FULL PRACTICUM REPORT
ENGINEERING HYDROLOGY
(19G04122301)

FAHMI ALFARABI
G041201016

SOIL AND WATER ENGINEERING LABORATORY
AGRICULTURAL ENGINEERING STUDY PROGRAM
DEPARTMENT OF AGRICULTURAL TECHNOLOGY
FACULTY OF AGRICULTURE
HASANUDDIN UNIVERSITY
MAKASSAR
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ENDORSEMENT PAGE

TITLE : ENGINEERING HYDROLOGY PRACTICUM FULL REPORT
NAME : FAHMI ALFARABI
NIM : G041201016
GROUP : I (ONE)

This Full Report is Prepared as One of the Requirements
To Complete the Laboratory Examination for Engineering Hydrology Practicum Course
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At

Agricultural Engineering Study Program
Department of Agricultural Technology
Faculty of Agriculture
Hasanuddin University
Makassar
2021

Approved,

Assistant 1	Assistant 2
MUH. WAHYU APRILIANDI	**HARVHIANTI HARUKI**
NIM. G041181305	**NIM. G041191074**

Assistant Coordinator

MUHAMMAD DAIFULLAH
NIM. G041181018

Knowing,
Course Coordinator

SAMSUAR, S.TP., M.SI.
NIP. 19850709201504 1 001

Makassar' May 26, 2022

FOREWORD

Praise the author for the presence of Allah SWT. For all the abundance of His grace and gifts. so that the author can take part in practicum activities and complete the Complete Engineering Hydrology Practicum Report. Shalawat and greetings do not forget the author devotes to the Prophet Muhammad SAW who has brought humans to the modern age like today.

The author can complete this Complete Engineering Hydrology Practicum Report inseparable from encouragement and assistance from Dylan Wielfred Paelongan and Muh. Akbar Satrianegara as assistants in this practicum, Rosalinda as assistant coordinator, as well as to friends from group one and Actuator classmates who have helped the author when in trouble writing this practicum report.

The author realizes that this practicum report is far from perfect. However, the author hopes that this practicum report can provide benefits for everyone who reads it later. The author hopes for constructive criticism and suggestions.

Makassar, November 26, 2021

Fahmi Alfarabi

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Fahmi Alfarabi[1)], Muh. Wahyu Apriliandi[2)] and Harvhianti Haruki[2)]
[1)] Practicum Practitioner of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University
[2)] Practicum Assistant of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

RESULTS AND DISCUSSION

Results

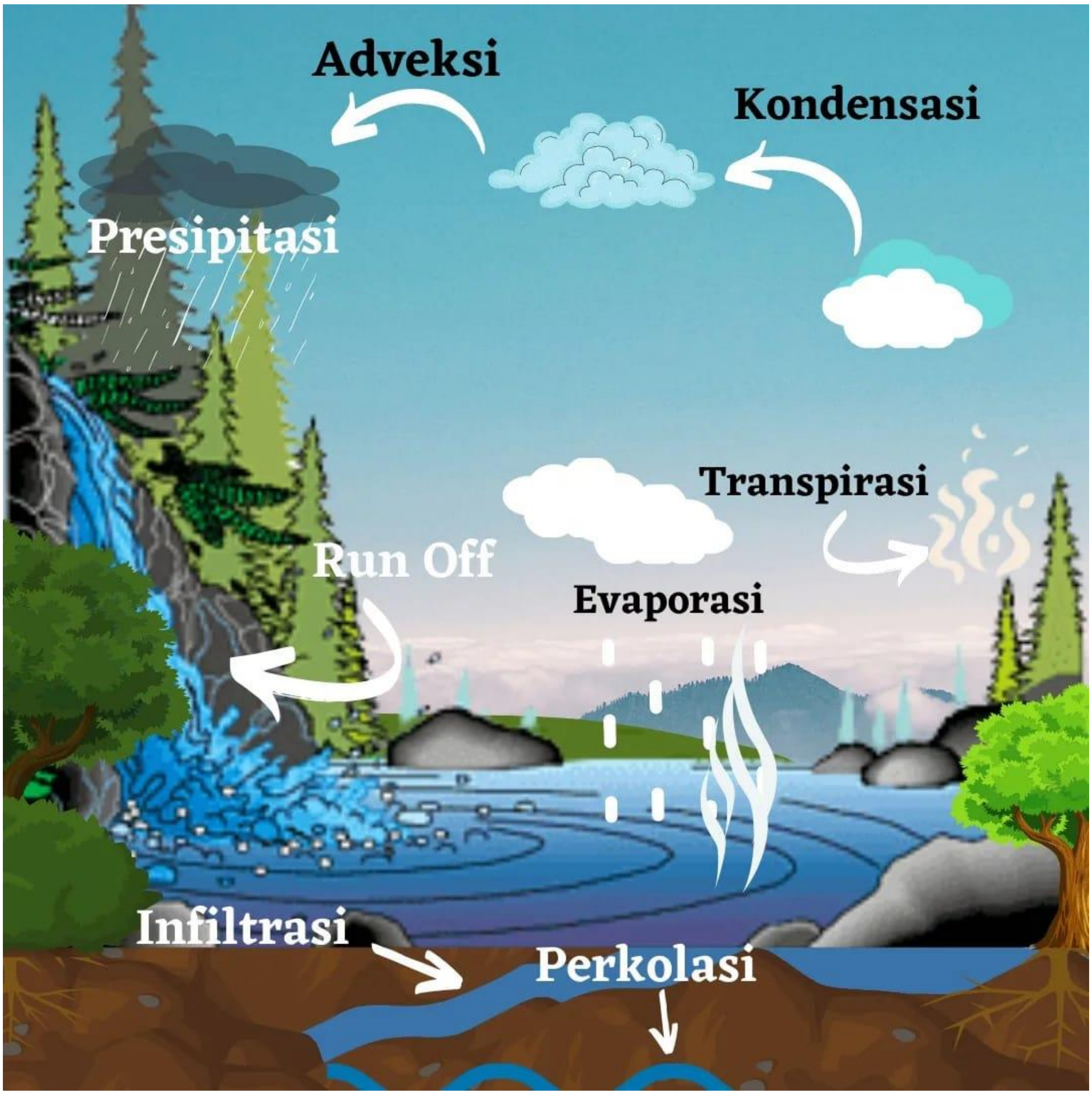

Image 1. Hydrology Cycle.

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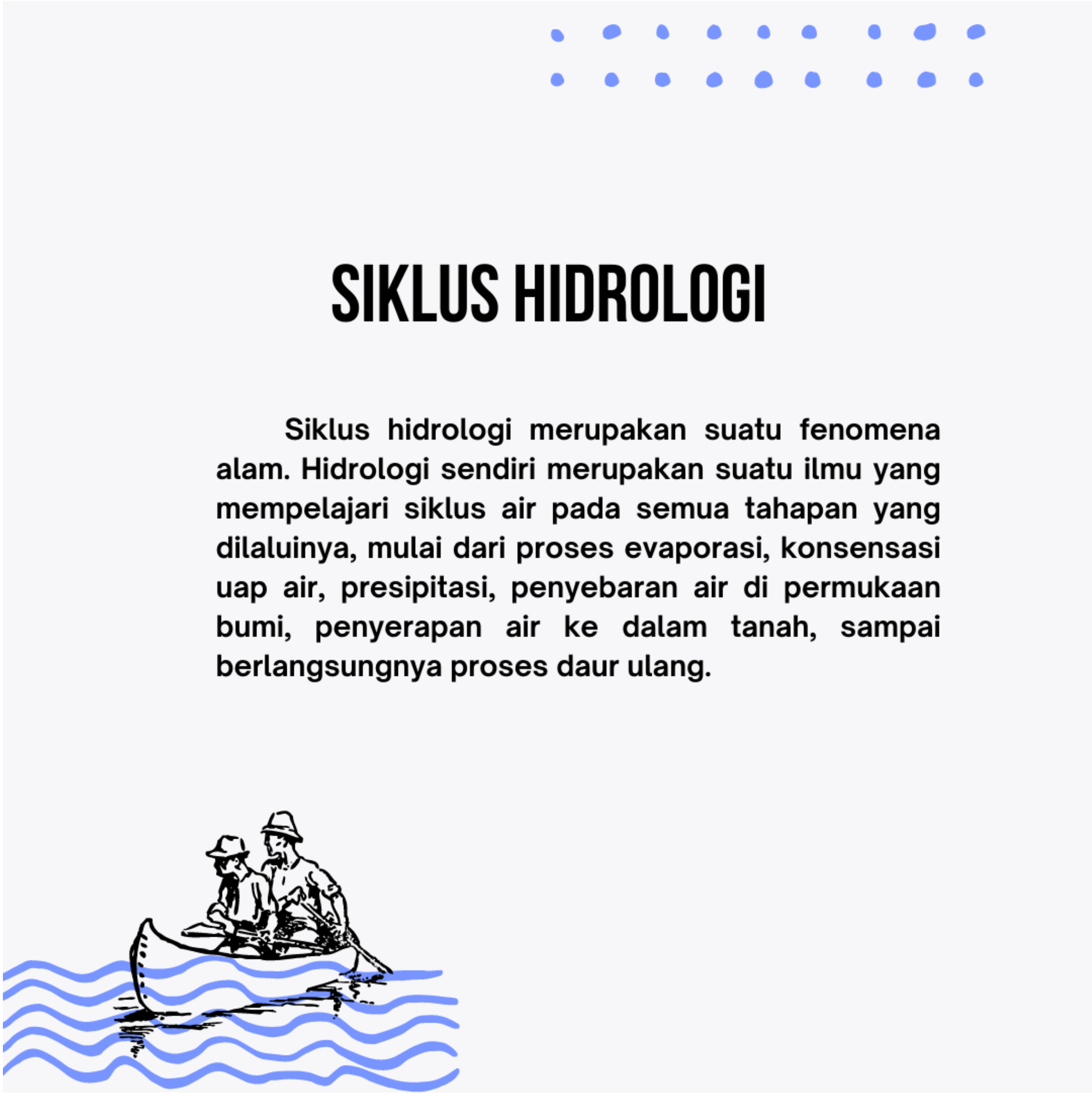

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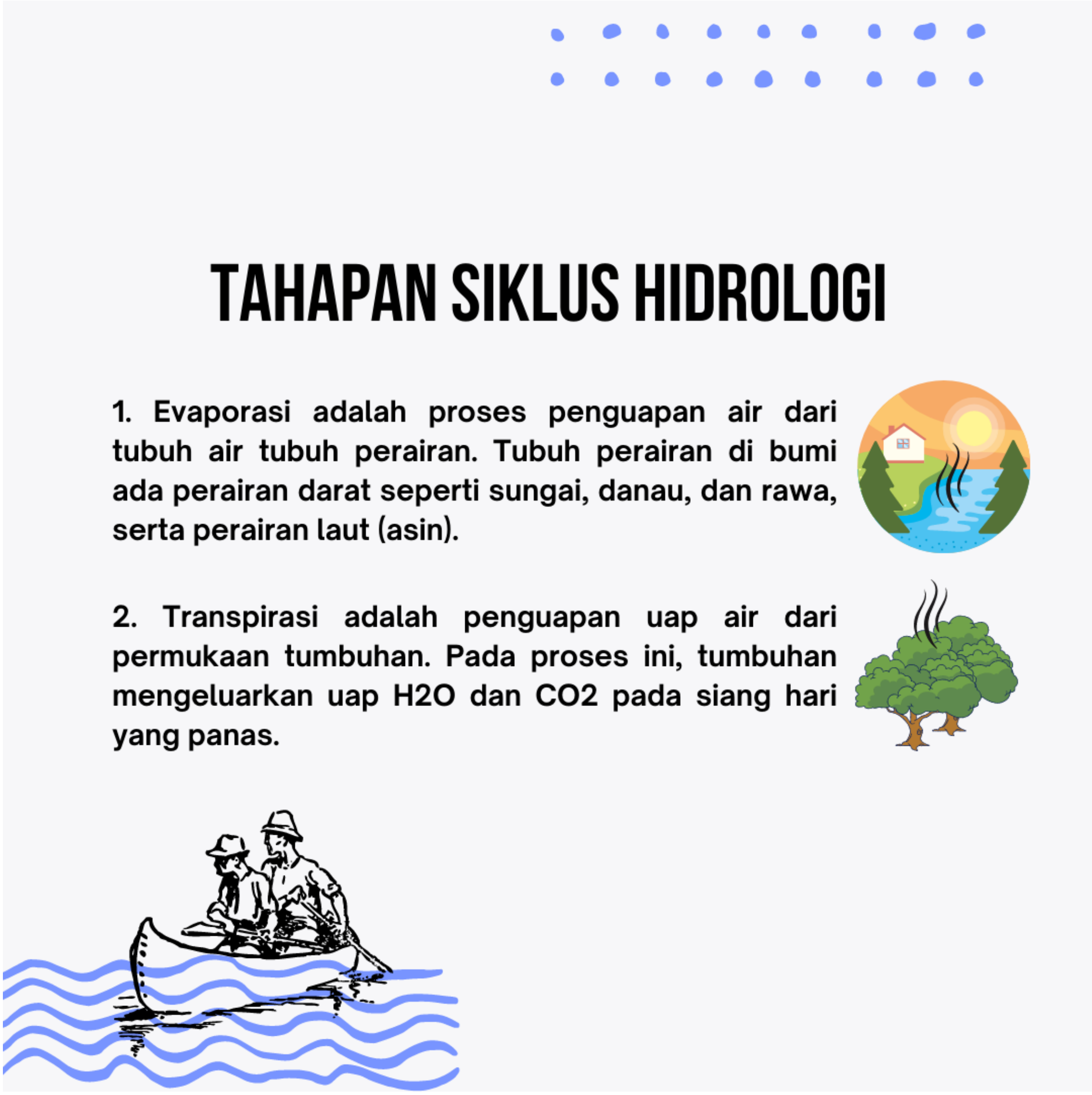
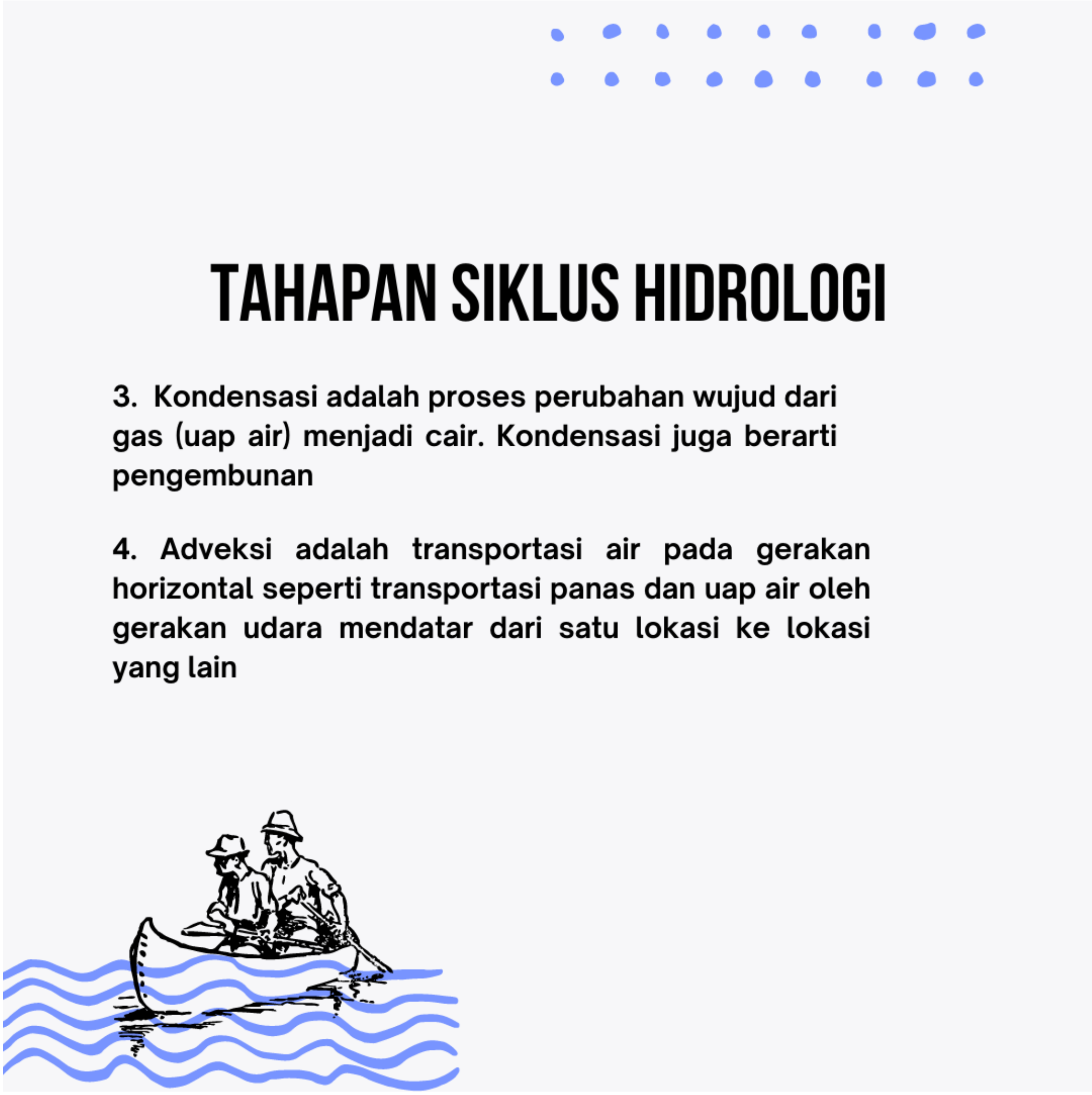


Image 3. Explanation of the Stages of the Hydrology Cycle of Evaporation and Transpiration.



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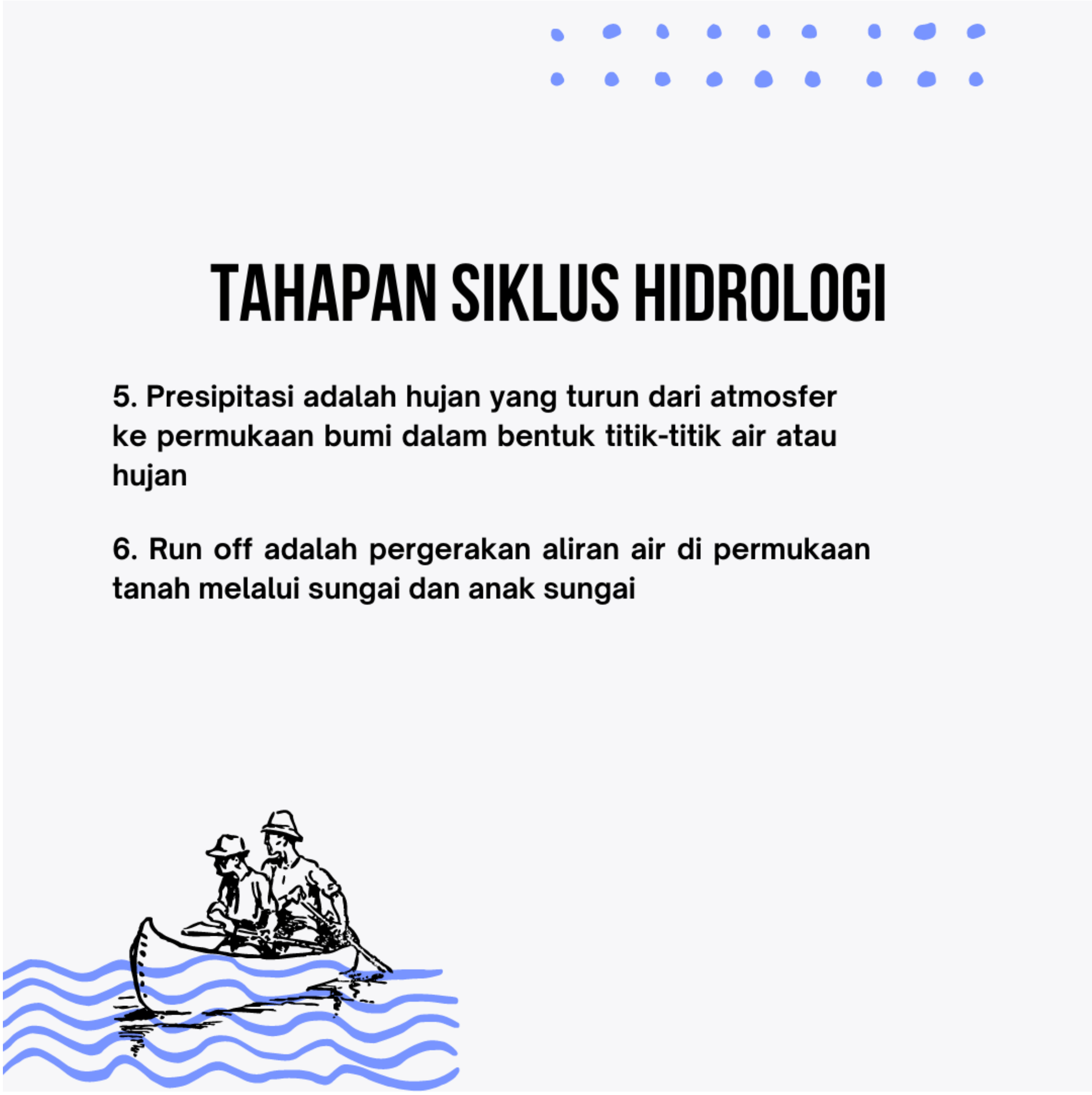

Image 5. Explanation of the Hydrology Cycle Stages of Precipitation and *Run Off*.

TAHAPAN SIKLUS HIDROLOGI

7. Infiltrasi adalah aliran air ke dalam tanah melalui permukaan tanah itu sendiri. Di dalam tanah, air mengalir ke arah pinggir, sebagai aliran perantara menuju mata air, danau, dan sungai atau secara vertikal yang dikenal dengan penyaringan menuju air tanah.

