially and temporally.

From the wide potential of dry land in Indonesia (especially in Tanimbar Island Regency Maluku Province), it is classified as quite high, but there are water supply and socio-economic problems that must be addressed to increase productivity in a sustainable manner. One of the actions to overcome them is the management of water resources effectively and efficiently.

The potential of irrigation of Kandar dry land, administratively located in the area of Kandar Village, Selaru District, West Southeast Maluku Regency with an area of 1101.23 ha. Geographically the plan's water source is at 8 ° 13'14.37 "South Latitude and 130 ° 58'14.34" East Longitude.

Existing conditions in the potential location of Kandar dry land irrigation at this time, the majority are still in the form of vacant land, some land has been utilized by the surrounding community, to grow food crops tend to be palawija, crops is relying on balanced the water needs only from the rainfall, so when there is no rain they will have a difficulty getting water to meet the water needs of plants. At the research location there is no irrigation system and at the Kandar dry land irrigation potential location, there is a source of water availability,

which is a spring, which is located around the location of the work plan, Weslyeta water springs. At present the source of springs, some have been used to meet the population's basic water needs.

2. Method and Materials

2.1. Research Methods

In this study several stages of data collection were carried out, starting with primary and secondary data. Primary data were obtained from direct measurements in the field and sampling in the form of topographic measurements to determine the elevation of the irrigation area and measurement of momentary discharge to compare with the calculated discharge and soil sampling to determine the type of soil at the study site. Secondary data was obtained from related parties to obtain the required data in the form of rainfall data, climatology data, discharge data, etc.

Based on the analysis of the physical properties of the Maluku Regency, shows that the West Southeast Maluku region has a low content weight, especially Kandar so that it becomes an indicator that the Kandar area has a high enough organic material so that when cultivated for horticultural crops it is quite good.

2.2. Method of Analysis

From the data obtained, then the rainfall, evapotranspiration, mainstay discharge and water balance are calculated. Furthermore, detailed calculations are made to plan the Kandar irrigation network, namely the calculation of channels and supporting buildings in it.

2.2.1. Effective Rainfall

Land that is in natural conditions always contains water. The most important thing for plants is that water in the soil must always be in a state that is easily absorbed [1]. To keep the availability of water in the soil always in a state that is suitable for plant growth, it is necessary to provide irrigation water or from its natural origin which is rainwater.

Effective rainfall is the amount of rainfall in an area that can be used directly by plants. The amount depends on the water needs of plants, according to the type of plant. To calculate effective rainfall is based on determining the average annual rainfall of several rainfall stations in one watershed, or sub-watershed. In this study to obtain effective rainfall the following probability equation is used: [2]

$$P_{80} = \frac{m}{n+1} x 100\%$$

With a probability of 80% and 50% effective rainfall can be calculated for rice and secondary crops (palawija). The amount of effective rainfall for rice and secondary crops is as follows [3]:

For rice and secondary crops the effective rainfall value is:

Rice re = (0,7xR80) / day

Re plwj = R50 / day

2.2.2. Dependable Discharge

Dependable discharge is the amount of water available for certain purposes (such as hydropower, irrigation, etc.) throughout the year with calculated failure risks. In the planning of water supply projects, a dependable discharge must first be sought, the aim of which is to determine the expected discharge that is always available in the river [4].

To calculate the dependable discharge, DR. F.J. Mock introduces a way to calculate river flow from rainfall data, evapotranspiration and river characteristics, when the availability of minimal or no discharge data is available. This method is known by the name of the Mock method mainstay calculation and specifically for rivers in Indonesia. This method is recommended for estimating river discharge based on the latest irrigation planning standards [3].

2.2.3. Potential Evapotranspiration

The amount of evapotranspiration can be determined by the Blaney-Criddle, Radiation, Thornwhite, Penman, Christiansen and Penman Modifications.