8. Perkolasi adalah air yang diserap melalui pori-pori tanah, bergerak secara vertikal maupun horizontal menuju muka air tanah.

Image 6. Explanation of the Stages of the Infiltration and Percolation Hydrology Cycle.

FENOMENA SIKLUS HIDROLOGI

Hujan Asam

Secara alami hujan asam dapat terjadi akibat semburan dari gunung berapi dan dari proses biologis di tanah, rawa, dan laut. Akan tetapi, mayoritas hujan asam disebabkan oleh aktivitas manusia seperti pembakaran bahan bakar fosil, industri, pembangkit tenaga listrik, kilang minyak, kendaraan bermotor dan pabrik pengolahan pertanian (terutama amonia).Gas-gas yang dihasilkan oleh proses ini dapat terbawa angin hingga ratusan kilometer di atmosfer sebelum berubah menjadi asam dan terdeposit ke tanah.

Hujan asam disebabkan oleh belerang (sulfur) yang merupakan pengotor dalam bahan bakar fosil serta nitrogen di udara yang bereaksi dengan oksigen membentuk sulfur dioksida dan nitrogen oksida.

Image 7. Explanation of the Hydrology Cycle Phenomenon.

CLIMATOLOGY DATA COLLECTION

Fahmi Alfarabi[1)], Muh. Wahyu Apriliandi[2)] and Harvhianti Haruki[2)]

[1)] Practicum Practitioner of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

[2)] Practicum Assistant of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

RESULTS AND DISCUSSION

Results

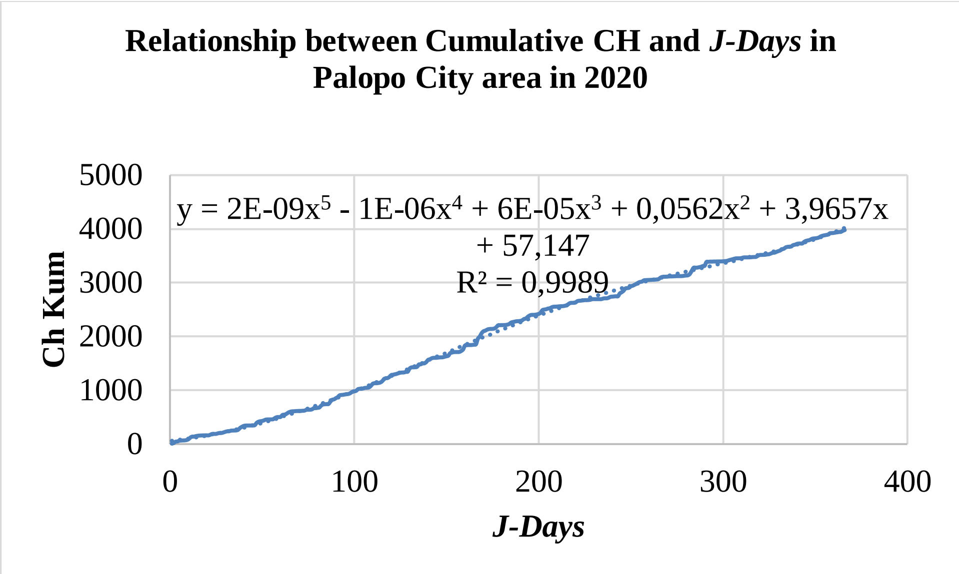

Image 8. Graph of Relationship between CH Kum and J-Days in Palopo City.

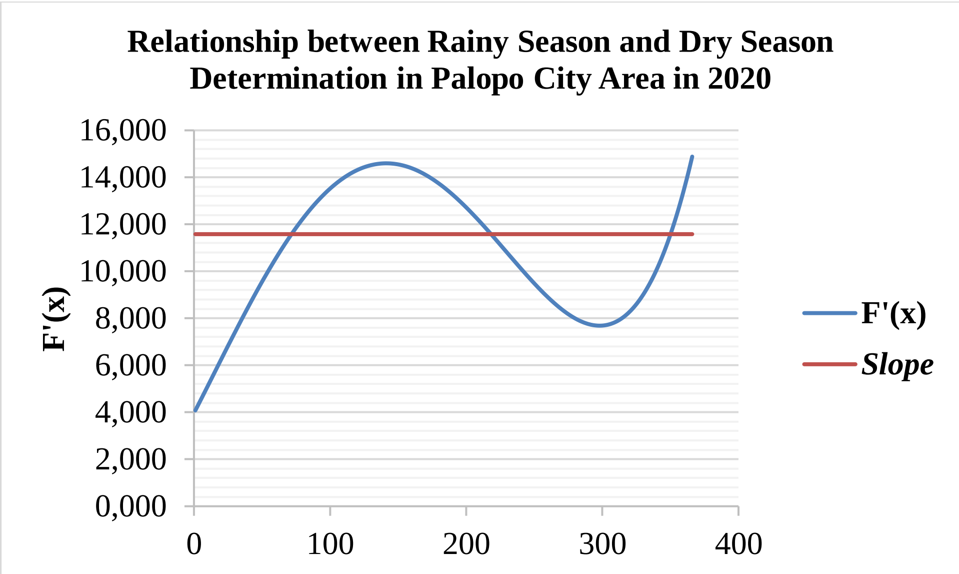

Image 9. Graph of Rainy and Dry Season Determination Results in Palopo City.

Table 1. Rainfall Polynomial Determination in Palopo City.

Tahun	Polinomial F(x)						R^2	*Slope*
2020	A5	A4	A3	A2	A1	A0	0,9989	11,5818
	1,846E-09	-1,129E-06	6,373E-05	5,618E-02	3,966E+00	5,715E+01		

Table 2. Determination of Rainy and Dry Seasons in Palopo City.

Year	Start of Dry Season	Start of Rainy Season	Length of Rainy Season	Max CH	Annual CH
2020	219	71	148	102,87	3978,13

Discussion

Climatological data or known as *climatological data is* known as data used to describe weather and climate conditions in an area. Climatological data collection is one form of activity from the weather and climate prediction process of an area both in the long and short term. Climatological data can be retrieved through official *websites* available on the internet such as BMKG and Nasa Power. Climatological data collection and processing activities are very useful in agriculture, for example, it can be used as a material for identifying the timing of a good crop planting period and also used as information in making good irrigation channels in an area. In addition, climatological data collection is often used to support the process of identifying regional development based on weather and climate conditions. This is in accordance with the statement Faisol *et al*., (2020), stating that data collection is used to determine the level of rainfall and drought in an area.

Climatology Data Retrieval practicum activities begin with downloading data available at Nasa Power and then processing the data. Climatological data modeling activities are carried out because they provide benefits such as knowing the relative changes in the atmosphere in an area. This is in accordance with the statement Worku *et al*., (2018)(2018), stating that a region needs a GCM (Global Climate Model) to assess relative changes in the climate system due to various radiation forcing and make climate predictions on seasonal to decade time scales and future climate projections.

Based on the results of climatological data processing that has been carried out, namely the relationship between cumulative rainfall and time, the results obtained illustrate that in Palopo city has a regression value of 0.9989 which is accurate. As for the determination of the rainy and dry seasons, it is found that the beginning of the dry season in 2020 is on day 219 while for the beginning of the rainy season in Palopo city is on day 71. The occurrence of the rainy season and dry season is due to several influencing factors such as the geographical location of an area and also the activities that occur in the area. This is in accordance with the statement of Wahyuni *et al*., (2021)Wahyuni et al. (2021) stated that the vast territory of Indonesia has a variety of different rainfall patterns in its various regions because Indonesia is located between the Asian continent and the Australian continent so that there can be a rainy season and dry season from the movement of the west monsoon wind and east monsoon wind.

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Faisol, A., Budiyono, B., Indarto, I., and Novita, E. (2020). Utilization of Global Precipitation Measurement (GPM) and Standardized Precipitation Index (SPI) Data for Meteorological Drought Detection in West Papua Province. *Agritechno Journal*, *13*(1), 8-15.

Juma'a, M. W., Limantara, L. M., and Wahyuni, S. (2021). Estimation of Rainfall Height from Climatological Data Using Artificial Neural Network (ANN) Model in Badung Regency, South Bali. *Journal of Water Resources Technology and Engineering*, *1*(1), 126-135.

Worku, G., Teferi, E., Bantider, A., Dile, Y. T., and Taye, M. T. (2018). *Evaluation of regional climate models performance in simulating rainfall climatology of Jemma sub-basin, Upper Blue Nile Basin,* Ethiopia. *Dynamics of Atmospheres and Oceans*, *83* (October 2017), 53-63.

ATTACHMENT

Attachment 1. Climatological Data Collection Procedures

The procedures for collecting climatological data are as follows:

1. Go to website*https://power.larc.nasa.gov/*

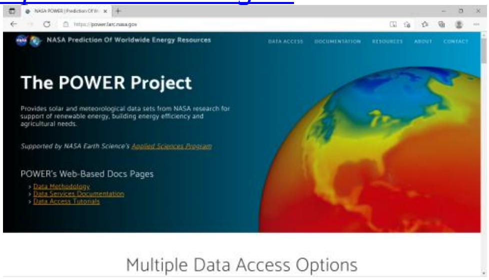

Image10. Display the NASA*project*.

2. *Scroll*down, then select Power Data Access Viewer.

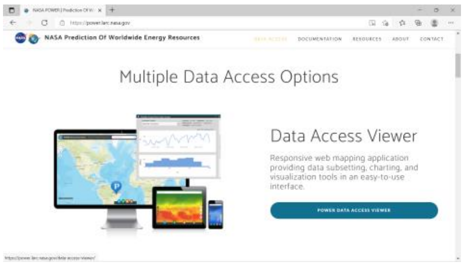

Image11. Appearance*Power Data Access Viewer*.

3. Click access data.

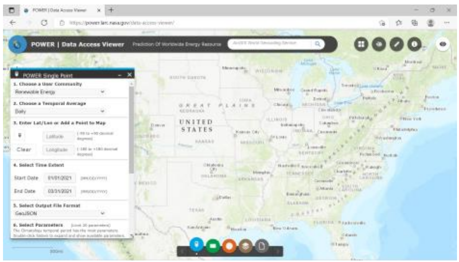

Image12. Appearance *Access Data*.

4. After that, Power Single Point Data Access will appear. In part 1, choose a single community, choose Agroclimatology.

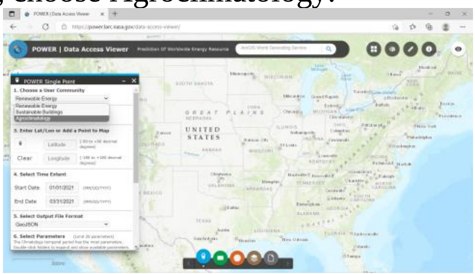

Image13. Appearance*Choose a Single Community*.

5. In the choose a Temporal Average section, select daily.

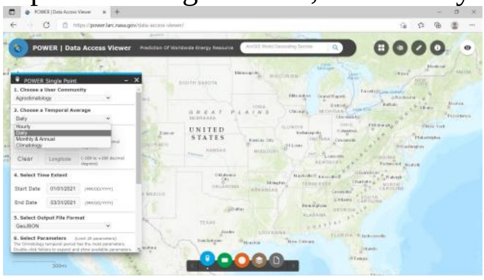

Image14. Display on C*hoose a Temporal Average*.

6. Find the location that you want to process the data.

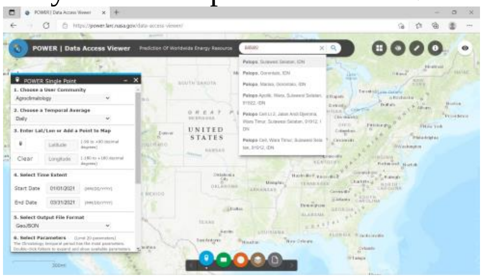

Image15. Display Select Location.

7. Clicking once part of the selected location.

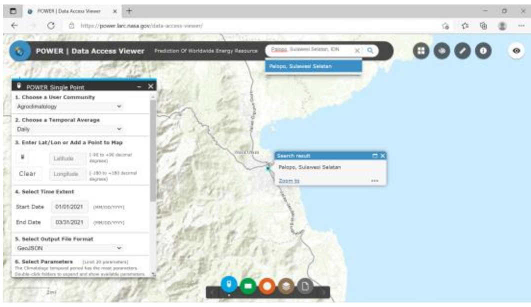

Image16. Selected location display.

8. Determine the time range, in the start date format (date, month, year) and in the end date format (month, day, year). Choose a time range of one year or 365 or 366 days. For example, for the start date (01/01/2020) and for the end date (31/12/2020).

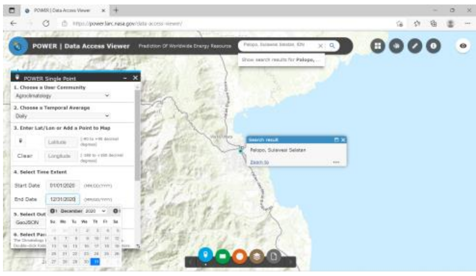

Image 17. Display on*Start dateand End Dates.*

9. In the Select output file formats section, choose CSV.

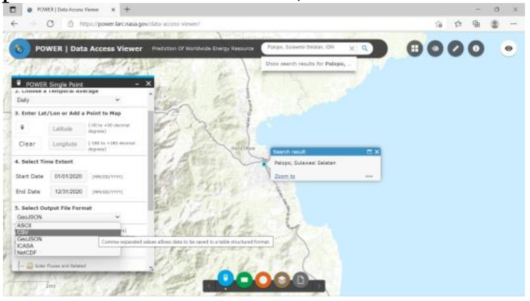

Image 18. Appearance*Select Output File Formats.*

10. In the Select Parameters section, click Humadity/Precipitation then check precipitation.

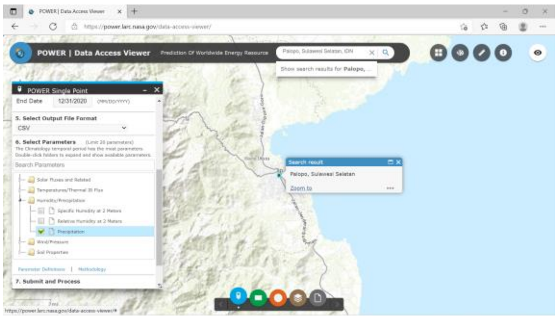

Image 19. Display on*Select Parameters.*

11. Click Submit.

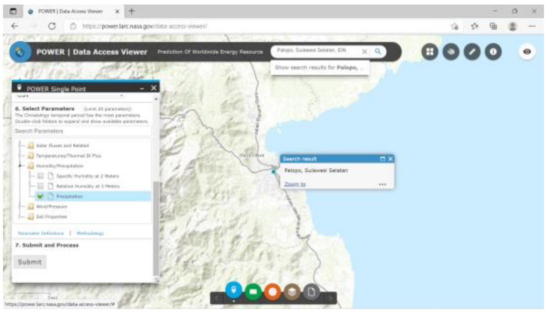

Image 20. Display on*Submit.*

12. After submitting, click CSV to download the data.

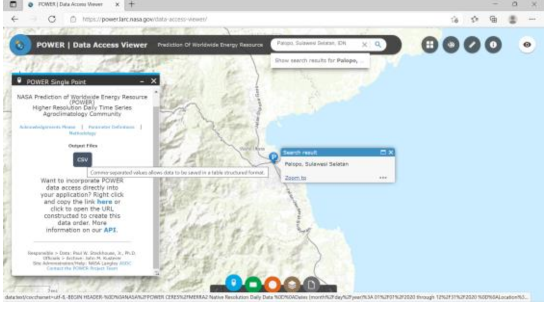

Image 21. CSV view.

Attachment 2. Climatological Data Processing Procedures

The procedures for processing climatological data are as follows:

1. Copying data day and Protector.

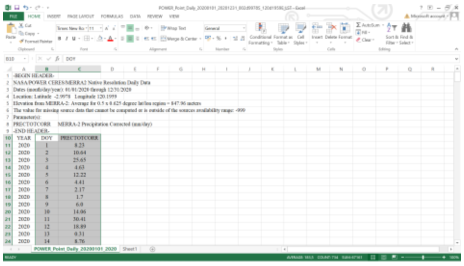

Image 22. Views on Data.

2. Placing the copy on a new sheet.

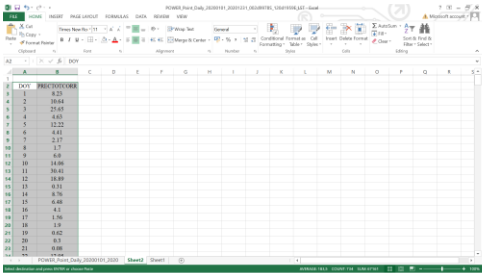

Image 23. Display on Move to*sheets*New.

3. Find the Cumulative Rainfall value with the formula Ch cumulative + Ch.

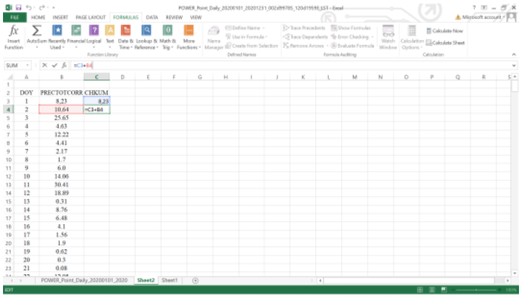

Image 24. CHKUM Value Display.

4. Make a graph of the relationship between CHKUM and Jdays by blocking CHKUM and Jdays then to insert, select insert scatter.

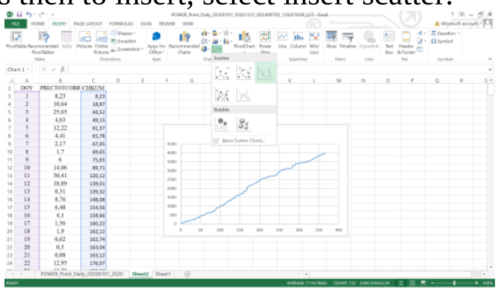

Image 25. Display on*Insert Menu.*

5. Find the value of F(X) using the formula below.

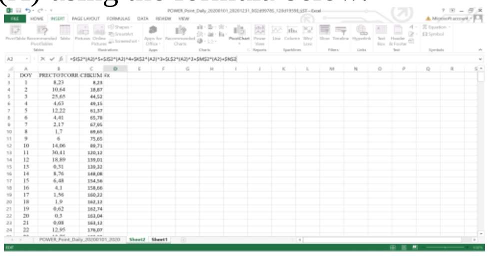

Image 26. Display Seeking F(X).

6. Find F'(X) using the formula below.

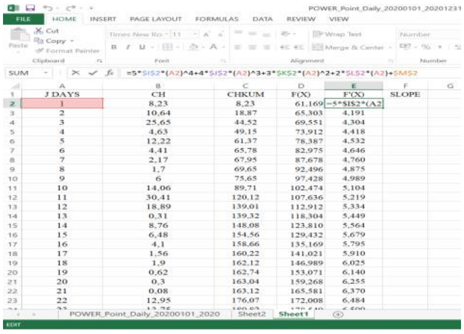

Image 27. The display seeks F'(X).

7. Find the SLOPE value using the formula below.

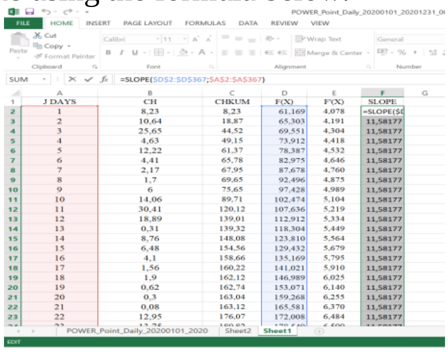

Image 28. Finding Value*SLOPE*.

8. Make a graph of the results of determining the rainy and dry seasons by blocking the Slope, F'(X) and days values, then selecting insert and selecting the insert scatter graph.

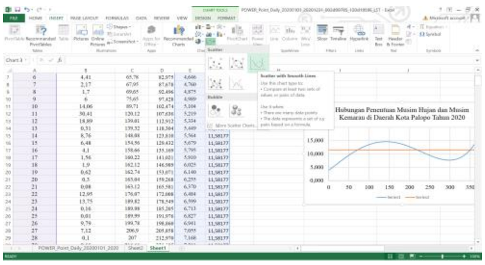

Image 29. Display of Making Graphs of Determination of Rainy and Dry Seasons.

9. Make a table of the beginning of the dry season, the beginning of the wet season, the length of the dry season, the maximum CH and annual CH.

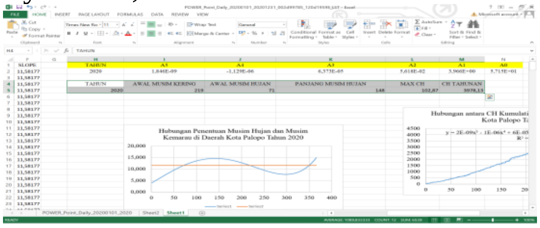

Image 30. Table View.

Attachment 3. Table of Cumulative J days, CH, CHKUM, F(X), F'(X) and SLOPE

Table 3. Cumulative J-Days, CH, CHKUM, F(X), F'(X) and SLOPE.

J DAYS	CH	CHKUM	F(X)	F'(X)	*SLOPE*
1	8,23	8,23	61,169	4,078	11.5818
2	10.64	18.87	65,303	4,191	11.5818
3	25.65	44,52	69,551	4,304	11.5818
4	4.63	49,15	73,912	4,418	11.5818
5	12,22	61,37	78,387	4,532	11.5818
6	4,41	65,78	82,975	4,646	11.5818
7	2,17	67.95	87,678	4,760	11.5818
8	1,7	69.65	92,496	4,875	11.5818
9	6	75.65	97,428	4,989	11.5818
10	14.06	89.71	102,474	5.104	11.5818
11	30,41	120,12	107,636	5,219	11.5818
12	18.89	139.01	112,912	5,334	11.5818
13	0.31	139,32	118,304	5,449	11.5818
14	8.76	148.08	123,810	5,564	11.5818
15	6,48	154.56	129,432	5,679	11.5818
16	4,1	158,66	135,169	5,795	11.5818
17	1.56	160,22	141,021	5,910	11.5818
18	1,9	162,12	146,989	6.025	11.5818
19	0.62	162.74	153,071	6,140	11.5818
20	0.3	163.04	159,268	6,255	11.5818
21	0.08	163,12	165,581	6,370	11.5818
22	12.95	176.07	172,008	6,484	11.5818
23	13.75	189,82	178,549	6,599	11.5818
24	0.16	189.98	185,205	6,713	11.5818
25	0.01	189.99	191,976	6,827	11.5818
26	9.79	199.78	198,860	6,941	11.5818
27	7,12	206,9	205,858	7,055	11.5818
28	0.1	207	212,970	7,168	11.5818
29	9,66	216.66	220,195	7,281	11.5818
30	11.62	228,28	227,533	7,394	11.5818
31	9,18	237,46	234,983	7,507	11.5818

32	0.57	238.03	242,546	7,619	11.5818
33	11.59	249,62	250,221	7,731	11.5818
34	2.36	251.98	258,007	7,842	11.5818
35	1.14	253,12	265,905	7,953	11.5818
36	1.52	254.64	273,913	8,063	11.5818
37	11.82	266,46	282,031	8.173	11.5818
38	34.03	300.49	290,260	8,283	11.5818
39	20,61	321,1	298,597	8,392	11.5818
40	16.97	338.07	307,044	8,501	11.5818
41	6,68	344.75	315,599	8,609	11.5818
42	0.78	345.53	324,261	8,716	11.5818
43	0.14	345,67	333,031	8,823	11.5818
44	0.01	345.68	341,908	8,930	11.5818
45	0.77	346.45	350,891	9,036	11.5818
46	5,34	351.79	359,979	9.141	11.5818
47	42,48	394,27	369,172	9,245	11.5818
48	21.69	415.96	378,469	9,349	11.5818
49	8,8	424.76	387,870	9,452	11.5818
50	5,11	429.87	397,374	9,555	11.5818
51	12,24	442.11	406,980	9,657	11.5818
52	13.66	455.77	416,688	9,758	11.5818
53	2.51	458,28	426,496	9,859	11.5818
54	0.38	458.66	436,404	9,958	11.5818
55	1,4	460.06	446,412	10.057	11.5818
56	2,11	462,17	456,518	10.155	11.5818
57	24,26	486,43	466,722	10.253	11.5818
58	14,47	500.9	477,023	10,349	11.5818
59	2,22	503,12	487,421	10.445	11.5818
60	1.82	504.94	497,913	10,540	11.5818
61	36.07	541.01	508,500	10.634	11.5818
62	6,29	547.3	519,181	10,727	11.5818
63	11.5	558.8	529,954	10,820	11.5818
64	23,66	582.46	540,820	10,911	11.5818
65	16.01	598.47	551,776	11,002	11.5818
66	9,7	608,17	562,822	11,091	11.5818
67	1.55	609.72	573,958	11,180	11.5818
68	3,19	612.91	585,182	11,268	11.5818
69	1.94	614.85	596,493	11.355	11.5818
70	1,13	615.98	607,891	11,440	11.5818
71	0.73	616,71	619,374	11.525	11.5818
72	3,2	619.91	630,941	11,609	11.5818
73	2.95	622.86	642,592	11,692	11.5818
74	14,27	637,13	654,325	11,774	11.5818

75	1.65	638.78	666,140	11,855	11.5818
76	0.54	639,32	678,035	11,935	11.5818
77	6,48	645.8	690,009	12.014	11.5818
78	21.37	667,17	702,062	12,092	11.5818
79	1.63	668.8	714,192	12.168	11.5818
80	5.03	673,83	726,398	12,244	11.5818
81	7.07	680.9	738,679	12,319	11.5818
82	34,74	715.64	751,035	12,392	11.5818
83	20.54	736,18	763,463	12,464	11.5818
84	4.06	740,24	775,963	12,536	11.5818
85	3,15	743.39	788,534	12.606	11.5818
86	1.85	745,24	801,175	12,675	11.5818
87	43.94	789,18	813,884	12,743	11.5818
88	34,66	823,84	826,660	12,810	11.5818
89	8.33	832.17	839,503	12,875	11.5818
90	22,2	854.37	852,411	12,940	11.5818
91	19.39	873.76	865,382	13,003	11.5818
92	32.96	906.72	878,417	13,065	11.5818
93	6,7	913.42	891,513	13.126	11.5818
94	3.61	917.03	904,669	13.186	11.5818
95	6.98	924.01	917,885	13,245	11.5818
96	5.07	929.08	931,159	13.302	11.5818
97	5.09	934,17	944,489	13,359	11.5818
98	16,68	950.85	957,876	13,414	11.5818
99	23,44	974,29	971,316	13,467	11.5818
100	6.95	981.24	984,810	13,520	11.5818
101	9.47	990.71	998,356	13,572	11.5818
102	30,81	1021.52	1011,953	13,622	11.5818
103	6,84	1028,36	1025,599	13,671	11.5818
104	0.78	1029,14	1039,294	13,718	11.5818
105	8.69	1037,83	1053,035	13,765	11.5818
106	8.05	1045.88	1066,823	13,810	11.5818
107	1,12	1047	1080,655	13,854	11.5818
108	8.54	1055,54	1094,531	13,897	11.5818
109	28.01	1083.55	1108,448	13,938	11.5818
110	39.04	1122.59	1122,407	13,978	11.5818
111	8.78	1131.37	1136,405	14,017	11.5818
112	0	1131.37	1150,441	14,055	11.5818
113	4.85	1136,22	1164,515	14,092	11.5818
114	7,7	1143.92	1178,624	14,127	11.5818
115	21.94	1165.86	1192,768	14.161	11.5818
116	36,86	1202.72	1206,945	14,193	11.5818
117	22.52	1225,24	1221,154	14,225	11.5818

118	2.35	1227,59	1235,394	14.255	11.5818
119	21.39	1248.98	1249,663	14,284	11.5818
120	34	1282.98	1263,961	14,311	11.5818
121	5.85	1288,83	1278,285	14,337	11.5818
122	9,13	1297.96	1292,635	14,362	11.5818
123	8,31	1306,27	1307,009	14,386	11.5818
124	12,12	1318,39	1321,407	14,409	11.5818
125	8.97	1327,36	1335,826	14,430	11.5818
126	3.89	1331.25	1350,266	14,450	11.5818
127	1.36	1332,61	1364,725	14,468	11.5818
128	11.15	1343.76	1379,202	14,486	11.5818
129	3,42	1347,18	1393,696	14,502	11.5818
130	57,71	1404.89	1408,205	14,517	11.5818
131	21.43	1426,32	1422,729	14,530	11.5818
132	0.45	1426,77	1437,265	14,542	11.5818
133	2.37	1429,14	1451,813	14,553	11.5818
134	7.01	1436,15	1466,371	14,563	11.5818
135	43,53	1479.68	1480,939	14,572	11.5818
136	3,27	1482.95	1495,514	14,579	11.5818
137	16,12	1499.07	1510,096	14,585	11.5818
138	2.82	1501.89	1524,683	14,590	11.5818
139	22,73	1524,62	1539,275	14,593	11.5818
140	41	1565,62	1553,869	14,595	11.5818
141	11.09	1576,71	1568,465	14,596	11.5818
142	19,21	1595,92	1583,061	14,596	11.5818
143	7,53	1603.45	1597,656	14,594	11.5818
144	0.44	1603.89	1612,249	14,592	11.5818
145	2.02	1605.91	1626,839	14,588	11.5818
146	4.97	1610.88	1641,425	14,583	11.5818
147	1.55	1612,43	1656,004	14,576	11.5818
148	2,19	1614,62	1670,577	14,569	11.5818
149	9.79	1624,41	1685,141	14,560	11.5818
150	8,62	1633.03	1699,696	14,550	11.5818
151	10.91	1643.94	1714,241	14,539	11.5818
152	47,48	1691,42	1728,773	14,526	11.5818
153	10.76	1702,18	1743,293	14,513	11.5818
154	8,18	1710.36	1757,799	14,498	11.5818
155	1.24	1711.6	1772,289	14,482	11.5818
156	0.13	1711.73	1786,763	14,465	11.5818
157	2.64	1714,37	1801,220	14,447	11.5818
158	16.99	1731.36	1815,657	14,428	11.5818
159	29,29	1760.65	1830,075	14,407	11.5818
160	71,26	1831,91	1844,472	14,386	11.5818

161	7,54	1839,45	1858,846	14,363	11.5818
162	1,8	1841.25	1873,198	14,339	11.5818
163	0.25	1841.5	1887,525	14,314	11.5818
164	2,5	1844	1901,826	14,288	11.5818
165	4.45	1848.45	1916,101	14,261	11.5818
166	7,48	1855,93	1930,348	14,233	11.5818
167	102.87	1958,8	1944,567	14.204	11.5818
168	38.55	1997,35	1958,756	14,174	11.5818
169	62,44	2059,79	1972,914	14,142	11.5818
170	36,36	2096,15	1987,041	14,110	11.5818
171	12.15	2108,3	2001, 134	14,077	11.5818
172	18.75	2127.05	2015,194	14,042	11.5818
173	11.03	2138.08	2029,218	14,007	11.5818
174	2.96	2141.04	2043,207	13,971	11.5818
175	0.77	2141.81	2057,159	13,933	11.5818
176	7,66	2149,47	2071,073	13,895	11.5818
177	23.99	2173.46	2084,948	13,856	11.5818
178	34,9	2208.36	2098,784	13,815	11.5818
179	2,28	2210.64	2112,579	13,774	11.5818
180	1.18	2211.82	2126,332	13,732	11.5818
181	0.35	2212,17	2140,043	13,689	11.5818
182	2.01	2214,18	2153,710	13,645	11.5818
183	7,13	2221.31	2167,333	13,600	11.5818
184	11,18	2232,49	2180,910	13,555	11.5818
185	26,61	2259,1	2194,442	13.508	11.5818
186	9.87	2268.97	2207,927	13,461	11.5818
187	7,63	2276.6	2221,364	13,413	11.5818
188	7,63	2284,23	2234,752	13,364	11.5818
189	1.48	2285.71	2248,091	13,314	11.5818
190	4.46	2290.17	2261,380	13,264	11.5818
191	9.85	2300.02	2274,618	13,212	11.5818
192	24,9	2324.92	2287,805	13,160	11.5818
193	9,2	2334,12	2300,939	13.107	11.5818
194	30,1	2364,22	2314,019	13,054	11.5818
195	24,1	2388,32	2327,046	13,000	11.5818
196	12.75	2401.07	2340,018	12,945	11.5818
197	0.99	2402.06	2352,935	12,889	11.5818
198	1.89	2403.95	2365,796	12,833	11.5818
199	6.95	2410.9	2378,601	12,776	11.5818
200	8,84	2419,74	2391,348	12,718	11.5818
201	21.38	2441,12	2404,038	12,660	11.5818
202	48,67	2489,79	2416,669	12,602	11.5818

203	11,14	2500.93	2429,241	12,542	11.5818
204	5,61	2506.54	2441,753	12,482	11.5818
205	12.87	2519,41	2454,206	12,422	11.5818
206	5,32	2524.73	2466,597	12,361	11.5818
207	17,72	2542.45	2478,928	12,300	11.5818
208	10.45	2552.9	2491,197	12,238	11.5818
209	2,32	2555,22	2503,403	12.176	11.5818
210	1.19	2556,41	2515,548	12,113	11.5818
211	4.04	2560.45	2527,629	12,050	11.5818
212	2.76	2563,21	2539,647	11,986	11.5818
213	1.28	2564.49	2551,601	11,922	11.5818
214	5,38	2569.87	2563,491	11,858	11.5818
215	9.53	2579,4	2575,316	11,793	11.5818
216	19.86	2599,26	2587,076	11,728	11.5818
217	22,44	2621.7	2598,771	11,663	11.5818
218	3,9	2625.6	2610,401	11,597	11.5818
219	0.21	2625.81	2621,965	11,531	11.5818
220	6.89	2632.7	2633,463	11.465	11.5818
221	25.58	2658,28	2644,895	11,399	11.5818
222	5.89	2664,17	2656,260	11.332	11.5818
223	3.45	2667,62	2667,559	11.265	11.5818
224	3,7	2671.32	2678,791	11.198	11.5818
225	4.76	2676.08	2689,956	11.131	11.5818
226	0.04	2676,12	2701,054	11,064	11.5818
227	2,19	2678,31	2712,084	10,997	11.5818
228	4.57	2682.88	2723,048	10,930	11.5818
229	10.95	2693,83	2733,944	10,863	11.5818
230	0.89	2694.72	2744,773	10,795	11.5818
231	0	2694.72	2755,535	10,728	11.5818
232	0	2694.72	2766,229	10,661	11.5818
233	0	2694.72	2776,856	10,594	11.5818
234	0	2694.72	2787,416	10.526	11.5818
235	11.26	2705.98	2797,909	10,459	11.5818
236	4,1	2710.08	2808,335	10.393	11.5818
237	0.25	2710.33	2818,694	10.326	11.5818
238	11.64	2721.97	2828,987	10,259	11.5818
239	16,47	2738,44	2839,213	10.193	11.5818
240	3,23	2741.67	2849,373	10.127	11.5818
241	3,47	2745,14	2859,466	10.061	11.5818
242	2.79	2747.93	2869,495	9,995	11.5818
243	0.12	2748.05	2879,457	9,930	11.5818
244	52,77	2800.82	2889,355	9,865	11.5818
245	22,41	2823,23	2899,188	9,801	11.5818

246	25,3	2848.53	2908,956	9,736	11.5818
247	44,24	2892.77	2918,661	9,673	11.5818
248	7,41	2900.18	2928,302	9,609	11.5818
249	6.02	2906,2	2937,880	9,547	11.5818
250	27,9	2934,1	2947,395	9,484	11.5818
251	10,15	2944,25	2956,849	9,422	11.5818
252	17.53	2961.78	2966,240	9,361	11.5818
253	16.69	2978,47	2975,571	9,301	11.5818
254	22.15	3000.62	2984,842	9,241	11.5818
255	13,44	3014.06	2994,053	9,181	11.5818
256	6,23	3020,29	3003,204	9,122	11.5818
257	22.88	3043,17	3012,298	9,064	11.5818
258	5,21	3048,38	3021,333	9.007	11.5818
259	1.56	3049.94	3030,312	8,951	11.5818
260	1.48	3051,42	3039,235	8,895	11.5818
261	1.81	3053,23	3048,103	8,840	11.5818
262	2.58	3055.81	3056,916	8,786	11.5818
263	1.67	3057,48	3065,675	8,733	11.5818
264	3,32	3060,8	3074,382	8,681	11.5818
265	5.56	3066,36	3083,036	8,629	11.5818
266	25,6	3091.96	3091,641	8,579	11.5818
267	15,34	3107,3	3100,195	8,530	11.5818
268	4.08	3111.38	3108,700	8,481	11.5818
269	0.24	3111.62	3117,158	8,434	11.5818
270	2.51	3114,13	3125,569	8,388	11.5818
271	2.97	3117,1	3133,935	8,343	11.5818
272	0.5	3117,6	3142,256	8,300	11.5818
273	1.34	3118.94	3150,535	8,257	11.5818
274	2,18	3121,12	3158,771	8,216	11.5818
275	1.78	3122,9	3166,966	8.176	11.5818
276	0.02	3122.92	3175,123	8.137	11.5818
277	0	3122.92	3183,241	8,100	11.5818
278	1.84	3124.76	3191,322	8,063	11.5818
279	5,2	3129.96	3199,368	8,029	11.5818
280	4.58	3134.54	3207,380	7,996	11.5818
281	4.09	3138,63	3215,360	7,964	11.5818
282	25,22	3163.85	3223,309	7,934	11.5818
283	56.07	3219.92	3231,228	7,905	11.5818
284	57,17	3277.09	3239,120	7,878	11.5818
285	2.92	3280.01	3246,985	7,853	11.5818
286	0.2	3280,21	3254,826	7,829	11.5818
287	8,21	3288,42	3262,644	7,807	11.5818
288	6,46	3294.88	3270,440	7,787	11.5818

289	15,31	3310,19	3278,218	7,768	11.5818
290	3,32	3313.51	3285,977	7,751	11.5818
291	71,79	3385,3	3293,721	7,736	11.5818
292	2.87	3388,17	3301,450	7,723	11.5818
293	3.88	3392.05	3309,168	7,712	11.5818
294	0.1	3392,15	3316,875	7,703	11.5818
295	1.71	3393.86	3324,574	7,696	11.5818
296	0.37	3394,23	3332,267	7,690	11.5818
297	0.65	3394.88	3339,956	7,687	11.5818
298	0.68	3395.56	3347,642	7,686	11.5818
299	0.42	3395.98	3355,329	7,687	11.5818
300	2,12	3398,1	3363,018	7,691	11.5818
301	3.98	3402.08	3370,712	7,696	11.5818
302	2.85	3404.93	3378,412	7,704	11.5818
303	10.73	3415.66	3386,121	7,714	11.5818
304	10.37	3426.03	3393,841	7,727	11.5818
305	8.37	3434,4	3401,575	7,741	11.5818
306	10.91	3445,31	3409,325	7,759	11.5818
307	7,23	3452.54	3417,093	7,778	11.5818
308	0.85	3453,39	3424,882	7,801	11.5818
309	1.09	3454.48	3432,695	7,825	11.5818
310	3.76	3458,24	3440,534	7,853	11.5818
311	10.71	3468.95	3448,401	7,883	11.5818
312	1.71	3470.66	3456,300	7,915	11.5818
313	0.12	3470.78	3464,233	7,951	11.5818
314	0.78	3471.56	3472,202	7,989	11.5818
315	0.97	3472.53	3480,211	8,030	11.5818
316	4,1	3476,63	3488,262	8,073	11.5818
317	1.77	3478,4	3496,359	8,120	11.5818
318	2.86	3481.26	3504,503	8,169	11.5818
319	21.35	3502.61	3512,699	8,222	11.5818
320	13,18	3515.79	3520,948	8,277	11.5818
321	0.55	3516,34	3529,255	8,336	11.5818
322	1.81	3518,15	3537,621	8,398	11.5818
323	2.62	3520.77	3546,051	8,462	11.5818
324	5,42	3526,19	3554,547	8,530	11.5818
325	4,34	3530.53	3563,113	8,602	11.5818
326	13,1	3543,63	3571,751	8,676	11.5818
327	12.62	3556,25	3580,466	8,754	11.5818
328	3,15	3559,4	3589,260	8,835	11.5818
329	14.97	3574,37	3598,137	8,920	11.5818
330	12.71	3587.08	3607,100	9.008	11.5818
331	12,17	3599.25	3616,153	9,099	11.5818

332	23,39	3622,64	3625,300	9,194	11.5818
333	9.39	3632.03	3634,543	9,293	11.5818
334	24.85	3656.88	3643,887	9,395	11.5818
335	9,27	3666,15	3653,335	9,501	11.5818
336	4.47	3670.62	3662,890	9,611	11.5818
337	3.58	3674,2	3672,558	9,724	11.5818
338	24,74	3698.94	3682,341	9,842	11.5818
339	7,4	3706,34	3692,243	9,963	11.5818
340	14.55	3720.89	3702,268	10,088	11.5818
341	7,78	3728,67	3712,420	10.217	11.5818
342	0.46	3729,13	3722,704	10,350	11.5818
343	0.39	3729.52	3733,123	10,488	11.5818
344	30,33	3759.85	3743,681	10,629	11.5818
345	17.75	3777,6	3754,382	10,775	11.5818
346	8,3	3785,9	3765,231	10,924	11.5818
347	7.95	3793.85	3776,232	11,078	11.5818
348	18.63	3812.48	3787,389	11.237	11.5818
349	9.78	3822,26	3798,706	11,399	11.5818
350	2.82	3825.08	3810,189	11,566	11.5818
351	4.66	3829,74	3821,840	11,738	11.5818
352	11.26	3841	3833,666	11,914	11.5818
353	19.97	3860.97	3845,670	12,095	11.5818
354	12.43	3873,4	3857,856	12,280	11.5818
355	7,49	3880.89	3870,231	12,470	11.5818
356	6,94	3887,83	3882,797	12,664	11.5818
357	8,61	3896,44	3895,561	12,864	11.5818
358	23.53	3919.97	3908,527	13,068	11.5818
359	2.72	3922,69	3921,699	13,277	11.5818
360	2.98	3925,67	3935,083	13,491	11.5818
361	6,82	3932,49	3948,683	13,710	11.5818
362	4.78	3937,27	3962,505	13,934	11.5818
363	6.08	3943.35	3976,553	14.163	11.5818
364	2,4	3945.75	3990,833	14,398	11.5818
365	20,22	3965.97	4005,350	14,637	11.5818
366	12,16	3978,13	4020,110	14,882	11.5818

INFILTRATION

Fahmi Alfarabi[1)], Muh. Wahyu Apriliandi[2)] and Harvhianti Haruki[2)]
[1)] Practicum Practitioner of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University
[2)] Practicum Assistant of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

Rain that falls on an area will be retained by vegetation or go directly to the ground and absorbed by the soil, where this process is called infiltration. The purpose of the Infiltration practicum is to determine the rate of entry of water to the surface and the rate of entry of water into the soil, in order to determine the value of infiltration parameters, namely fo, fe and K and can determine the estimation equation and make the Horton model infiltration curve and calculate the total infiltration volume during a certain time. The method used to obtain infiltration data is to use a *double ring infiltrometer* by placing the tool on a piece of land with a depth of 5 cm then filling the outer ring and then filling the inner *ring* to see the infiltration rate until it reaches a constant rate. The results obtained in the Infiltration practicum include the longer the duration of time running, the speed of the infiltration rate will slowly slow down for a certain depth until it touches a constant speed condition. The conclusions obtained after the Infiltration practicum include that the infiltration measurement method can be used by applying the Horton method and the Koskiatov method.