The simplified Penman formula in accordance with the recommendations by the 1977 UN Food and Agriculture Organization (FAO) for a more realistic calculation to be used in Indonesia is as follows: [5]

Eto   =   c.Eto*

ETo*   =   W.(0,75.Rs – Rn1) + (1-W).f(u).(ea-ed)

2.2.4. Plant Consumptive Water Needs

Plant consumptive water demand is approached based on plant coefficient factors at the growth stage and climate data as follows [5] :

Et crop =Kc . ETo

2.2.5. Efficiencyof Irrigation

Efficiency of Irrigation is the ratio between the flow of water that reaches the agricultural land with the flow of irrigation water that comes out of the door. Some of the most important factors that influence the size of the irrigation efficiency include the following: [6]

2.2.6. Water Balance

In the calculation of the water balance, the demand for the yields generated for the cropping patterns used will be compared with the dependable discharge for every half month and the area that can be irrigated.

**3. Results and discussion**

3.1.Dependable Flow

The results of the dependable flow using the FJ.Mock method with several values of k (groundwater recession factor) and i (infiltration coefficient) adjusted to field conditions, then the values k = 70%, 60%, 30%, 25% and i = 40%, 60%, 30%. The following is the average calculation result of the specified k and i values which can be seen in table 1.

Tabel 1. Dependable Flow 80% of Kandar Irrigation Area, with Average I and K

Month	Discharge (m³/sec)										
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Jan	3,910	4,020	3,551	3,341	5,211	4,436	3,831	4,141	5,251	5,963	4,264
Feb	2,566	3,999	3,415	1,932	3,213	2,554	3,741	2,911	2,255	2,711	2,449
Maret	1,972	2,449	1,432	2,520	1,454	4,310	2,031	2,649	1,110	2,688	4,552
April	0,768	0,927	1,258	2,746	3,344	2,879	1,466	5,198	4,760	4,912	2,208
Mei	0,783	3,163	5,814	0,734	2,771	0,889	2,200	2,611	2,752	1,112	6,820
Juni	0,322	1,864	1,140	0,437	0,962	2,325	1,292	0,900	5,284	2,279	1,458
Juli	0,188	0,577	0,621	0,252	0,467	0,572	0,441	0,504	2,024	0,614	0,854
Agust	0,117	0,336	0,364	0,155	0,278	0,334	0,260	0,302	0,778	0,358	0,493
Sept	0,077	0,209	0,572	0,101	0,176	0,208	0,164	0,192	0,557	0,223	0,316
Okt	0,048	0,125	0,188	0,063	0,107	0,125	0,099	0,117	1,364	0,134	0,194
Nop	0,032	0,082	1,328	0,042	0,071	0,082	0,065	0,078	0,352	0,088	0,130
Des	0,021	0,071	0,251	0,027	0,045	0,051	0,653	0,049	1,943	2,631	0,082
Min	0,021	0,071	0,188	0,027	0,045	0,051	0,065	0,049	0,352	0,088	0,082
Av	0,900	1,485	1,661	1,029	1,508	1,564	1,354	1,638	2,369	1,976	1,985
Max	3,910	4,020	5,814	3,341	5,211	4,436	3,831	5,198	5,284	5,963	6,820

Then the dependable discharge calculation for Weslyeta Kandar District water source using FJ.Mock method and the dependable discharge taken at 80%, it can be seen in graph 3.1. the biggest debit in December was 3,663 m³/sec and the minimum debit in December was 0.034 m³/sec.
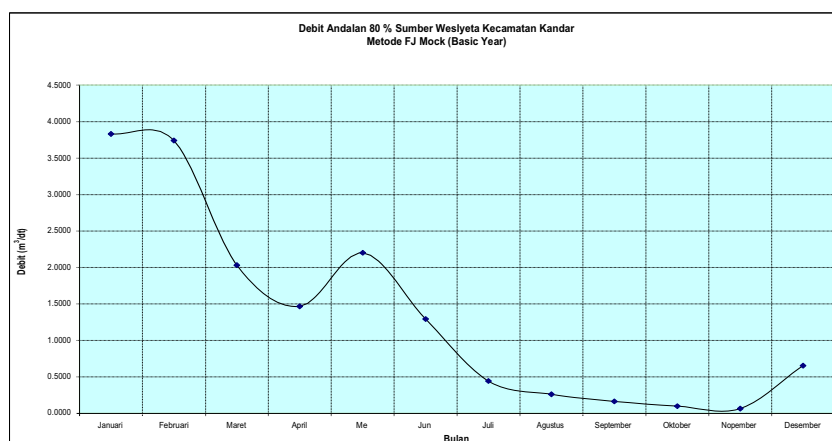
Graph 1. Dependable Flow 80% of Kandar Irrigation Area