Keywords: *Double Ring Infiltrometer*, Infiltration, Soil.

INTRODUCTION

Background

The condition of agricultural land that requires optimal water supply makes experts find out what factors can be done to maintain fertile soil conditions on agricultural land. In addition, the provision of appropriate irrigation channels must be made properly and efficiently. One of the problems often faced in agriculture is insufficient water supply. This is because the need for water for plants is currently constrained due to the soil structure of an area and vegetation factors that occur.

Infiltration is used as one of the parameters in hydrology that is useful to evaluate or measure accurately. Infiltration is known as the process of water flow into the vertical soil profile through the soil surface. The factors that can affect the infiltration rate include soil type, inorganic materials contained in the soil, porosity, specific gravity, initial moisture content, soil structure and organisms in the soil. (Ayu & Prijono, 2017).

The accuracy of infiltration data not only depends on the method used in the process of testing the soil's ability to absorb water, but also depends on external factors that are useful as parameters such as *head of ponding*, *ring* diameter, initial soil moisture content and saturated hydraulic conductivity of the soil. Measuring cumulative infiltration can be done by several methods which include using dimensional analysis techniques in developing cumulative infiltration relationships based on the diameter of the infiltrometer (Fatehnia & Tawhnia, 2011). (Fatehnia & Tawfiq, 2018)..

Infiltration rate measurement can generally be done using the Horton method. The use of the Horton method is one of the well-known infiltration models in hydrology compared to other methods. The Horton method recognizes that infiltration capacity decreases continuously with time until it approaches a constant value. The decrease in infiltration capacity is more controllable because it is influenced by factors operating at the soil surface rather than flow processes in the soil. This model is very simple and more suitable for experimental data. The main weakness of this model lies in determining the parameters fo, fc and K. (Susanawati *et al.,* 2018).

Ring infiltrometers are specifically used to determine cumulative infiltration, infiltration rate and infiltration capacity. The use of *doubling infiltrometers* to reduce the influence of lateral seepage. The infiltration rate is initially high, as water enters deeper and deeper into the wet soil profile, the suction of the soil matrix is reduced and only the pull of gravity affects the movement of water, causing the infiltration rate to decrease over time until it approaches a constant condition (Darajat et al., 2011). (Darajat *et al.,* 2019)..

The infiltration rate process that occurs in a land has a capacity. The capacity in question includes the ability of the soil to absorb surface water into the soil. Infiltration capacity serves to minimize the continuation of land surface flow. This is because the longer the infiltration rate occurs, it will cause the soil pores to become dense and saturated. In addition, soil infiltration capacity can also be influenced by several things including pollution or soil structure in a field of land (Ramdana *et al.,* 2021).

Based on the description above, it is necessary to conduct an Infiltration practicum in order to know the rate of water entering the surface and the rate of water entering the soil. In addition, it can make direct measurements of infiltration that occurs in the soil that will be applied for agricultural purposes.

Purpose and Usefulness of Practicum

The purpose of the Infiltration practicum is to determine the rate of entry of water to the surface and the rate of entry of water into the soil, in order to determine the value of infiltration parameters namely fo, fe and K and be able to determine the estimation equation and make the Horton model infiltration curve and calculate the total infiltration volume during a certain time.

The usefulness of the Infiltration practicum is that it can calculate the level of water absorbed in the soil when it rains so that farmers know what crops to plant.

PRACTICUM METHODOLOGY

Time and Place

Infiltration Practicum was conducted on Friday, March 18, 2022 at 15.00 WITA until completion at the Soil and Water Engineering Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, Makassar.

Tools

The tools used in the Infiltration practicum are ruler, *double ring infiltrometer*, bucket, plastic, *stopwatch,* board, hammer, clamp, stationery and *cellphone* camera.

Material

The materials used in the Infiltration practicum are water and a plot of land.

Practical Procedures

The working procedure for this Infiltration practicum is:

A. Data Retrieval

1. Prepare the tools and materials used.
2. Determine the infiltration measurement site.
3. Plugging the *double ring infiltrometer* into the ground with the help of a board.
4. Strike the board with a hammer until the depth of the *double ring infiltrometer is* 5 cm deep.
5. Attach a ruler to the inner and outer *rings* to determine the amount of water absorbed by the soil.
6. Fill water into the outer *ring to a* height of 14 cm.
7. Slowly fill the inner *ring to* the desired water level.
8. Turn on the *stopwatch* to calculate the infiltration rate and record the changes per 3 minutes and 5 minutes until the result is constant.
9. Documenting the practicum.

B. Horton Method Data Processing

1. Open *Microsoft Excel* and enter the infiltration data obtained from the infiltration data collection results in the form of time and water level drop.
2. Convert existing time units in minutes into hours.
3. Determining the value of f_0 .
4. Determining the value of f_c .
5. Determines the value of $f - f_{0c}$.
6. Determines the value of $\log f - f_{0c}$.
7. Graph the relationship between the value of $\log f - f_{0c}$ and time in hours.
8. Then find the regression value by right-clicking the graph and selecting *add trendline*.
9. Enter the gradient value based on the y-value on the graph.
10. Calculate the value of the geophysical constant (k).
11. Determine the value of e^-kt.
12. Then calculate the infiltration capacity f (mm/hour) using the Horton method formula.
13. Convert infiltration capacity units to cm/hour.
14. Calculating infiltration volume.
15. Graph the relationship between infiltration rate and time in hours.
16. Right-click on the infiltration rate graph then *select* data and then edit data *series*.
17. Add titles and legends.

C. Koskiatov Method Data Processing

1. Open *Microsoft Excel* and enter the infiltration data obtained from the infiltration data collection results in the form of time and water level drop.
2. Convert existing time units in minutes into hours.
3. Calculating the infiltration interval.
4. Calculating the cumulative infiltration value.
5. Calculating the log t value.
6. Calculating the log cumulative infiltration value.

7. Graph the relationship between log t and cumulative log.
8. Then find the regression value by right-clicking the graph and selecting *add trendline*.
9. Next, calculate the a and b values based on the y values on the graph.
10. Calculate infiltration capacity using the Koskiatov method formula.
11. Right-click on the infiltration rate graph then *select* data and then edit data *series*.
12. Add titles and legends.

Formula Used

The formula used is:

A. Horton Method

$$f = f_c + (f - f_{0c})e^{-kt}$$

Description:
f= Infiltration capacity (cm/h),
f_c = Constant infiltration (cm/h),
f_0 = Initial infiltration (cm/h),
k= Geophysical constant.
e= 2.718 and
t= time (hour).

B. Koskiatov Method

$$f = a \times t^b$$

Description:
f= Infiltration capacity (cm/h),
a= Regression coefficient,
b= Regression constant and
t= Time (hour).

C. Water Volume

$$v = \frac{fc.t + ((f_0 - f_c)}{1 - e^{(-kt)}}$$

Description:
t= time (hour),
f = infiltration capacity (mm/hour),
fc = constant infiltration (mm/hour),
fo = initial infiltration (mm/hour),
k= geophysical constant,
e= 2.718 and
v= infiltration volume (mm^3).

RESULTS AND DISCUSSION

Results

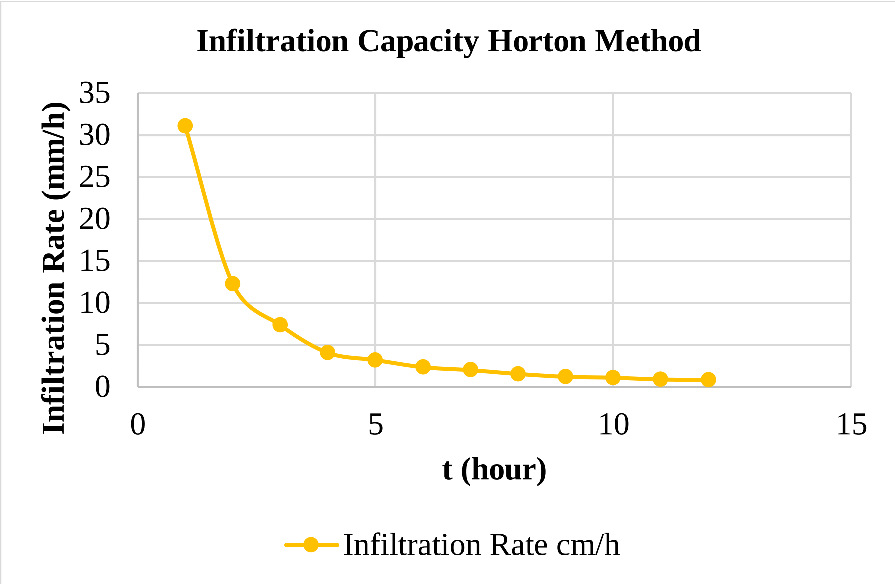

Image 31. Infiltration Capacity Graph of Horton Method.

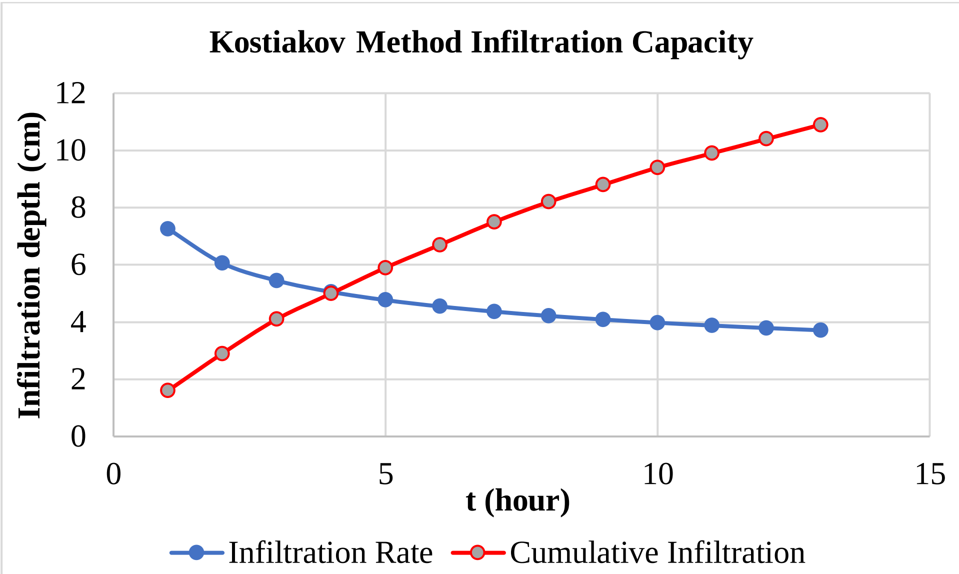

Image 32. Kostiakov Method Infiltration Capacity Graph.

Discussion

Based on the results obtained in the first graph, namely the relationship between infiltration depth and time for the Horton method, it can be seen that the longer the duration of time running, the speed of the infiltration rate will slowly slow down for a certain depth until it touches a constant speed condition. This is in accordance with the statement Susanawati *et al*. (2018)Horton's method recognizes that the infiltration capacity of a land will decrease steadily as time increases until it approaches a constant value.

Berdasarkan grafik kedua dapat diketahui bahwa hubungan antara waktu dan kedalaman infiltrasi terhadap metode Kostiakov akan terus meningkat. This is clarified by the graphical relationship that illustrates the increasing time the rate or depth of infiltration will decrease. However, the cumulative infiltration will increase with time. This is in accordance with the statement of Darajat *et.al* (2019), stating that the Kostiakov method equation has a constant parameter obtained from the initial to final rate value with the initial soil moisture content shown from linear regression analysis and the logarithm value against time (t) and cumulative infiltration (F).

Faktor-faktor yang mempengaruhi infiltrasi pada saat pengukuran diantaranya jenis tanah dan penggunaan *double ring infiltrometer. The* use of *double rings* with the intention of reducing the influence of lateral seepage which can cause the measurement results of this tool to be not easily extrapolated to the field scale. Soil type can be used as a material for analyzing the density of pores in the soil that can cause a slowdown in the infiltration rate such as the initial condition of the occupied soil that has been exposed to rain so that it affects the infiltration process. This is in accordance with the statement Ayu & Prijono (2019)Ayu & Prijono (2019) stated that several factors affect infiltration including soil type, inorganic materials, porosity, specific gravity, specific gravity, initial moisture content, soil structure and organisms in the soil.

CONCLUSIONS

Based on the Infiltration practicum activities that have been carried out, it can be concluded that in the infiltration process the rate of water entering the soil can be measured using a *double ring inflometer*. After being measured using an *infliltrometer*, the data obtained can be processed by the Horton and Kostiakov methods so as to obtain an infiltration parameter in the form of f0, fc and K. The relationship between time and depth of infiltration using the Horton method where the increasing time the rate or depth of infiltration decreases until it reaches a constant rate. In addition, the infiltration curve of the relationship between time, depth and infiltration capacity is obtained using the Kostiakov method which can be seen that the increasing time, the rate or depth of infiltration decreases and then the infiltration capacity of the soil increases until the saturation point.

REFERENCES

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Fatehnia, M. and Tawfiq, K. 2018. *Driving Vertical Saturated Hydraulic Conductivity of Soil Using Double Ring Infiltrometer Infiltration Information. Journal Environmental and Technology*. Vol.2: 224-230.

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Ramdana, C. P, Devianti & Zulfahrizal. (2021). Accuracy of Kostiakov Infiltration Model with Rainfall Simulator Measurement on Several Soil Textures. Scientific Journal of Unsyiah Agriculture Students, 6(2), 47-56.

Wulan Ayu, I. and Prijono, S. 2017. *Assessment of Infiltration Rate under Different Drylands Types in* Unter-Iwes *Subdistrict* Sumbawa Besar, Indonesia. *Journal of Natural Sciences Research*. Vol.3: 72-78.

ATTACHMENT

Attachment 4. Measurement Results Table

Table 4. Infiltration Measurement Results Using *Double Ring Infiltrometer.*

t (hour)	H (cm)
0	15.15
0.05	13.55
0.1	12.25
0.15	11.05
0.2	10.15
0.25	10.4
0.3	8.45
0.35	7.65
0.4	6.95
0.45	6.35
0.5	5.75
0.55	5.25
0.6	4.75
0.65	4.25

Attachment 5. Calculation Result Table

Table 5. Infiltration Capacity Calculation Horton Method.

t (hour)	H (cm)	Infiltration Interval (cm)	f0	fc	f0-fc	log f0-fc	m	k	(-k*t)	e^-kt	infiltration rate (cm/h)	infiltration rate (mm/hour)	Water volume
0	15,06	0											
0,05	13,46	1,6	32,00	0,8	31,20	1,49	4.588	0.635	-0,032	0,969	31	0,031	1,575
0,1	12,16	1,3	13,00	0,8	12,20	1,09	-4.588	0.635	-0,064	0,938	12	0,012	1,262
0,15	10,96	1,2	8,00	0,8	7,20	0,86	-4.588	0.635	-0,095	0,909	7	0,007	1,150
0,2	10,06	0,9	4,50	0,8	3,70	0,57	-4.588	0.635	-0,127	0,881	4	0,004	0,855
0,25	9,16	0,9	3,60	0,8	2,80	0,45	-4.588	0.635	-0,159	0,853	3	0,003	0,847
0,3	8,36	0,8	2,67	0,8	1,87	0,27	-4.588	0.635	-0,191	0,826	2	0,002	0,750
0,35	7,56	0,8	2,29	0,8	1,49	0,17	-4.588	0.635	-0,222	0,801	2	0,002	0,746
0,4	6,86	0,7	1,75	0,8	0,95	-0,02	-4.588	0.635	-0,254	0,776	2	0,002	0,656
0,45	6,26	0,6	1,33	0,8	0,53	-0,27	-4.588	0.635	-0,286	0,751	1	0,001	0,569
0,5	21,5	0,6	1,20	0,8	0,40	-0,40	-4.588	0.635	-0,318	0,728	1	0,001	0,571
0,55	21	0,5	0,91	0,8	0,11	-0,96	-4.588	0.635	-0,349	0,705	1	0,001	0,491
0,6	20,5	0,5	0,83	0,8	0,03	-1,48	-4.588	0.635	-0,381	0,683	1	0,001	0,497

Table 6. Calculation of Infiltration Capacity of Koskiatov Method.

t (hour)	**H (cm)**	**interval (cm)**	**cumulative infiltration (cm)**	**log t**	**cumulative log**	**infiltration rate**
0	15,06	0	0	0	0	0
0,05	13,46	1,6	1,6	-1,301029996	0,204119983	7,262
0,1	12,16	1,3	2,9	-1	0,462397998	6,058
0,15	10,96	1,2	4,1	-0,823908741	0,612783857	5,448
0,2	10,06	0,9	5	-0,698970004	0,698970004	5,053
0,25	9,16	0,9	5,9	-0,602059991	0,770852012	4,767
0,3	8,36	0,8	6,7	-0,522878745	0,826074803	4,545
0,35	7,56	0,8	7,5	-0,455931956	0,875061263	4,365
0,4	6,86	0,7	8,2	-0,397940009	0,913813852	4,215
0,45	6,26	0,6	8,8	-0,346787486	0,944482672	4,087
0,5	21,5	0,6	9,4	-0,301029996	0,973127854	3,976
0,55	21	0,5	9,9	-0,259637311	0,995635195	3,878
0,6	20,5	0,5	10,4	-0,22184875	1,017033339	3,791
0,65	20	0,5	10,9	-0,187086643	1,037426498	3,712

Attachment 6. Horton and Koskiatov Method Graphs

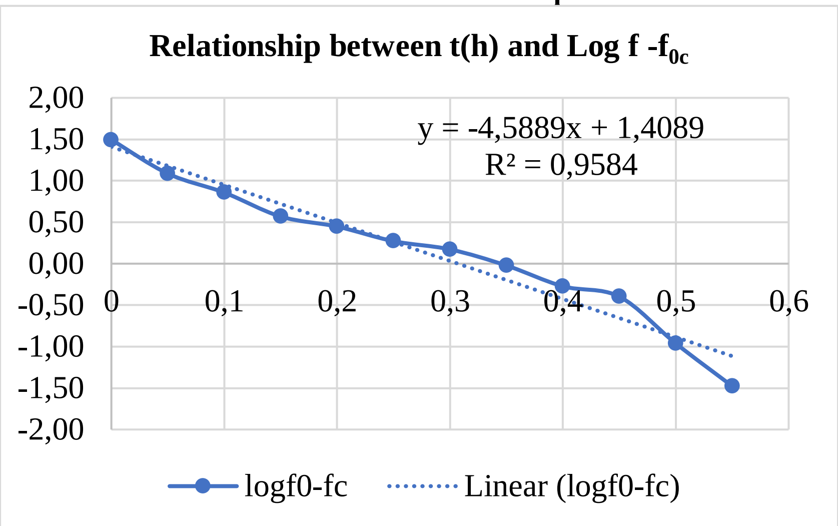

Image 33. Relationship between t(h) and Log $f - f_{0c}$ Horton Method.

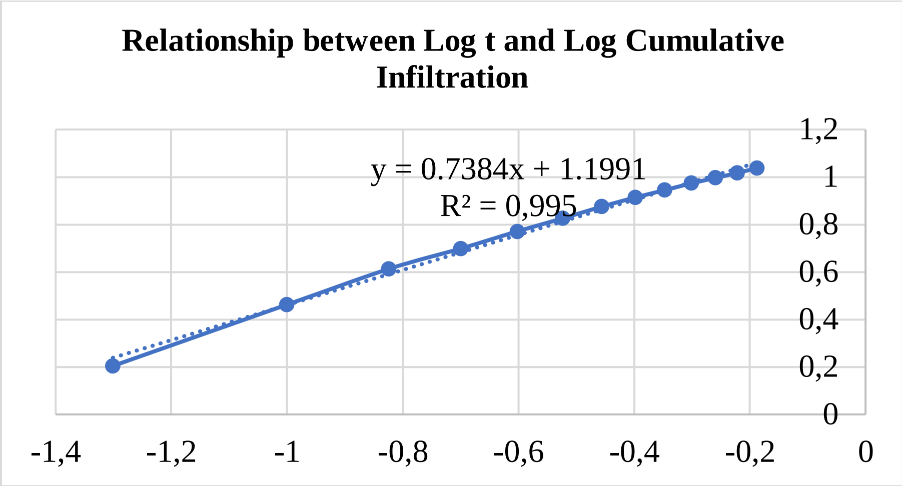

Image 34. Relationship Graph of Log t and Log Cumulative Infiltration Koskiatov Method.

Attachment 7. Documentation of Infiltration Practicum

Image 35. Documentation of Infiltration Practicum.

WATERSHED DELINEATION

Fahmi Alfarabi[1)], Muh. Wahyu Apriliandi[2)] and Harvhianti Haruki[2)]
[1)] Practicum Practitioner of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University
[2)] Practicum Assistant of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

RESULTS AND DISCUSSION

Results

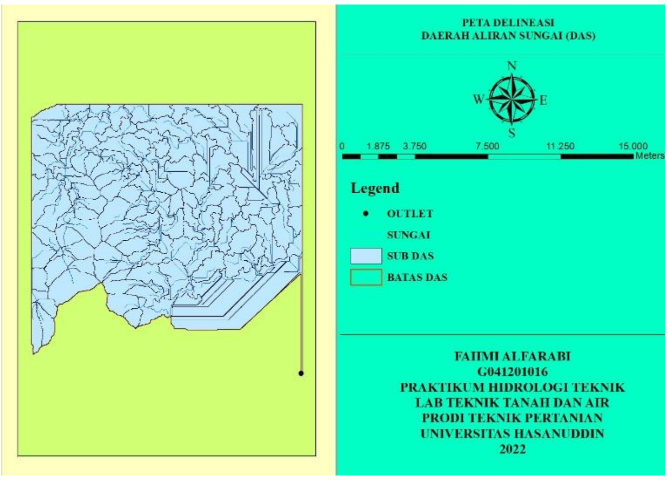

Image 36. Watershed Delineation Map.