3.2. . *Water Balance*

Water balance for the availability of water and irrigation water requirements for the irrigation area of the area with an area of irrigation 1101.23 Ha with two cropping patterns, namely: Corn-Peanut-Nutmeg and Corn-Corn-Peanut

Tabel 2. Water Supply and Irrigation Water Balance Sheet

No	Month	Water Needs				Water Supply	Surplus
		PTT 01	PTT 02	PTT 01	PTT 02		
1	Januari	0,000	0,076	0,000	0,061	3,6630	3,6325
2	Februari	0,253	0,992	0,202	0,794	2,3327	1,8346
3	Maret	0,979	0,814	0,783	0,651	1,4411	0,7239
4	April	1,197	0,026	0,957	0,020	1,0597	0,5707
5	Mei	1,252	0,206	1,001	0,165	0,8253	0,2421
6	Juni	0,422	0,859	0,338	0,687	0,6222	0,1097
7	Juli	0,392	1,063	0,314	0,850	0,3280	-0,2540
8	Agustus	0,577	0,677	0,462	0,541	0,1971	-0,3045
9	September	0,543	0,130	0,434	0,104	0,1260	-0,1431
10	Oktober	0,692	0,756	0,554	0,605	0,0772	-0,5022
11	Nopember	0,563	0,719	0,450	0,575	0,0515	-0,4612
12	Desember	0,000	0,255	0,000	0,204	0,0341	-0,0680
	Rerata	0,5725	0,5478	0,4580	0,4382		0,4484

From the calculation of the water balance on D.I Kandar, the total land area of 1101.23 hectares, with the system of planting corn - peanuts - soybeans - nutmeg, between the availability of water and water needs, there was a surplus of water availability between 0.1097 - 3.6325 m3/sec in January to June. And there was a deficit of water availability of -0.068 - (-0.5022) in July to December. To overcome the deficit of water availability, it is necessary to carry out a pattern of water distribution operation with a rotation or class system.

3.3. *Retrieval Building Planning*

Kandar Irrigation Area, Selaru District, Using the Direct Retrieval building and Water Reservoir, for taking pumps. The area of the irrigation network is divided into tertiary blocks with a flat area of no more than 150 ha as far as possible, whereas in steep slopes as far as possible the area of the plot is not more than 80 ha.

In planning the main network, the irrigation network scheme is made first to facilitate and systematize further planning, while the irrigation network scheme planned at each location can be seen in Figure 1.
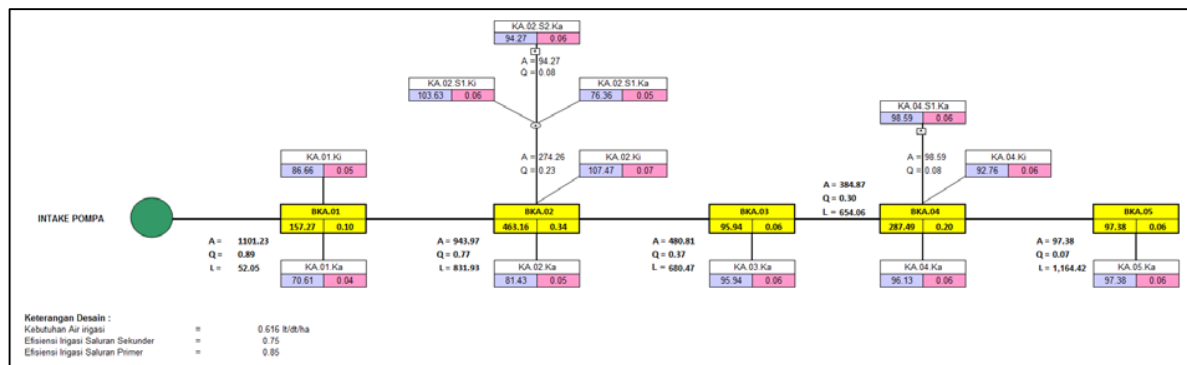
Figure 1. Kandar Irrigation Network Scheme Calculation of Irrigation Channel Dimensions With Q = 100% in the Kandar Irrigation Area