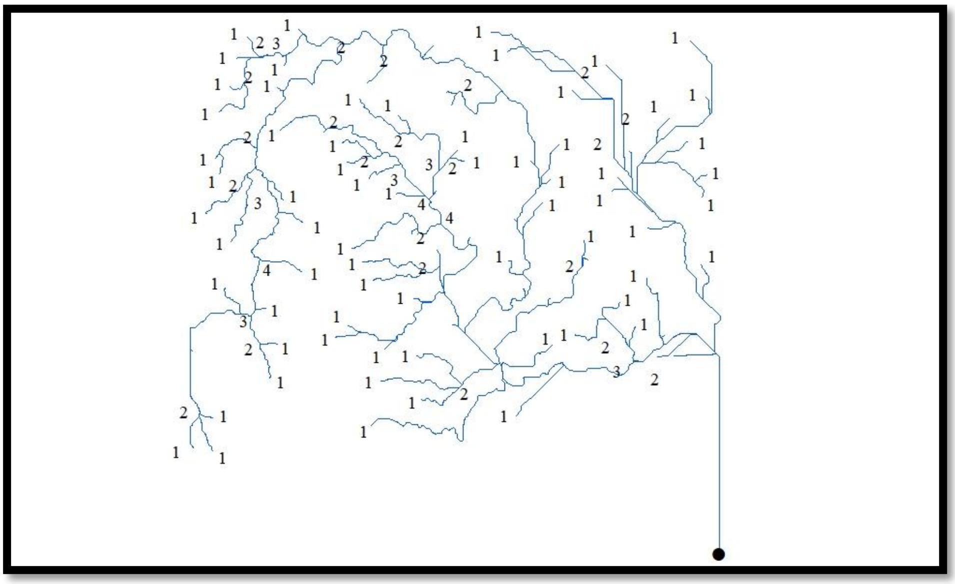

Image 37. Strahler Method River Order Determination.

Discussion

Watershed Delineation practicum activities obtained a Watershed boundary map made using the ArcGIS application, the map made comes from *Digital Elevation Model* (DEM) data that has been prepared then *inputted* into ArcGIS *software* and then cut around the watershed. This is in accordance with the statement Vittala *et al.* (2017), stating that the resulting digital data has advantages such as being able to be imported and analyzed by GIS *software* properly and get accurate results.

The river flow pieces that have been obtained will determine the order of each branch of the river flow that has been cut. The determination of the order in each river branch is carried out using the Strahler method. The method is used to determine the order of the river based on the arrangement of the flow levels, where the level of river flow upstream is called order 1, then the level order that is connected is called order 2 then the river flow of the order that is not level is called order 3 or greater. This is in accordance with the statement of Pattiselanno and Soetrisno (2017), stating that the Strahler method, where the most upstream river flow is called the first order, the meeting between the first order is called the second order and so on is characterized by the order number that is the largest of the other orders.

The data obtained in the Watershed Delineation practicum include *outlet* and *inlet* points. *The outlet* point is known as the end point of the flow formed from the *inlet* connection while the *inlet point is* known as the points of flow that flow along the watershed. Making a watershed map has benefits including on the map describing the main and branch rivers, upstream and downstream. In addition, the application of the Watershed Delineation map has the benefit of knowing the condition of an area whether it is in a flood area. This is in accordance with the statement of Purwono *et al.* (2018), stating that determining the boundaries of a watershed has several purposes, including knowing the shape of the flow hydrograph in analyzing flood-prone areas.

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Pattiselanno, S. and Soetrisno, A. 2017. Mitigation of Flood Water Level Character from Morphometry of Wai Loning - Negeri Laha Watershed, Based on *Geographic Information System* (GIS). *Symmetric Journal*. (7), 1-7.

Purwono, N., Prayudha, H., Yosef, P., and Priyadi, K. 2018. Digital Elevation Model (DEM) Filtering Technique for Watershed Boundary Delineation. Journal of Geography. 13(1), 490-504.

ATTACHMENT

Attachment 8. DEM Data Download Procedure

A. Downloading DEM Data

1. Open the DEMNAS *website* (indonesia.go.id).

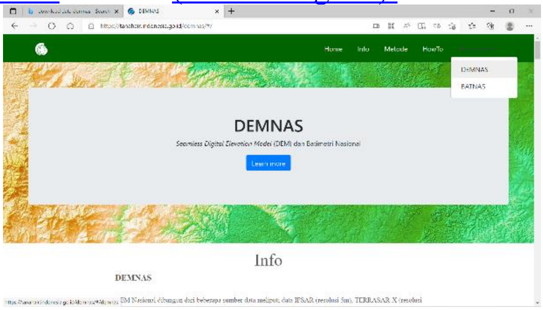

Image 38. DEMNAS *website*.

2. Log in with a previously created account.

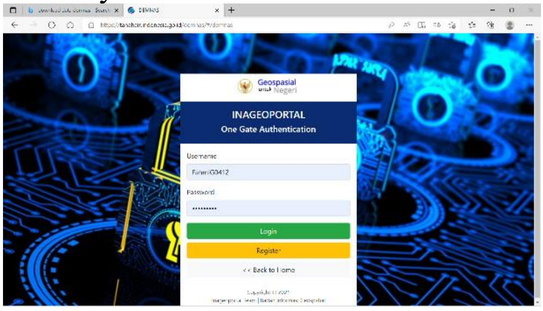

Image 39. Account *login*

3. Type the name of the area to be delineated.

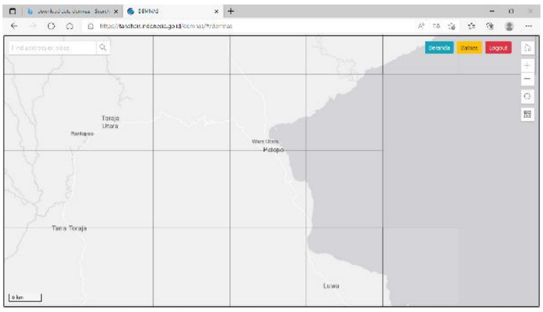

Image 40. Searching for Regions.

4. Clicking on the region then downloads the DEM data.

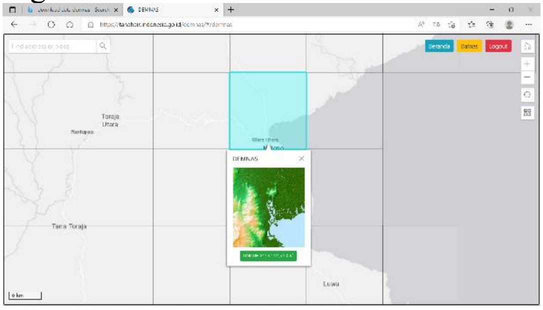

Image 41. Downloading DEM data.

B. DEM Data Processing.

5. Open *ArcGIS software*.

Image 42. Opening *ArcGIS software*.

6. Dragged the downloaded DEM data into *ArcGIS software*.

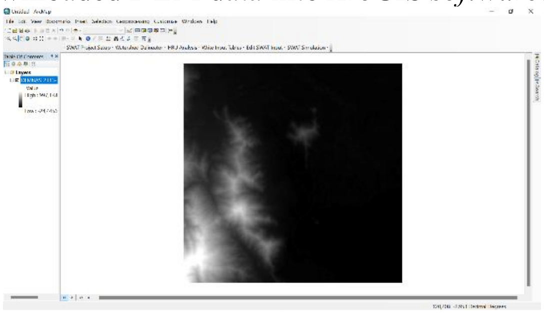

Image 43. DEM data display in *ArcGIS*.

7. Clicking on *arctoolbox*, data *management tool*, *projections and transformations*, *raster and* double-clicking on the *raster project.*

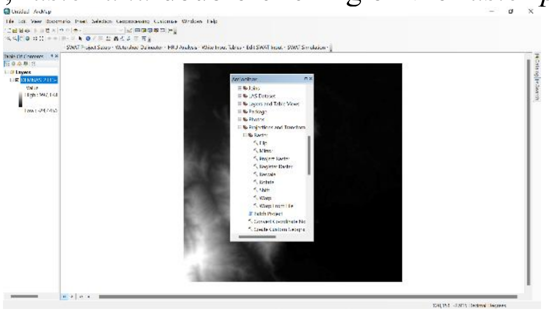

Image 44. *Arctools* view.

8. Enter the DEM data in the *raster input.*

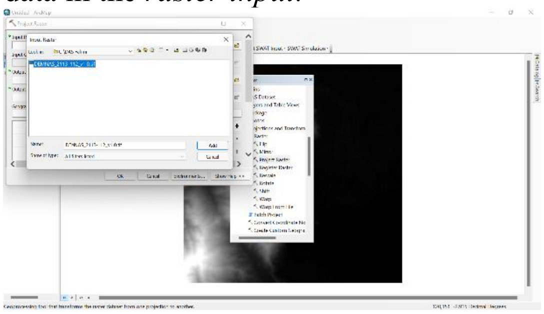

Image 45. *Raster Input*.

9. Clicking the *coordinate system input* then selecting *geographic coordinate system, world* and selecting WGS 1984 UTM *zone* 50S then click *ok.*

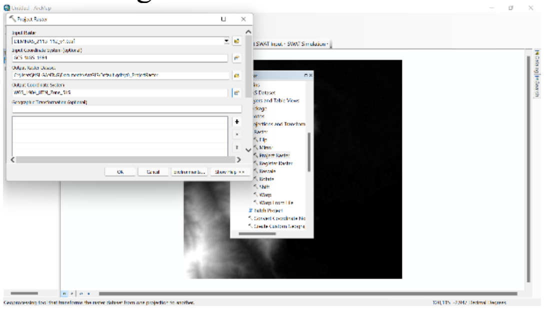

Image 46. *Coordinate System Input*.

10. Save the converted data as an *ArcGIS file*.

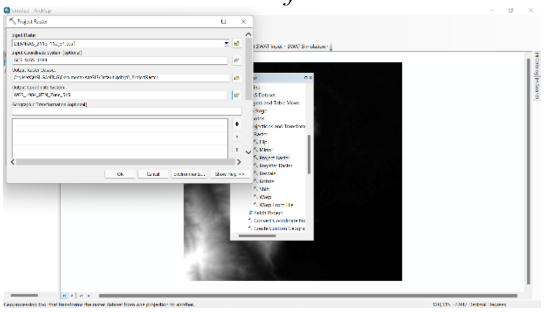

Image 47. *Save Data*.

11. Create a new training folder and enter the DEM data that has been downloaded and open *ArcGIS* then click *costumize*, *toolbar* and check *ArcSWAT*.

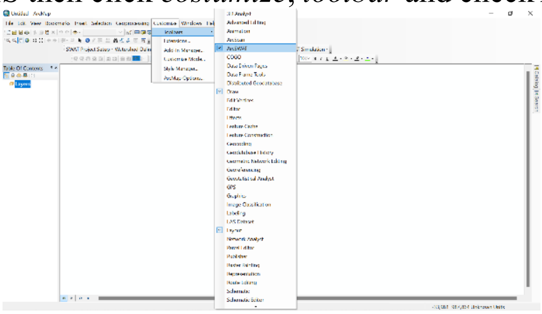

Image 48. *ArcSWAT toolbar*.

12. Choose SWAT *project setup* and select *new* SWAT then select *no* then enter the exercise *folder* and click *ok.*

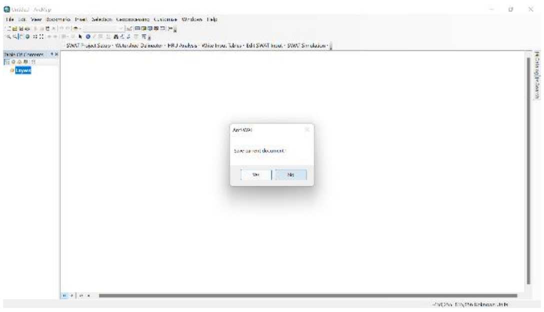

Image 49. *New Swat Project*.

13. Selecting the *watershed delineator* and *automatic watershed delineator.*

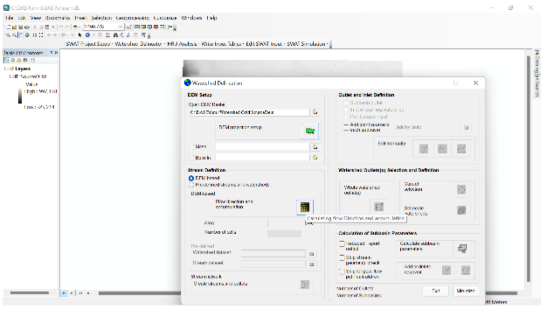

Image 50. Selecting the *Automatic Watershed Delineator*.

14. Input the downloaded DEM data in the *open* DEM *raster* by selecting *load from disk* and selecting the DEM data.

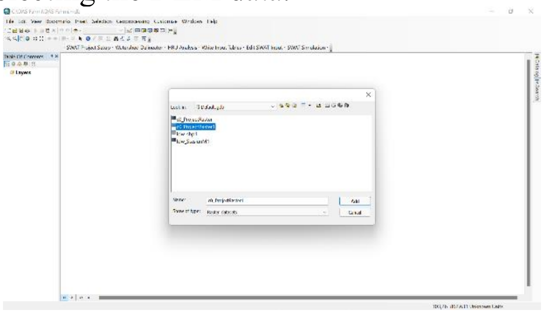

Image 51. Selecting DEM Data.

15. Click on DEM *projection set up* and change the Z *unit* to meter and click *ok.*

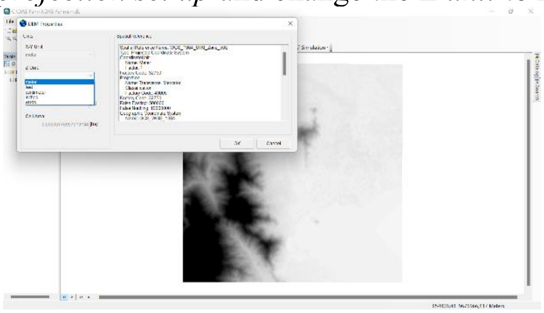

Image 52. Selecting Meters in the Z *Unit*.

16. Clicking *calculating direction and accumulation and* changing the number to 50.

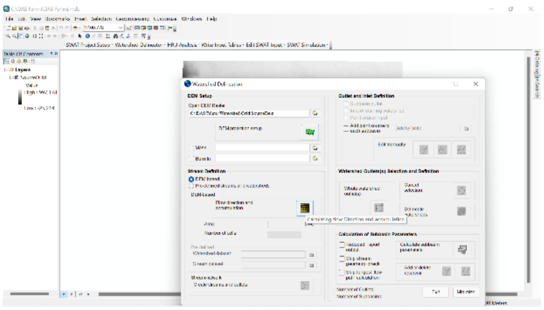

Image 53. Clicking *Flow Direction and Accumulation*.

17. Clicking on *create streams and outlets* then *zoom* one point on the line.

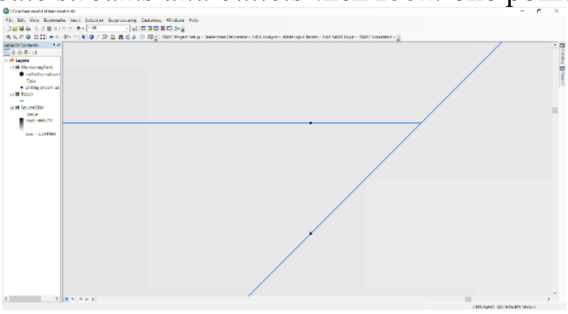

Image 54. Zoom Point on Line.

18. Selecting the *whole watershed outlet* then blocks a point on the line.

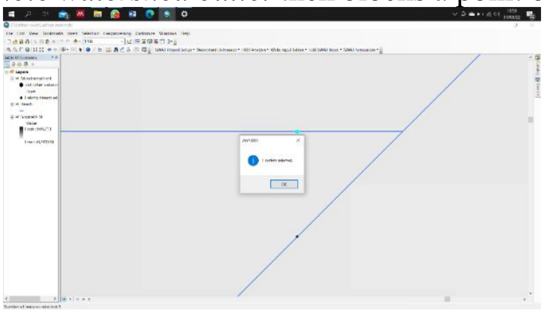

Image 55. Point Block.

19. Clicking *delineate watershed* then clicking *calculate subbasin parameters.*

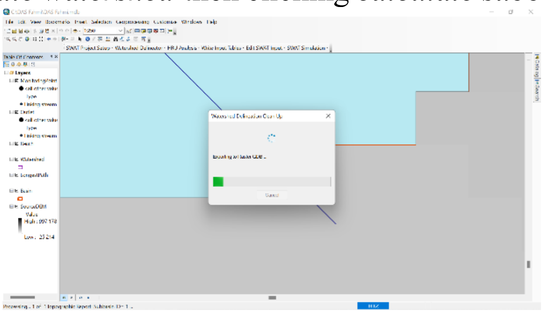

Image 56. Clicking *Delineate Watershed and Calculate Subbasin Parameters*.

20. After completion, continue with making a *layout of the* watershed delineation results.

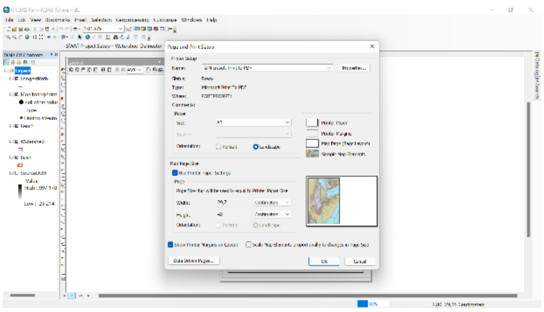

Image 57. Starting *Layout*.

21. Create a *layout* with the design as below.

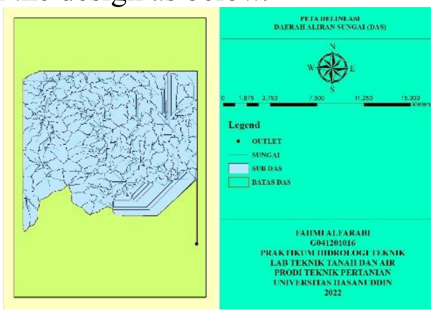

Image 58. Layout Design Results.

RAINFALL RATE

Fahmi Alfarabi[1)], Muh. Wahyu Apriliandi[2)] and Harvhianti Haruki[2)]
[1)] Practicum Practitioner of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University
[2)] Practicum Assistant of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

Rainfall in an area can be measured by utilizing data from rainfall stations and processed from commonly used methods such as arithmetic methods, thiessen polygon and isohyet. The purpose of the Rainfall Practicum is to be able to calculate the average rainfall, rainfall plan, discharge plan and discharge mainstay and know the methods used in calculating the average rainfall, rainfall plan, discharge plan and discharge mainstay. The method used to calculate average rainfall is to process data using the thiessen polygon method and isohyet using ArcGIS *software*. The results of the Rainfall practicum are known that the thiessen polygon map *layout* as one of the methods used to input rainfall data will then limit the area based on the existing stations and then form a polygon. The isohyet polygon is used to measure each rainfall intensity based on its topographic location. In addition, methods that can be used to measure rainfall include using the normal distribution method, log normal, log pearson III and gumbel. In conclusion, the rainfall that occurs in the planned rainfall distribution can be obtained using data from NASA or direct measurements using an *ombrometer*.

Keywords: Rainfall, Isohyet, Thiessen.

INTRODUCTION

Background

Phenomena that occur in various parts of Indonesia today cannot be separated from the geography and topography of the region. This is known because geography will affect the shape of climatic conditions in the region. Indonesia's geographical location between two continents and two oceans causes Indonesia to have different seasons for each region. As a country that has a tropical climate, Indonesia has two seasons, namely the dry season and the rainy season. The rain that occurs in some areas is influenced by the Hydrology cycle which will state how much rain intensity occurs in the area.

Rainfall, also known as the amount of rain that falls in a certain time, can be measured using an *ombrometer*. The *ombrometer* tool is used as a tool to take rain data that occurs for several days. Rainfall measurements are made as needed. In the rainfall measurement plan is used to determine a magnitude of rainfall intensity with predictions from the coming year. Data known to the amount of rainfall intensity can then be used to calculate the runoff water discharge of a watershed at the measurement location. (Ajr & Dwirani, 2019).

In addition to the planned rainfall, there is also effective rainfall which is known as rainfall that falls on several areas and can be used by plants for their growth period. The amount of rainfall that occurs can be utilized to meet water needs, so as to minimize the discharge required from the intake gate. Given that the amount of rainfall that falls is not all that can be used for plants in their growth, it is necessary to calculate and find the effective rainfall of the region. (Hakim *et al.,* 2017).

Rainfall measurements can use several methods including the thiessen polygon and isohyet methods. The thiessen method is known as a method used to calculate the amount of rain weight that occurs in several areas from each station that represents the surrounding area. In an area within a watershed, it is assumed that the rain that occurs is the same as that occurring at the nearest station, so that the rain recorded at a station represents that station. This method is used when the distribution of rainfall stations in the area under review is uneven. The form of rainfall calculation is done by taking into account the influence of each station (Lashari *et al.,* 2017).

Accurate and effective rainfall data is essential when conducting research. If you want to make an isohyet map, it can be done after making a thiessen map. Isohyet maps are reliable because they can describe the spatial behavior of rainfall intensity and its pattern. The map is developed through Geographic Information System (GIS) software with accurate annual rainfall and seasonal rainfall data. Good utilization of isohyet maps can be used to help detect the location of flood-affected plains. (Jun, 2018).

Rainfall is generally described as the amount of rainwater that falls on an area during one period. Rainfall is divided into two which include effective rainfall which is utilized by plants and planned rainfall which is used as an estimated estimate of rainfall that occurs during one year. The maximum daily rainfall value is used to calculate the rainfall plan with a period of 2 to 100 years using four types of distributions. The distributions in question include normal, log normal, log pearson III and gumbel distributions. The longer the period of the rainy year that occurs, the higher the planned rainfall will be. Effective rainfall is widely used as an analytical material to determine the effect of rain falling on the earth's surface that has undergone the evaporation process or the evapotranspiration process in an area while rainfall intensity is known as the length of rainfall that occurs (Widiansyah & Setiawan, 2020).