3.4. Perencanaan Petak Tersier

In the Dry Land Irrigation Planning activities, the scope of activity includes planning of primary and secondary channels. Primary channel is the main channel that connects the main building and Water Source Taking with the building for tapping or tapping buildings. While the Secondary Channel is a channel that connects the building for tapping one with another tapping building, which starts from the building for the primary channel.

The relationship to the distribution of Tertiary Plots and Water Needs can be seen in the table below:

Table 3. Distribution of Kandar Tertiary Irrigation Area, Kandar Village, Selaru District

No	Name of Plot	Areal		Water Needs		
		(m²)	(Ha)	l/dt/ha	l/dt	m³/dt
1	KA.01.Ka	706097,80	70,61	0,616	43,46	0,043
2	KA.01.Ki	866569,77	86,66	0,616	53,34	0,053
3	KA.02.Ka	814260,41	81,43	0,616	50,12	0,050
4	KA.02.Ki	1074695,30	107,47	0,616	66,15	0,066
5	KA.03.Ka	959418,62	95,94	0,616	59,06	0,059
6	KA.04.Ka	961318,87	96,13	0,616	59,17	0,059
7	KA.04.Ki	927605,35	92,76	0,616	57,10	0,057
8	KA.05.Ka	973824,53	97,38	0,616	59,94	0,060
9	KA.02.S1.Ka	763551,19	76,36	0,616	47,00	0,047
10	KA.02.S1.Ki	1036322,16	103,63	0,616	63,79	0,064
11	KA.02.S2.Ka	942734,04	94,27	0,616	58,03	0,058
12	KA.04.S1.Ka	985948,89	98,59	0,616	60,69	0,061
	Jumlah		1101,23	6,771	617,171	0,617
	Rerata			0,616	56,488	0,056

From the results of division based on predetermined plots, then the capacity of the canal is calculated using a pair of stones and calculating the appropriate measuring tools. The following is the result of calculating the capacity of the canal and measuring devices used for irrigation areas