For several years, the rainfall period of an area is always different so that in determining rainfall a method is needed. The methods that can be used include normal distribution, log normal, gumbel and log pearson III. Choosing an inappropriate distribution can have an impact, especially for farmers who rely on rain as a source of plant water. Therefore, it is very necessary to use a suitable method to get accurate and effective predictions. The use of methods can be seen from the rainfall data of an area. Therefore, rainfall data must be taken from an accurate source or based on direct measurement. (Ruhiat, 2022).

Based on the description above, it is necessary to conduct a Rainfall practicum in order to know the tools used in measuring rainfall and the application of the thiessen polygon method and the isohyet method in calculating the average rainfall in an area. In agriculture, knowing rainfall is very useful in determining the suitable planting period in an area.

Purpose and Usefulness of Practicum

The purpose of the Rainfall Practicum is to be able to calculate rainfall using an *ombrometer* tool, to be able to calculate average rainfall, rainfall plan, discharge plan and mainstay discharge, to be able to know the methods commonly used to calculate average rainfall, rainfall plan, discharge plan and also mainstay discharge.

The purpose of the Rainfall practicum is to determine the design rainfall and the possibility of flooding that will occur in an area.

PRACTICUM METHODOLOGY

Time and Place

Rainfall Practicum was held on Friday, March 11, 2022 at 13.00 WITA until completion at the Soil and Water Engineering Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, Makassar.

Tools

The tools used in the Rainfall practicum are computers or laptops, ArcGIS *software*, *ombrometers* and measuring cups.

Material

The materials used in the Rainfall Practicum are rainfall data and the Menlareng watershed.

Practical Procedures

The working procedure for this Rainfall practicum is:

A. Data collection using a rainfall gauge (*ombrometer*)
1. Set up the *ombrometer* tool.
2. Place the device in an open space.
3. Collect data every 7:00 am and 7:00 pm.
4. Measuring rainfall using a measuring cup.
5. Record the measurement results.

B. Regional Rainfall

a. Thiessen polygon method rainfall
1. Open ArcGIS and select *add* data and then *connect to folder.*
2. Input the file containing the Menlareng watershed in shp form.
3. Click *geoprocessing,* then select *Arc toolbox* then click *excel to table.*
4. Enter the Salangketo station *file* in excel and select ok.
5. Right-click on Salangketo station and select *display* XY data.
6. Selects coord_Y for the Y *field* and CH for the Z *field.*
7. Right-clicking on Salangketo station then clicking on data and selecting *export* data.
8. Enter the data into *saving data* by renaming the *Export_Output file* to rain station.
9. Choose the *search tool and* search for thiessen.
10. Enter the rain station file in the *input features.*
11. Renamed the rain station *file* to *polygon* in the *feature class output.*

12. Click *environments* then click *processing extent then* select *default* then *same as display.*
13. Open *geoprocessing* and select a *clip.*
14. Enter the *polygon file* in the *input features* then the DAS_Menlareng *file* in the *clip features* then click ok.
15. Right-clicking *polygon_create thiessen* and selecting *join and relates* then select *join.*
16. Selecting *input_FID* on *choose the field in this layer that the join will be based on.*
17. Insert a rain station *file* on *choose the table to join to this layer, or load the table from disk.*
18. Select FID in *choose the field in the table to base the join on* and click ok.
19. Right-click on the *layers and* select *properties.*
20. Clicking *coordinate system* then select UTM then WGS 1984 then select *southern hemisphere* and click WGS 1984 UTM Zone 50S.
21. Right-clicking *polygon_createthiessen* and opening the *open attribute table.*
22. Select *table options* and *add field.*
23. Rename to area with *float type.*
24. Block the *polygon_createthiessen* column. *Clip the* area then right-click then select *calculate geometry* and select *yes.*
25. Change the *units* to *hectares* (ha) and select ok.
26. Right-clicking the *table options* and selecting *export.*
27. Save the data with the name datasiapolah.dbf.
28. Opened the *folder* on the laptop and changed the dbf format to xls.
29. Open data.xls with *excel*
30. Right-clicking *polygon_createthiessen* and opening *properties.*
31. Change the *value field* to CH and click *add all values* then change the color as desired.
32. Choose *labels and* then click on the *label field and* select CH, select ok.
33. Right-click the rain station and select *properties.*
34. Select *labels* then click on the *label field and* select Id, select ok.

b. Regional rainfall isohyet method

1. Open the *search tool* and search for IDW then select IDW (3D *Analyst*) (*tool*).
2. Entering the rain station *file* at the *input point futures*, then clicking Z *Value filed* then selecting CH.
3. Open the *environment* and select the *processing extent* and change the *default* to *same as layer* DAS_Menlareng.
4. Choose *raster analysis* then click *mask* and select watershed_Menlareng, click ok.
5. Select *list by drawing order* and navigate to Menlareng *Excel Thiessen* Station.
6. Right-clicking IDW_shp1 and selecting *properties.*
7. Clicking the *symbology* section and selecting *classes* to 5 and click ok.

C. Rainfall plan

1. Open the prepared 2013-2022 rainfall data.
2. Find the max rainfall value for each year and add NIM.
3. Find the average value of the max rainfall value for 2013-2022.
4. Find the difference between the mean value and the max value.

5. Find the value of $(Xi-X)^2$, $(Xi-X)^3$ and $(Xi-X)^4$.
6. Sum the values of $(Xi-X)^2$, $(Xi-X)^3$ and $(Xi-X)^4$.
7. Find the standard deviation, coefficient of variation, coefficient of kurtosis and skewness.

a. Gumbel method rainfall planning
1. Specifies years of 2, 5, 10, 50 and 100.
2. Enter the Yn value according to the table of average values of variant reduction (Yn).
3. Enter the Sn value according to the standard deviation table of variate reduction (Sn).
4. Entering the Yt value according to the variate reduction table (YT).
5. Entering the standard deviation and average rainfall values.
6. Calculating rainfall values.

b. Normal distribution method rain planning
1. Specifies years of 2, 5, 10, 50 and 100.
2. Entering the KT value according to the table of the normal distribution method-the value of the Gauss reduction variable.
3. Entering the standard deviation and average rainfall values.
4. Calculating rainfall values.

c. Log normal rainfall planning method.
1. Specifies years of 2, 5, 10, 50 and 100.
2. Entering the KT value according to the *standard variable* (Kt) table for the log normal distribution method.
3. Entering the standard deviation and average rainfall values.
4. Calculating rainfall values.

d. Rainfall planning log pearson type III method
1. Enter the max and average rainfall values for 2013-2022.
2. Find the log value of max rainfall 2013-2022.
3. Find the log value of the average value.
4. Search for log Xi-log Xrt, $(logXi-logXrt)^2$, $(logXi-logXrt)^3$ and $(logXi-logXrt)^4$.
5. Sum the values of log Xi-log Xrt, $(logXi-logXrt)^2$, $(logXi-logXrt)^3$ and $(logXi-logXrt)^4$.
6. Find the standard deviation and skewness values.
7. Entering the KT value according to the K price table for the log Pearson III distribution method.
8. Enter the log Xrt value, standard deviation and average rainfall.
9. Calculating rainfall values.

8. Make a graph between the rainfall values of the Gumbel method, normal method, log normal and person type III.

Formula Used

1. Daily Rainfall (Breeder Tool)

$$I = \frac{R}{t}$$

Description:
I = Rainfall intensity (mm/hour),
R = Total rainfall (mm),
t = Duration of rainfall (hours).

2. Regional Rainfall
a. Algebraic Method

$$P = \frac{P_1 + P_2 + P_3 + \ldots + P_n}{n}$$

Description:
P= Average rainfall (mm),
n= Number of stations.
b. *Thiessen* Polygon Method

$$P = \frac{A_1 P_1 + A_2 P_2 + \ldots + A_n P_n}{A}$$

Description:
P= Average rainfall (mm),
A_n = Area of each rainfall station (m^2),
P_n = Rainfall per station (mm).
3. Rainfall Plan
a. Gumbel Method

$$X_t = \bar{X} + \frac{Sd}{Sn}(Y_t - Y_n)$$

Description:
X_t = Rainfall value with T years of measured data (mm),
$\bar{X}$ = Average rainfall value (mm),
Sd = Standard deviation,
Sn = Standard deviation of the reduced variance,
Y_t = Variance reduction value,
Y_n = Mean value of reduced variance.
b. Normal Method

$$X_t = \bar{X} + Kt \cdot Sd$$

Description:
X_t = Rainfall value with T years of measured data (mm),
$\bar{X}$ = Average rainfall value (mm),
Sd = Standard deviation,
Kt=Standardized variable for a return period of t years.
c. Log Normal Method

$$X_t = \bar{X} + Kt \cdot Sd$$

Description:
X_t = Rainfall value with T years of measured data (mm),
$\bar{X}$ = Average rainfall value (mm),
Sd = Standard deviation,
Kt=Standardized variable for a return period of t years.
4. Standard Deviation

$$S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})}{n-1}}$$

Description:
S = Standard deviation,
X_i = Rainfall in year i (mm),
$\bar{X}$ = Average rainfall value (mm),
n = Number of rainfall events.

5. Coefficient of Variation

$$Cv = \frac{S}{\overline{X}}$$

Description:

Cv= Coefficient of variation,

S = Standard deviation,

$\overline{X}$ = Average rainfall value (mm).

6. Kurtosis Coefficient

$$Ck = \frac{n \times \sum_{i=1}^{n} (X_i - \overline{X})^3}{(n-1) \times (n-2) \times (n-3) \times S^4}$$

Description:

Ck = Coefficient of kurtosis,

n =The amount of rainfall data,

X_i =Rainfall in year i (mm),

S = Standard deviation.

$\overline{X}$ = average rainfall value (mm).

7. Skewness Coefficient

$$Cs = \frac{n \times \sum_{i=1}^{n} (X_i - \overline{X})^3}{(n-1) \times (n-2) \times S^3}$$

Description:

Cs = Coefficient of kurtosis.

n =The amount of rainfall data.

X_i =Rainfall in year i mm),

S = Standard deviation,

$\overline{X}$ = Average rainfall value (mm).

8. Standard Deviation for Log Pearson Type III

$$Sd= \sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n-1}}$$

Description:

Sd= Standard deviation,

X_i = Rainfall in year i (mm),

$\overline{X}$ = Average rainfall value (mm),

n = Number of bulk data.

9. Coefficient of Skewness for Log Pearson Type III

$$Cs=\frac{\sum_{i=1}^{n} \{(X_i - \overline{X})\}^3}{(n-1)(n-2)Sd^3}$$

Description:

CS= Coefficient of skewness,

X_i = Rainfall in year i (mm),

$\overline{X}$ = Average rainfall value (mm),

N = The amount of rainfall,

Sd = Standard deviation.

RESULTS AND DISCUSSION

Results

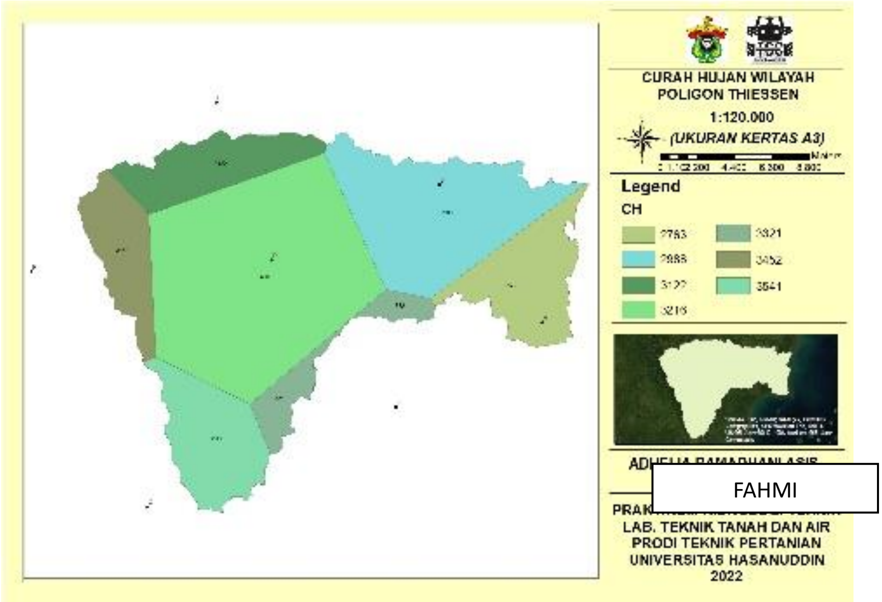

Image 59. Thiessen Polygon Results of Menlareng Watershed.

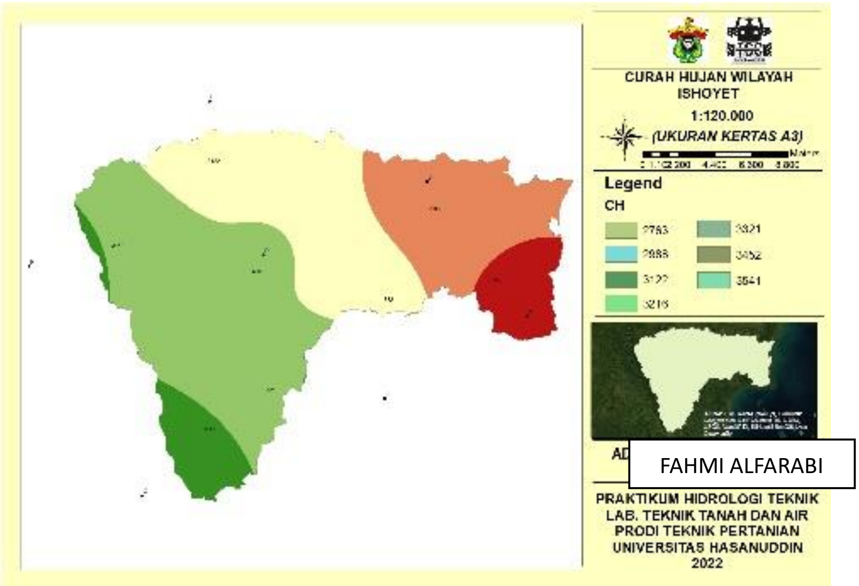

Image 60. Isohyet results of Menlareng watershed.

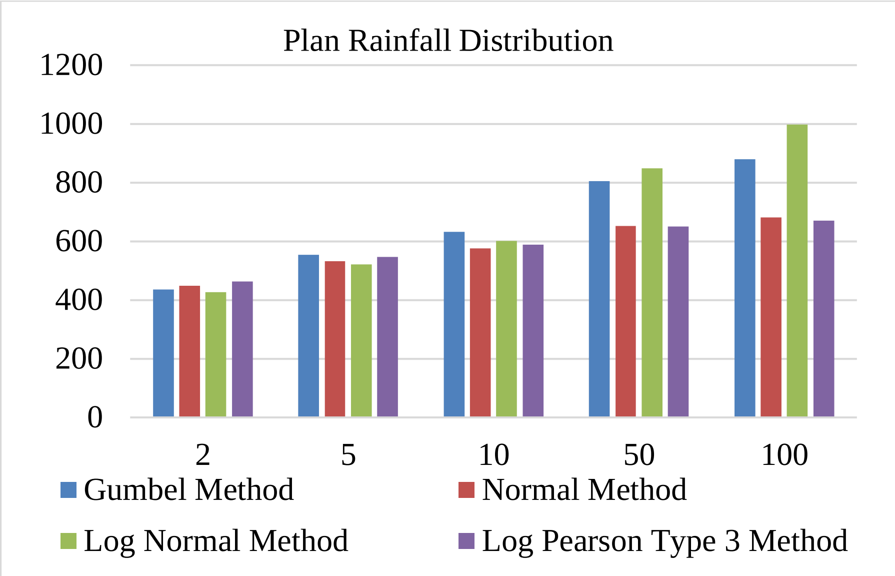

Image 61. Rainfall Distribution Plan**.**

Discussion

Rainfall measurements can be used using an *ombrometer. The ombrometer* tool functions as a rainfall measuring device that is installed in an open place. The unit of the *ombrometer* tool is mm which is used to measure the amount of rainfall that occurs at one time. This is in accordance with the statement of Ajr & Dwirani (2019), stating that the *ombrometer* tool is used as a tool to take rain data that occurs for several days.

Rainfall practicum activities are known that the thiessen polygon map *layout* as one of the methods used to input rainfall data will then limit the area based on existing stations and then form a polygon. This is in accordance with the statement of Lashari *et al.* (2017), stating that the calculation of the average rainfall of the thiessen polygon method is done by taking into account the influence area of each station.

The map *layout* using the isohyet method is done by inputting Menlareng rainfall data then after the data is entered it will display areas that have different colors. This indicates that the area around the area has rainfall according to the height of the land in the area. This is in accordance with the statement of Jun (2018), stating that the right isohyet map can help detect the location of the plains affected by flooding.

Rainfall is generally known as the amount of water collected during a rainy period. Rainfall can be divided into two parts: effective rainfall and planned rainfall. Effective rainfall is known as the amount of rainwater that can be utilized by plants while planned rainfall is known as the estimated rainfall that will occur in an area for one year. Rainfall can be measured by measuring the length of time rain occurs in a time known as rainfall intensity. Rainfall intensity serves to determine the rainfall plan. Distribusi curah hujan rencana dapat digolongkan dengan menggunakan empat metode yang diantaranya distribusi normal, log normal, log pearson III dan gumbel. The utilization of these methods is used to estimate a more accurate rainfall plan. This is in accordance with the statement of Widiansyah and Setiawan (2020), stating that rainfall is known as the amount of rainwater that falls during a certain period of time. by using four types of distribution, namely normal distribution, log normal, log pearson III and gumbel.

Based on the data processing performed, the suitable method used is the *pearson lot* method type III with the condition Cs≠0. Differences in rainfall in a region require determining the characteristics of a method that is suitable for use in the data obtained. This is in accordance with the statement of Widiansyah and Setiawan (2020), stating that data in statistics is known as four types of frequency distribution which are widely used in hydrology, namely the Normal distribution, Log Normal. Gumbel and Person III logs, each of which has unique properties in predicting rainfall.

CONCLUSIONS

Based on the Rainfall practicum that has been carried out, it can be concluded that the rainfall that occurs in the planned rainfall distribution can be obtained using data from NASA or direct measurements using an *ombrometer*. One of the methods used in measuring regional rainfall is using the algebraic method with the thiessen polygon method. When you want to know the rainfall can be done by using the thiessen polygon and isohyet method. As for the use of the thiessen polygon method is by averaging rainfall based on stations within the station area even though the station is outside the watershed. Thiessen stations consist of at least 3 stations. In addition, there is also the isohyet method where this method is oriented towards interpolating a watershed based on stations located in the watershed area. Methods used in measuring rainfall include using the normal distribution, log normal, log pearson III and gumbel. Methods that can be used in the measurement of rainfall plan using normal and pearson type III method.

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ATTACHMENT

Attachment 9. Rainfall gauge (*Ombrometer*)

Image 62. Rainfall Gauge.

Attachment 10. Rainfall Intensity Calculation

Rainfall on Sunday, March 13, 2022

Description. R = 4.6 mm.

t = 6 hours.

Id. I =...?

Penye. $I = \frac{R}{t}$

$$I = \frac{4,6}{6} = 0.77 \text{ mm/hour.}$$

Attachment 11. Arithmetic and Thiessen Polygon Calculations.

a. Arithmetic Calculation

$$P = \frac{P_1 + P_2 + P_3 + \ldots + P_n}{n}$$

$$P = \frac{4486 + 2839 + 2763 + 4543 + 5644}{5}$$

$$= 4055$$

b. Thiessen Polygon Calculation.

$$P = \frac{A_1P_1 + A_2P_2 + \ldots + A_nP_n}{A}$$

$$P = \frac{7403052.96+6626140.83+16741599.1+23132821.5+7899495.82+23987464.2}{5}$$

$$= 8.732.230,7$$

Attachment 12. Rainfall Practicum Procedure

1. Open ArcGis *software*.

Image 63. Opening *ArcGIS Software*.

2. Clicking *add* data and selecting the Menlareng watershed map and clicking ok.

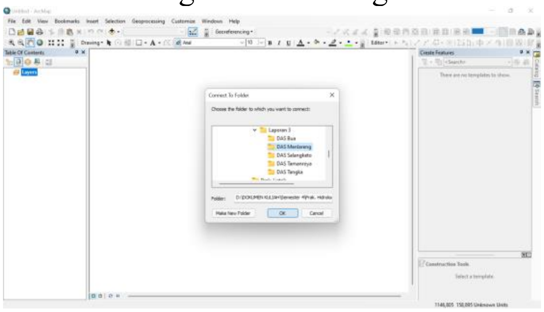


Image 64. *Add Data*.

3. Clicking on *conversion tools* then selecting *excel* then selecting *Excel to Table*.

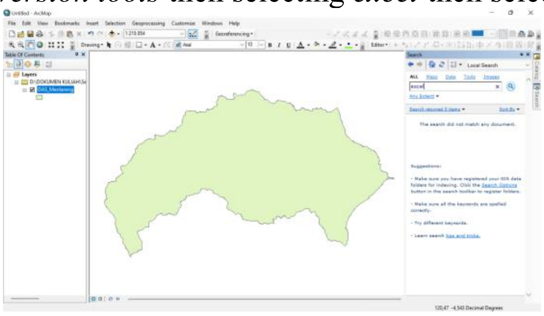


Image 65. *Excel* to *Table* Window.

4. Inputting rain station data in *excel* form on *Excel to Table* data *input*.

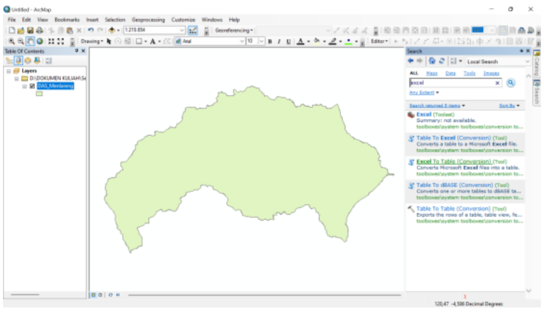


Image 66. Inputting *Excel* Data.

5. Right-click the converted table data on the *layer and* select *display* XY data.

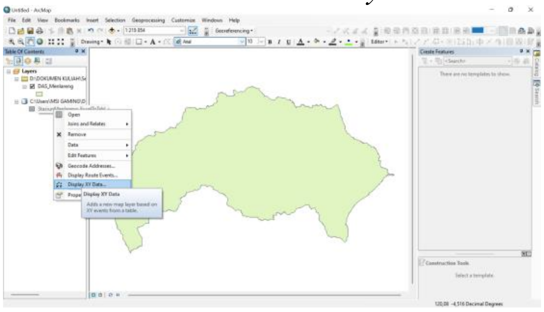


Image 67. Display of Selecting *Display* X and Y.

6. Then fill in the X, Y and Z *fields* with coord_x, coord_y and CH.

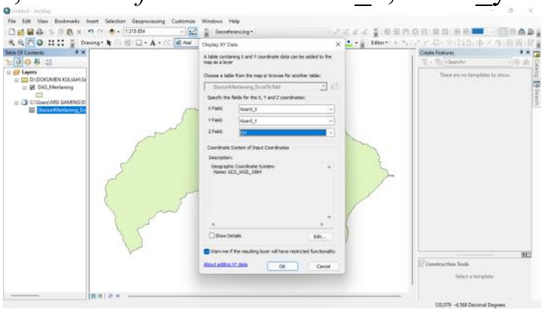


Image 68. Display of Entering *Display* X and Y.

7. Right-clicking a rain station on the *layer* and selecting data and *export* data.

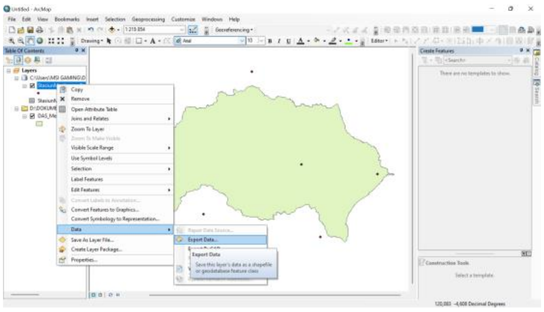


Image 69. *Export Data* View.

8. Then name the rain station in .shp form in the desired folder.

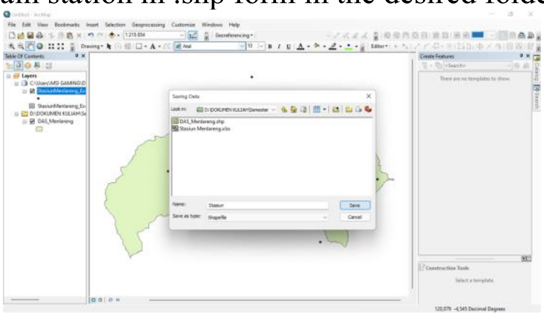


Image 70. Display of Naming a Rain Station.

9. After that, *add* data and add the rain station in .shp form and then click ok.

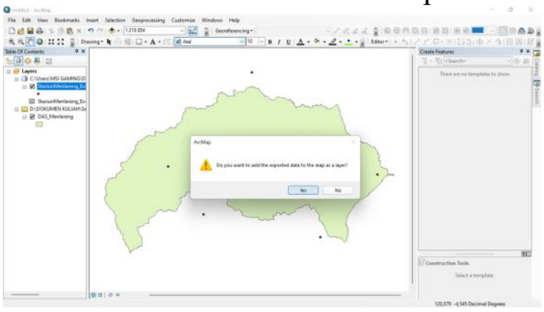


Image 71. View of Adding a Station to a *Layer*.

10. Type *thiessen* in *search* and select *create thiessen* polygon.

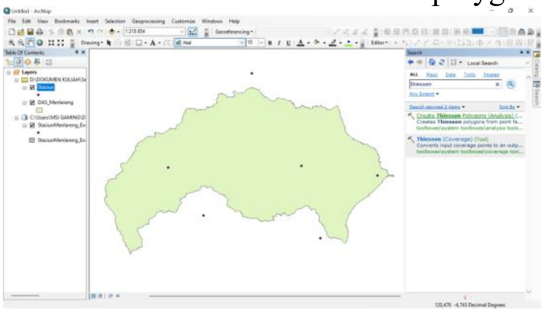


Image 72. Display of Selecting Thiessen Polygon.

11. *Input* .shp rain station data at the *input* while the *output is* named polygon.

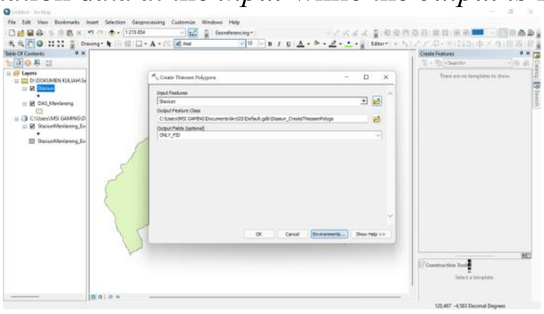


Image 73. Display of Inputting Station Data.

12. After that, type the *clip* back into *search*.

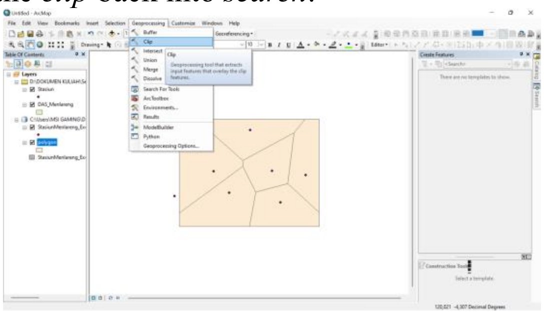


Image 74. *Clip* Window View.

13. Re-input the .shp rain station data and then in the *clip* select the Menlareng watershed map *file* and the *output is* named *thiessen*.

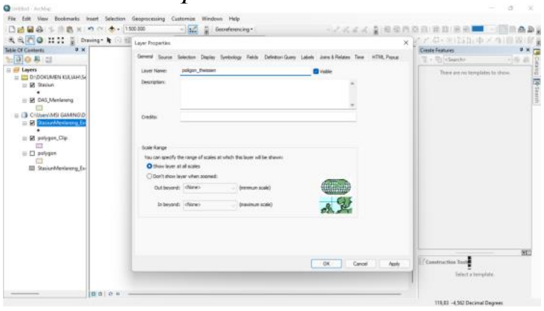


Image 75. Display of Inputting Menlareng Watershed Map.

14. Uncheck the polygon, in the *layer* section.

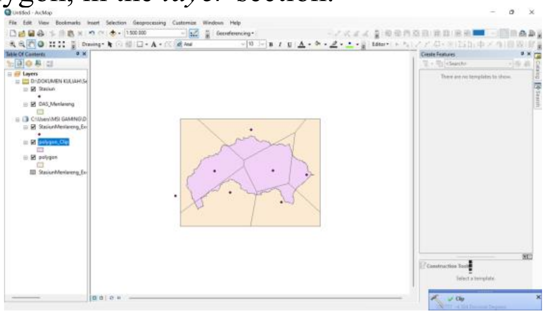


Image 76. Display of Unchecking Polygons.

15. Right-clicking the *thiessen layer* and selecting *join and relate* then selecting *join*.

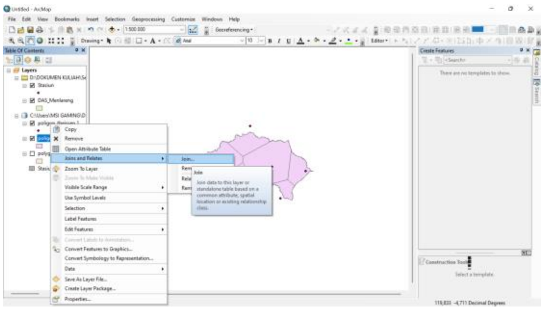


Image 77. Display of *Join and Relate Data*.

16. Then select *input_FID* in the first *field and* then secondly select the .shp rain station and thirdly select CH and click ok.

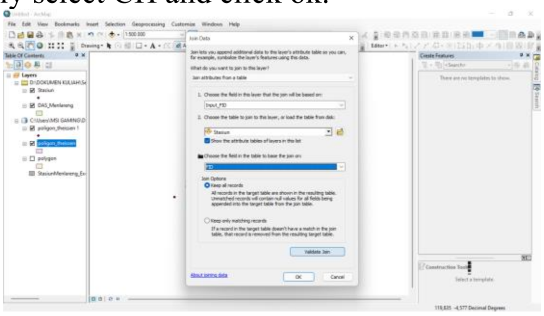


Image 78. Display of Inputting FID on *Field*.

17. Right-clicking *layers* and selecting *properties* then selecting *projected cordinate systems* then selecting UTM after that selecting WGS 1984 and selecting *southern hemisphere*. And selecting utm 50s and clicking ok.

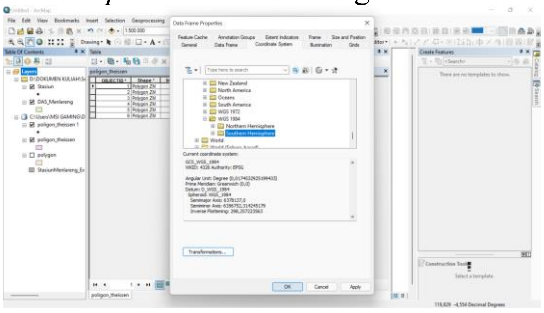


Image 79. Display of Setting UTM.

18. Right-clicking on the *thiessen layer* and selecting *open attribute table*.

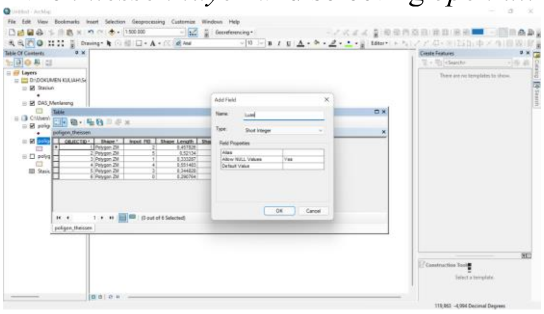


Image 80. Display of Entering a Table Caption.

19. Right-clicking the *layers* and selecting *properties*.

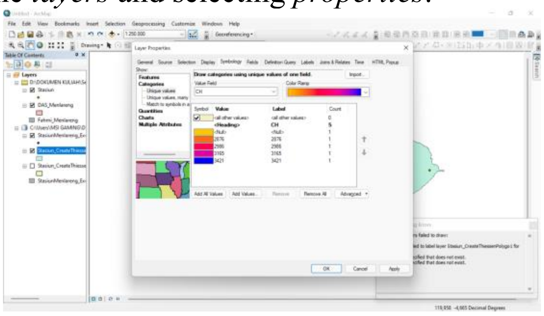


Image 81. Map Color Setting Display.

20. Open *labels* then check the *features label* and select CH in the *label field*.

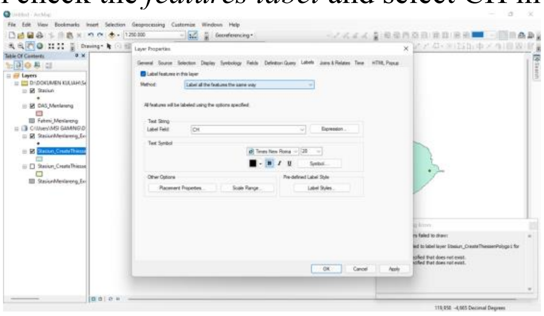


Image 82. Display of Opening *Labels*.

21. Click on *search* and then search for IDW (3D *Analyst*).

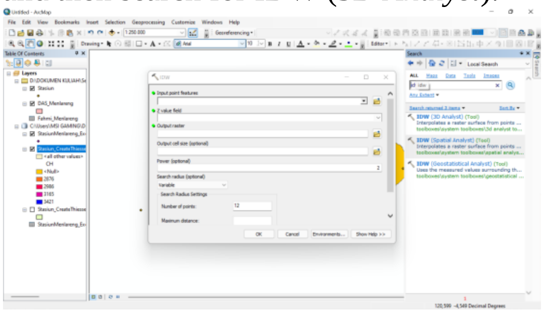


Image 83. IDW Window View.

22. Clicking the *insert* and then selecting the legend.

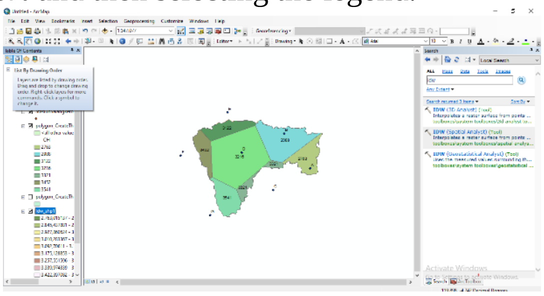


Image 84. Map *Insert* Window.

23. Insert text and Hasanuddin University logo in the *layout view*.

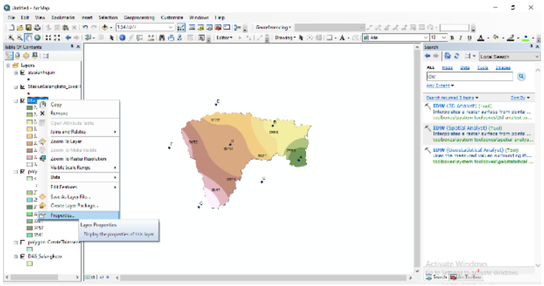


Image 85. Display of Entering Map Identity.

24. Save the map *file*.

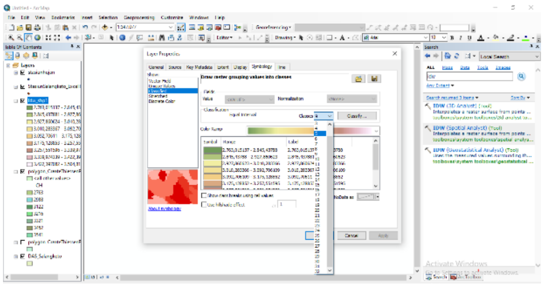


Image 86. Display of Selecting Classes and Saving the File.

Attachment 13. Rainfall Data Obtained on ArcG IS

Table 7. Rainfall obtained.

Station	Coord_X	Coord_Y	CH	Extensive	CH*Area
A	19.475478	-5.84382	4486	1137.14	5101210.04
B	12.440923	-5.45395	2839	4233.97	12020240.8
C	15.349328	-5.20535	2763	7154.7	19768436.1
D	18.348237	-5.54884	4543	5386.35	24470188.1
E	17.908760	-5.40349	5644	2187.62	12346927.3

Attachment 14. Makassar's Total Rainfall 2013-2022

Table 8. Rainfall data.

No.	Total Rainfall											
	Jan	Feb	Mar	Apri l	May	June	July	Agus	Sept	Oct	Nov	Des
2013	478.2	206.5	217.2	193.4	106.0	169.2	81.6	16.8	4.96	27.57	116.7	388.8
2014	440.5	167.5	219.2	183.8	81.25	92.54	37.0	7.89	0.7	2.84	74.54	317.7
2015	477.0	230.6	194.0	259.7	48.91	58.05	2.37	0.66	0.37	6.47	132.1	411.7
2016	277.1	279.8	199.6	151.6	73.96	82.34	48.2	4.18	100.2	292.0	181.2	281.9
2017	304.2	265.0	214.0	118.8	75.94	108.1	39.7	26.6	58.41	109.9	232.0	607.2
2018	364.1	324.68	331.32	131.72	36.1	76.32	46.34	5.42	3.55	17.55	152.2	432.31
2019	327.7	179.9	274.99	249.8	59.13	51.24	4.99	1.98	1.18	6.78	29.94	157.48
2020	303.0	252.5	240.22	170.46	186.55	90.19	19.51	67.36	24.54	113.04	285.26	477.82
2021	530.9	292.99	356.85	157.96	87.51	81.47	115.1	74.82	74.91	127.89	331.17	578.39
2022	243.76	377.92	244.2	37.08	0	0	0	0	0	0	0	0

Attachment 15. Normalized rainfall planning

Table 9. Gumbel Method Rainfall Planning.

Tahun	Yn	SN	Yt	K	S	X	XT/mm
2	0,4952	0,9496	0,3665		99,436706	449,09	435,6132686
5	0,4953	0,9496	1,4999		99,436706	449,09	554,2859933
10	0,4954	0,9496	2,2502		99,436706	449,09	632,8426668
50	0,4955	0,9496	3,9019		99,436706	449,09	805,788817
100	0,4956	0,9496	4,6001		99,436706	449,09	878,8898751

Attachment 16. Normalized rainfall planning

Table 10. Normal Method Rainfall Planning.

Year	KT	X	S	XT/mm
2	0	449,09	99,43671	449,09
5	0,84	449,09	99,43671	532,62
10	1,28	449,09	99,43671	576,37
50	2,05	449,09	99,43671	652,94
100	2,33	449,09	99,43671	680,78

Attachment 18. Log Normal Rainfall Planning

Table 11. Rainfall Planning Log Normal Method.

Year	Kt	X	S	XT/mm
2	-0,22	449,09	0,1004924	426,8
5	0,64	449,09	0,1004924	520,77
10	1,26	449,09	0,1004924	601,11
50	2,75	449,09	0,1004924	848,57
100	3,45	449,09	0,1004924	997,77

Annex 19. Log Pearson Type III Rainfall Planning Method

Table 12. Rainfall Planning Log Pearson Type III Method.

Year	KT	Log Xrt	X	S	XT/mm
2	0,132	2,65233338	449,09	0,100492355	463,0185
5	0,856	2,65233338	449,09	0,100492355	547,4631
10	1,166	2,65233338	449,09	0,100492355	588,1762
50	1,606	2,65233338	449,09	0,100492355	651,2146
100	1,733	2,65233338	449,09	0,100492355	670,6356

EVAPORATION AND EVAPOTRANSPIRATION

Fahmi Alfarabi[1)], Muh. Wahyu Apriliandi[2)] and Harvhianti Haruki[2)]
[1)] Practicum Practitioner of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University
[2)] Practicum Assistant of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

The process of water evaporation is divided into three processes, namely evaporation, evapotranspiration and transpiration. Evaporation is the process of converting water into water vapor (vaporation), and then moving water vapor from the surface of the evaporation field into the atmosphere. Evaporation can not only be done using heavy or sophisticated equipment. Drying or evaporation of liquid materials using traditional tools in the form of a *pan is* also an example of evaporation, namely open evaporation. This practicum aims to make students able to know how the evaporation process can occur, how factors can affect evaporation and can calculate the evaporation rate using an evaporation pan tool. The method used in the Evaporation and Evapotranspiration practicum is by watering the lysimeter for 7 days and watering it every 1 hour. In addition, indirect measurements for plant water needs using *Microsoft Excel using* 3 methods namely Penman-Monteith, Thornthwaite and Blaney Criddle. The results obtained after practicing Evaporation and Evapotranspiration include knowing the graphical relationship between Etc and Eto values and knowing the methods used in estimating plant water needs such as the Penman-monteith, Thornthwaite and Blaney Criddle methods. The conclusions obtained from the Evaporation and Evapotranspiration practicum include that evaporation and evapotranspiration are known as the evaporation process that occurs from the water surface to the atmosphere which will then be lowered again in the form of a cycle that takes place continuously. The process of evaporation and transpiration that takes place simultaneously is known as the process of evapotranspiration.

Keywords: Water, Evaporation, Evapotranspiration.

INTRODUCTION

Background

Simply put, the evaporation process that occurs in water bodies is known as part of the hydrological cycle. The process of water evaporation in water bodies such as lakes, rivers and seas can be known as the evaporation process. The evaporation process is also known as the initial process of rain. This is because the water vapor carried through the evaporation process will be the main ingredient in the formation of rain.

Evaporation generally refers to the process of changing the status of water from liquid to gaseous vapor. In the process of the hydrological cycle, water moves from the oceans to the atmosphere as the first stage in the hydrological cycle and affects the input of water to the land surface. About 85% of evaporation on Earth occurs in the oceans. The amount of evaporation on the land surface is smaller than in the ocean, but 60-70% of the volume of rainfall evaporates on the land surface (Wati *et al*., 2018).

The evaporation process is strongly influenced by differences in vapor pressure, air temperature, wind, water quality and evaporation surface. Water is transferred from the land surface to the atmosphere through two different processes: evaporation and transpiration. Evaporation occurs on the surface of free water such as water in the ocean, lakes or water between soil pores. Evaporation can occur due to several influencing factors including air temperature, wind speed, air pressure, solar radiation and humidity. The measurement of the amount of evaporation can be done by various methods such as direct measurement with an evaporation pan or calculations with various methods and a combination of both which are usually used in measuring the evaporation rate (Simbolon, 2021).

Evapotranspiration is known as a combination of two cycles between evaporation and transpiration, which is influenced by several factors including climate and physiological plant vegetation. In addition to being a parameter for calculating water balance, some information about evapotranspiration rates is widely used to obtain data on plant interactions such as evaporation that occurs from the ground to the atmospheric layer (Syarifudin, 2017).

Evapotranspiration can be divided into two, namely potential evapotranspiration (ETp) and actual evapotranspiration (ETa). These two terms are similar, but the concepts are fundamentally different. The evapotranspiration process also affects the humidity of the air in the atmospheric layer. When the air is moist and reaches its capacity, the water will fall back to the earth as rain (Chen, *et al.*, 2017).