No. Bangunan	Nama Bangunan	Masuk	Keluar	Luas (Ha)	Q	Debit Rencana (m3/dt)	Lebar (m)	high (m)	Jagaan (m)	Debit (m)	Koefisien	Bukaan Pintu Lebar (b)	Tinggi (a)	(Z) (m)	Head Lose (Z) (m)	Ukur Lebar (b)	Tinggi (h1) (m)	Elev 1	Elev 2	Elev 3	Elev 4	Elev 5
1	BKA.01	Saluran Primer	Intake KA - BKA.01	1101,23	Q100	1,109	2,50	0,51	0,49	0,576								6,84	7,327	6,33	6,14	
				1101,23	Q70	0,777	2,50	0,42	0,58	0,403											6,14	
		Saluran Primer	BKA.01 - BKA.02	943,97	Q100	0,967	2,50	0,47	0,53									6,61	7,14	6,14	6,14	
				943,97	Q70	0,677	2,50	0,38	0,62													
		Saluran Tersier	BKA.01 - KA.01.ka	70,61	Q100	0,054	1,00	0,20	0,80	0,069	0,800	0,500	0,200	0,200	0,200	1,000	0,101	6,64	7,44	6,44	6,14	6,04
				70,61	Q70	0,038	1,00	0,16	0,84	0,048	0,800	0,500	0,200	0,200	0,200	1,000	0,079					
		Saluran Tersier	BKA.01 - KA.01.ki	86,66	Q100	0,067	1,00	0,22	0,78	0,084	0,800	0,500	0,200	0,200	0,200	1,000	0,115	6,64	7,41	6,41	6,14	6,01
				86,66	Q70	0,047	1,00	0,18	0,82	0,059	0,800	0,500	0,200	0,200	0,200	1,000	0,091					
	BKA.02	Saluran Primer	BKA.01 - BKA.02	943,97	Q100	0,967	2,50	0,47	0,53									6,43	6,958	5,96	5,77	
				943,97	Q70	0,677	2,50	0,38	0,62													
		Saluran Primer	BKA.02 - BKA.03	480,81	Q100	0,465	2,50	0,31	0,69									6,20	6,89	5,89	5,77	
				480,81	Q70	0,325	2,50	0,25	0,75													
		Saluran Sekunder	BKA.02 - BKA.02.S	274,26	Q100	0,281	1,50	0,36	0,64	0,290	0,800	0,500	0,300	0,050	0,050	1,500	0,230	6,13	6,77	5,77	5,77	5,42
				274,26	Q70	0,197	1,50	0,29	0,71	0,203	0,800	0,500	0,300	0,050	0,050	1,500	0,181					
		Saluran Tersier	BKA.02 - KA.02.ka	81,43	Q100	0,044	1,00	0,18	0,82	0,055	0,800	0,500	0,200	0,200	0,200	1,000	0,087	6,23	7,05	6,05	5,77	5,65
				81,43	Q70	0,031	1,00	0,15	0,85	0,040	0,800	0,500	0,200	0,200	0,200	1,000	0,070					
		Saluran Tersier	BKA.02 - KA.02.ki	107,47	Q100	0,058	1,00	0,21	0,79	0,073	0,800	0,500	0,200	0,200	0,200	1,000	0,105	6,23	7,02	6,02	5,77	5,62
				107,47	Q70	0,041	1,00	0,17	0,83	0,052	0,800	0,500	0,200	0,200	0,200	1,000	0,084					
2	BKA.02.S1	Saluran Sekunder	BKA.02 - BKA.02.S1	274,26	Q100	0,197	1,50	0,29	0,71									5,50	6,21	5,21	4,90	
				274,26	Q70	0,141	1,50	0,24	0,76													
		Saluran Sekunder	BKA.02.S1 - BKA.0	94,27	Q100	0,068	1,50	0,16	0,84	0,085	0,800	0,500	0,200	0,050	0,050	1,500	0,089	5,30	6,15	5,15	4,90	4,90
				94,27	Q70	0,048	1,50	0,13	0,87	0,061	0,800	0,500	0,200	0,050	0,050	1,500	0,071					
		Saluran Tersier	BKA.02.S1 - KA	76,36	Q100	0,041	1,00	0,17	0,83	0,052	0,800	0,500	0,200	0,200	0,200	1,000	0,084	5,30	6,13	5,13	4,90	4,73
				76,36	Q70	0,029	1,00	0,14	0,86	0,037	0,800	0,500	0,200	0,200	0,200	1,000	0,067					
		Saluran Tersier	BKA.02.S1 - KA	103,63	Q100	0,056	1,00	0,20	0,80	0,070	0,800	0,500	0,200	0,200	0,200	1,000	0,102	5,10	5,90	4,90	4,90	4,50
				103,63	Q70	0,040	1,00	0,17	0,83	0,050	0,800	0,500	0,200	0,200	0,200	1,000	0,082					
	BKA.02.S2	Saluran Sekunder	BKA.02.S1 - BKA.02.S2	94,27	Q100	0,068	1,50	0,16	0,84									4,79	5,64	4,64	4,40	
				94,27	Q70	0,048	1,50	0,13	0,87													
		Saluran Tersier	BKA.02.S2 - KA	94,27	Q100	0,051	1,00	0,19	0,81	0,064	0,800	0,500	0,200	0,200	0,200	1,000	0,096	4,59	5,40	4,40	4,40	4,00
				94,27	Q70	0,036	1,00	0,16	0,84	0,046	0,800	0,500	0,200	0,200	0,200	1,000	0,077					
3	BKA.03	Saluran Primer	BKA.02 - BKA.03	480,81	Q100	0,465	2,50	0,31	0,69									5,97	6,656	5,66	5,43	
				480,81	Q70	0,325	2,50	0,25	0,75													
		Saluran Primer	BKA.03 - BKA.04	384,87	Q100	0,378	2,00	0,31	0,69	0,225	0,800	1,000	1,000	0,225	0,200	1,000	0,123	5,74	6,43	5,43	5,43	
				384,87	Q70	0,265	2,00	0,25	0,75	0,158	0,800	1,000	1,000	0,225	0,200	1,000	0,097					
		Saluran Tersier	BKA.03 - KA.03.ka	95,94	Q100	0,074	1,00	0,24	0,76	0,093	0,800	0,500	0,200	0,200	0,200	1,000	0,124	5,77	6,53	5,53	5,43	5,13
				95,94	Q70	0,052	1,00	0,19	0,81	0,065	0,800	0,500	0,200	0,200	0,200	1,000	0,097					
4	BKA.04	Saluran Primer	BKA.03 - BKA.04	384,87	Q100	0,378	2,00	0,31	0,69									5,68	6,366	5,37	5,18	
				384,87	Q70	0,265	2,00	0,25	0,75													
		Saluran Primer	BKA.04 - BKA.05	97,38	Q100	0,088	2,00	0,13	0,87	0,052	0,800	1,000	1,000	0,225	0,200	1,000	0,116	5,45	6,32	5,32	5,18	
				97,38	Q70	0,062	2,00	0,11	0,89	0,037	0,800	1,000	1,000	0,225	0,200	1,000	0,092					
		Saluran Sekunder	BKA.04 - BKA.04.S	98,59	Q100	0,101	1,50	0,20	0,80	0,104	0,800	0,500	0,300	0,050	0,050	1,500	0,116	5,38	6,18	5,18	5,18	4,83
				98,59	Q70	0,071	1,50	0,16	0,84	0,073	0,800	0,500	0,300	0,050	0,050	1,500	0,092					
		Saluran Tersier	BKA.04 - KA.04.ka	96,13	Q100	0,074	1,00	0,24	0,76	0,093	0,800	0,500	0,200	0,200	0,200	1,000	0,124	5,48	6,24	5,24	5,18	4,84
				96,13	Q70	0,052	1,00	0,19	0,81	0,065	0,800	0,500	0,200	0,200	0,200	1,000	0,097					
		Saluran Tersier	BKA.04 - KA.04.ki	92,76	Q100	0,071	1,00	0,23	0,77	0,090	0,800	0,500	0,200	0,200	0,200	1,000	0,121	5,48	6,24	5,24	5,18	4,84
				92,76	Q70	0,050	1,00	0,19	0,81	0,063	0,800	0,500	0,200	0,200	0,200	1,000	0,095					
	BKA.04.S1	Saluran Sekunder	BKA.04 - BKA.04.S1	98,59	Q100	0,101	1,50	0,20	0,80									4,73	5,53	4,53	4,29	
				98,59	Q70	0,071	1,50	0,16	0,84													
		Saluran Tersier	BKA.04.S1 - KA	98,59	Q100	0,076	1,00	0,24	0,76	0,096	0,800	0,500	0,200	0,200	0,200	1,000	0,126	4,53	5,29	4,29	4,29	3,89
				98,59	Q70	0,053	1,00	0,20	0,80	0,067	0,800	0,500	0,200	0,200	0,200	1,000	0,099					
5	BKA.05	Saluran Primer	BKA.04 - BKA.05	97,38	Q100	0,088	2,00	0,20	0,80									5,05	5,85	4,85	4,61	
				97,38	Q70	0,062	2,00	0,11	0,89													
		Saluran Tersier	BKA.05 - KA.05.ka	97,38	Q100	0,075	1,00	0,24	0,76	0,095	0,800	0,500	0,200	0,200	0,200	1,000	0,125	4,85	5,61	4,61	4,61	4,21
				97,38	Q70	0,052	1,00	0,20	0,80	0,066	0,800	0,500	0,200	0,200	0,200	1,000	0,098					

4. Conclusion

1. Irrigation water supplied by water (Kandar Irrigation Area) is sufficient for irrigation needs.
2. Current Irrigation Land Conditions are generally still quite good, but there are some places where there is too much saturated soil conditions that need to be drained first.

3. The total area of Kandar Irrigation Area, Kandar village, Selaru District, West Southeast Maluku Regency is 1101.23 ha with a length of primary channel 3383m and length of secondary canal 3053m.

5. References

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