Evapotranspiration data processing is carried out with supporting applications such as *cropwat* (*decision support system*) which is used to plan and organize knowing the data automatically based on the location of an area under review. *Cropwat* is simply known as *software* for calculating standard evapotranspiration rates, crop water requirements and crop irrigation arrangements (Dasril *et al*., 2021).

Based on the description above, a practicum on Evaporation and Evapotranspiration is carried out so that practitioners can find out the process of evaporation and evapotranspiration and know the factors that affect the hydrological cycle process at the evaporation and evapotranspiration stages which can later be applied to determine the amount of plant water needs.

Purpose and Usefulness of Practicum

The objectives of the Evaporation and Evapotranspiration practicum are able to know the evaporation process, able to know the factors that cause evaporation, able to calculate the evaporation rate using the evaporation pan tool, able to know the evapotranspiration process, able to know the factors that cause evapotranspiration, able to know how to calculate the evapotranspiration value using the lysimeter tool and able to use the *cropwat* application.

The purpose of the Evaporation and Evapotranspiration practicum is to be able to know how the process of evaporation and evapotranspiration and to be able to know the factors that affect evaporation and evapotranspiration and the importance of evaporation and evapotranspiration in agriculture.

PRACTICUM METHODOLOGY

Time and Place

Infiltration Practicum was conducted on Saturday, May 21, 2022 at 15.00 WITA until completion at the Soil and Water Engineering Laboratory, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, Makassar.

Tools

The tools used in the Evaporation and Evapotranspiration practicum are evaporation pan, ruler, laptop, *microsoft excel software. lysimeter*, bucket, ombrometer and *cropwat software*.

Material

The materials used in the Evaporation and Evapotranspiration practicum are water, climatological data and plant parameter data.

Practicum Procedure

The procedure of the Evaporation and Evapotranspiration practicum, namely**:**

A. Evaporation Measurement using an Evaporation Pan

1. Prepare the tools and materials used.
2. Painted the evaporation pan first using iron paint.
3. Place the evaporation pan in an open place and not obstructed by buildings or trees.
4. Filling the evaporation pan with water until it reaches the predetermined height limit.
5. Observe the rise and fall of the water level at every 7:00 AM for 1 week.
6. Record the measurement results.
7. Calibrate the evaporation pan.
8. Document the results of the practicum.

B. Evapotranspiration measurement using a lysimeter.

1. Pouring water at the top of the lysimeter as much as the predetermined volume.
2. Watering every 1 hour from 08.00 to 17.00.
3. Open the appliance faucet in the morning.
4. Calculate the volume of water released by the faucet.
5. Re-perform procedures 1-3 every day for one week.

C. Procedure for Using *Cropwat Software*.

1. Open *cropwat software*.
2. Select the settings menu and then select options.
3. Replace *temperature* with *average temperature*, *humadity* with *relative humadity in* %, *windspeed* with *hours sunshine*, ETo % *of daylength*.
4. After changing press ok.
5. Selecting *Climate/Eto*.
6. Entering the values in each parameter table obtained from the data so that the Rad and ETo values appear.
7. Screenshot the results obtained.

D. Data Processing Procedure.

1. Open *excel software*.
2. Input 10 years of station rainfall data.

3. Find monthly and daily Re rice and Re secondary crops by using the formula 0.7 x R80%.
4. Calculating the effective CH of rice and secondary crops.
5. Calculate crop SKA using 3 methods namely Penman-Monteith, Thornthwite and Blaney-Criddle.
6. Calculate the SKA value of the crop.
7. Process the data obtained during the evaporation pan measurement to obtain ETo and Etc.
8. After obtaining the ETo and ETc values, graph the relationship between ETo and ETc.
9. Create each plant water demand unit digram using data from the Penman-Monteith, Thornthwite and Blaney Criddle methods.
10. Include the results of the data processing in the lab report and appendices.

Formula Used

The formula used in the Evaporation and Evapotranspiration practicum is:

1. Penman-Mounteith

$$ETo = \frac{0{,}408\Delta R_n + \Upsilon(\frac{900}{T_{m+273}})u_2(e_s - e_a)}{\Delta + \Upsilon(1+0{,}34\ u_2)}$$

Description:
ETo= potential evapotranspiration (mm/day),
Rn= net solar radiation (MJ/m^2 /day),
T_m = average air temperature (°C),
u_2 = average wind speed at a height of 2 m (m/s),
e_s = saturated water vapor pressure (kPa),
e_a = actual water vapor pressure (kPa),
Δ= water vapor pressure *slope* (kPa/°C),
ϒ= *psychrometric* constant (kPa/°C).

2. Thornthwite

$$ETo = 1.62 \left[\frac{10Tm}{I}\right]^a$$

$$I = \sum_{n-1}^{I^2} \frac{Tm}{s}^{1{,}514}$$

$$a = (675\times10^{-9}) \times (I^3) - (771\times10^{-7}) \times (I^2) + (179\times10^4) \times (I) + (492\times10)^{-3}$$

Description:
ETo= crop evapotranspiration (cm),
I= heat index in units,
Tm = monthly average temperature (°C),
a= constant.

3. Blaney Criddle

$$ETo = P\ (0.4 \times T_m + 8)$$

Description:
ETo= crop evapotranspiration (mm/day),
P= daily average percentage of solar irradiation (latitude position),
Tm = monthly average temperature (°C).

RESULTS AND DISCUSSION

Results

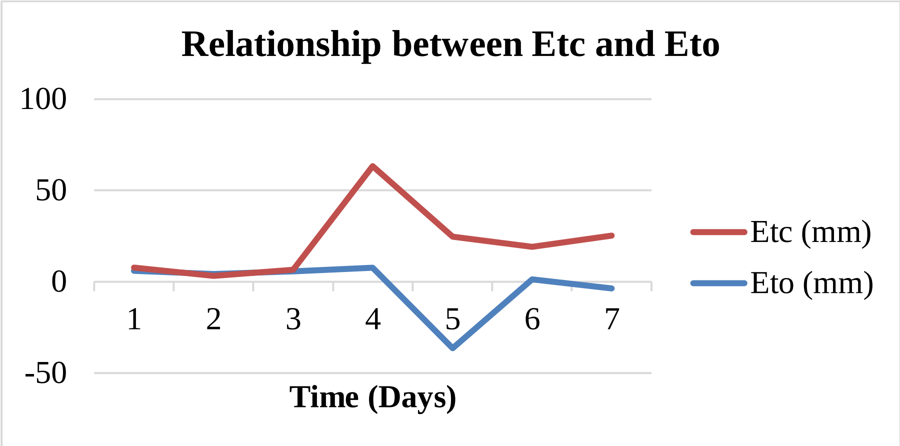


Image 87. Graph of the Relationship Between Etc and Eto.

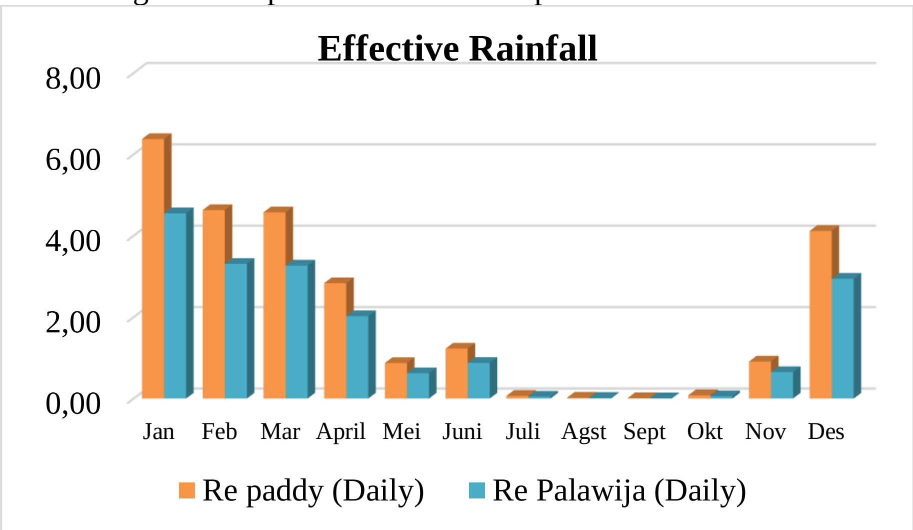


Image 88. Effective Rainfall Diagram.

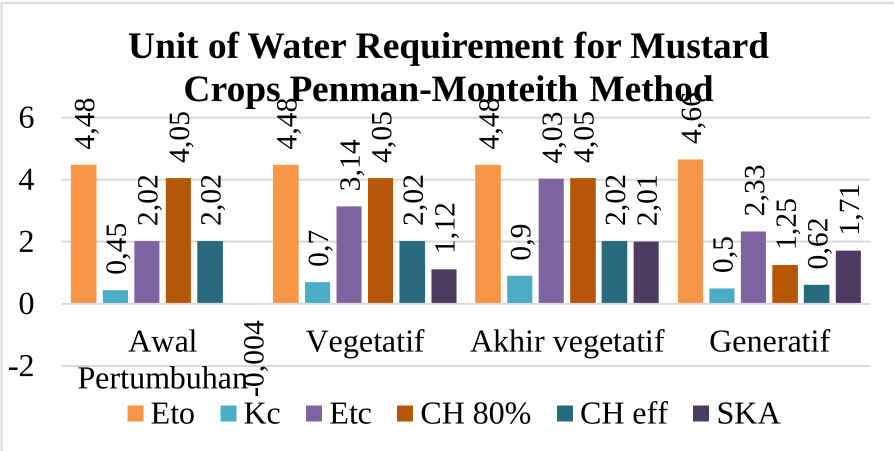
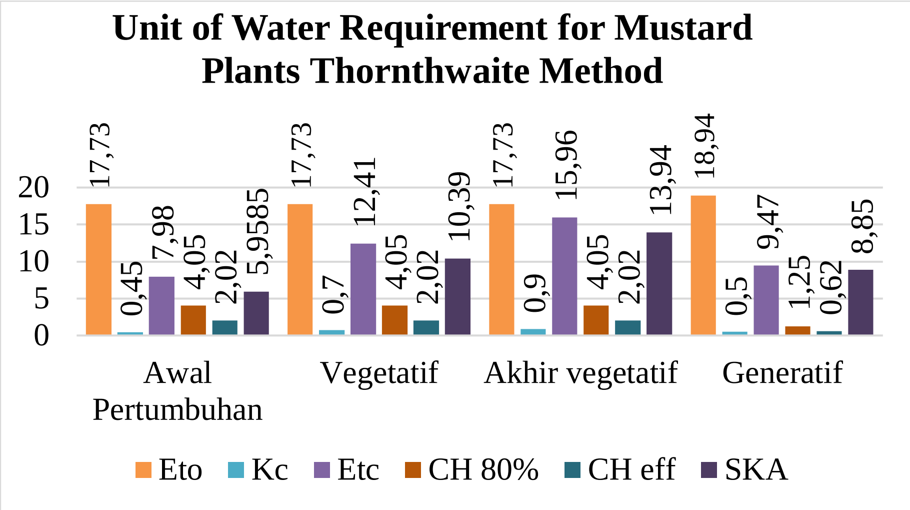


Image 89. Unit Diagram of Water Requirement for Mustard Plants by Penman-Montetith Method



Gambar 90. Unit Diagram of Water Requirements for Mustard Plants Thornthwaite Method.

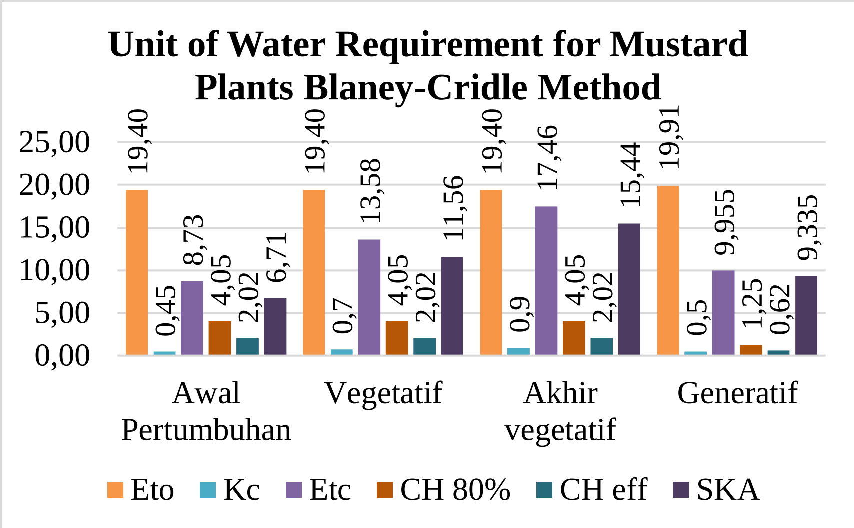


Image 91. Unit Diagram of Water Requirements for Mustard Plants Blaney Cridle Method.

Discussion

Based on the Evaporation and Evapotranspiration practicum activities that have been carried out, it can be seen that evaporation and evapotranspiration include one cycle of the evaporation process towards the atmosphere which will be condensed until it drops back to the initial stage. The evapotranspiration value obtained by using the *Cropwat* application by entering the value of the calculation unit of the average value of temperature, wind speed, humidity and sunlight intensity then all values are summed and averaged to get the evapotranspiration value. This is in accordance with the statement Prastowo *et al.* (2016)*Cropwat is* one of the *software* that can determine evapotranspiration, irrigation schedules and water requirements for different cropping patterns.

The results obtained after data processing show that the relationship between Eto and Etp is not directly proportional. This is due to an error in the number of lysimeters filled every day. The measurement data obtained is used to measure how much the plant's ability to absorb water. This is in accordance with the statement of

Wati *et al.* (2018), stating that evaporation generally refers to the process of changing the status of water from liquid to gas vapor.

The unit graph of water demand from mustard plants as a measurement sample can show that how much water is needed in the initial process of growth until the final stage. There are several methods of estimating evapotranspiration that can be done such as the Penman-monteith, Thornthwaite and Blaney Criddle methods using supporting applications such as *Microsoft Excel* and *Cropwat software*. The best method used in the measurement is Penman-monteith. This is because in this method many parameters are used. This is in accordance with the statement of Dasril *et al*. (2021), stating that *Cropwat* is simply known as *software* for calculating standard evapotranspiration rates, crop water requirements and crop irrigation arrangements.

The type of mustard plant used needs to know its coefficient value to facilitate the data processing stage. This is because the coefficient value of the plant will show the value of the initial growth period to the final stage of growth. The coefficient value of mustard plants includes the initial growth period of 0.45, the vegetative period of 0.70, the final vegetative period of 0.90 and the generative period of 0.50. After data processing, the value of one plant water requirement (SKA) can be obtained using three methods including using the Penman-monteith, Thornthwaite and Blaney Criddle methods. The relationship between the plant coefficient value and the SKA value is directly proportional. The greater the plant coefficient value, the greater the SKA value. The late vegetative period has a greater coefficient value so that the highest SKA phase is in that period. Important information about the water needs of plants to grow during one period and will show how much evapotranspiration occurs such as potential evapotranspiration and actual evapotranspiration. This is in accordance with the statement of Chen *et al.* (2017), stating that evapotranspiration can be divided into two, namely potential evapotranspiration (ETp) and actual evapotranspiration (ETa).

CONCLUSIONS

Based on the Evaporation and Evapotranspiration practicum, it can be concluded that in the hydrological cycle evaporation can be understood as the evaporation process that occurs in water bodies that evaporate into the atmosphere and then will fall back to the earth's surface after going through several advanced stages. The evaporation and transpiration stages that occur at the same time can be known as the evapotranspiration stage which is simply understood as the result of the evaporation and transpiration processes that take place in one cycle. There are several factors that affect the evaporation process including climatological factors in an area ranging from sunlight conditions to rainfall. Therefore, these factors are very influential at the time of data collection which will eventually be processed using supporting *software* such as *Cropwat* which will give rise to an estimated value of plant water needs.

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ATTACHMENT

Attachment 20. CH, Evaporation and lysimeter measurement table.

Table 13. CH, Evaporation and lysimeter measurements

Day/Date	CH (mm)	Evaporation Measurement Results (cm)	Eto (mm)	Pr Lysimeter 2	Etc (mm)
Thursday, March 10th, 2022	0	0,85	5,950	58,56	5,95
Friday/11 March 2022	0	0,60	4,200	60,76	4,20
Saturday, March 12, 2022	0	0,83	5,810	59,45	5,81
Sunday, March 13th, 2022	0	1,10	7,700	16,32	7,70
Monday, March 14, 2022	59	-5,20	-36,400	58,45	-36,40
Tuesday, March 15th, 2022	1	0,20	1,400	46,84	1,40
Wednesday, March 16, 2022	16	-0,50	-3,500	49,91	-3,50

Initial water level of the evaporation pan: 5.25 cm
Evaporation pan coefficient: 0.7
Total water applied to the lysimeter: 60 liters

Attachment 21. Table ETo.

Month	Avg Temp	Humidity	Wind	Sun	Rad	ETo
	°C	%	km/day	%	MJ/m²/day	mm/day
January	27.6	83	222	36	16.3	3.79
February	27.9	80	178	62	21.5	4.68
March	27.8	82	178	57	20.3	4.38
April	28.5	80	133	67	20.9	4.48
May	28.8	76	133	81	21.6	4.66
June	27.8	77	133	62	17.6	3.87
July	27.3	71	178	88	22.1	4.77
August	27.5	68	178	97	25.3	5.42
September	28.0	78	178	97	27.1	5.55
October	29.4	68	178	98	28.1	6.29
November	29.4	74	178	90	26.5	5.89
December	29.0	79	178	69		
Average	**28.3**	**76**	**170**	**75**	**22.5**	**4.89**

Image 92. Eto value in *Cropwat*.

Attachment 23. Table of Probability/Effective CH of Rice and Crops.

Table 14. Probability/Effective CH of Rice and Crops

No	P (%)	Jan	Feb	Mar	April	Mei	Juni	Juli	Agst	Sept	Okt	Nov	Des
1	9%	478.23	377.92	356.85	259.74	186.55	169.26	115.1	74.82	100.29	292.05	331.17	607.25
2	18%	530.99	324.68	331.32	249.8	106.07	108.19	81.6	67.36	74.91	127.89	285.26	578.39
3	27%	477.01	292.99	274.99	193.44	87.51	92.54	48.27	26.67	58.41	113.04	232.07	477.82
4	36%	440.56	279.86	244.2	183.88	81.25	90.19	46.34	16.82	24.54	109.96	181.27	432.31
5	45%	364.18	265.01	240.22	170.46	75.94	82.34	39.79	7.89	4.96	27.57	152.2	411.75
6	55%	327.76	252.5	219.28	157.96	73.96	81.47	37.01	5.42	3.55	17.55	132.12	388.89
7	64%	304.24	230.67	217.29	151.67	59.13	76.32	19.51	4.18	1.18	6.78	116.77	317.78
8	73%	303.05	206.55	214.09	131.72	48.91	58.05	4.99	1.98	0.7	6.47	74.54	281.97
9	82%	277.19	179.9	199.68	118.88	36.1	51.24	2.37	0.66	0.37	2.84	29.94	157.48
10	91%	243.76	167.58	194.04	37.08	0	0	0	0	0	0	0	0
	R80%	282.36	185.23	202.56	121.45	38.66	52.60	2.89	0.92	0.44	3.57	38.86	182.38
	Re padi (Bulanan)	197.65	129.66	141.79	85.01	27.06	36.82	2.03	0.65	0.31	2.50	27.20	127.66
	Re padi (Harian)	6.38	4.18	4.57	2.74	0.87	1.19	0.07	0.02	0.01	0.08	0.88	4.12
	Re Palawija (Bulanan)	141.18	92.62	101.28	60.72	19.33	26.30	1.45	0.46	0.22	1.78	19.43	91.19
	Re Palawija (Harian)	4.55	2.99	3.27	1.96	0.62	0.85	0.05	0.01	0.01	0.06	0.63	2.94

Attachment 24. Penman-Monteith Method Crop SKA Table.

Table 15. Crop SKA Penman-Monteith Method.

Tahapan	Waktu	Eto	Kc	Etc		CH 80%		CH eff		SKA	
				mm/hari	mm/bulan	mm/hari	mm/bulan	mm/hari	mm/bulan	mm/hari	mm/bulan
awal pertumbuhan	0/10 april	4.48	0.45	2.02	60.48	4.05	121.45	1.96	60.72	0.06	-0.24
vegetatif	11/20 april	4.48	0.70	3.14	94.08	4.05	121.45	1.96	60.72	1.18	33.36
akhir vegetatif	21/26 april	4.48	0.90	4.03	120.96	4.05	121.45	1.96	60.72	2.07	60.24
generatif	27/38 april	4.66	0.50	2.33	72.23	1.25	38.66	0.62	19.33	1.71	52.90

Attachment 25. Thornthwite Method Plant SKA Table.

Table 16. SKA of Thornthwite Method Plants

Tahapan	Waktu	Eto	Kc	Etc		CH 80%		CH eff		SKA	
				mm/hari	mm/bulan	mm/hari	mm/bulan	mm/hari	mm/bulan	mm/hari	mm/bulan
awal pertumbuhan	0/10 april	17.73	0.45	17.28	518.40	4.05	121.45	1.96	60.72	15.32	457.68
vegetatif	11/20 april	17.73	0.70	17.03	510.90	4.05	121.45	1.96	60.72	15.07	450.18
akhir vegetatif	21/26 april	17.73	0.90	16.83	504.90	4.05	121.45	1.96	60.72	14.87	444.18
generatif	27/38 april	18.94	0.50	18.44	553.20	1.25	38.66	0.62	19.33	17.82	533.87

Attachment 26. Blaney-Criddle Method Plant SKA Table.

Table 17. Blaney-Criddle Method Plant SKA.

Tahapan	Waktu	Eto	Kc	Etc		CH 80%		CH eff		SKA	
				mm/hari	mm/bulan	mm/hari	mm/bulan	mm/hari	mm/bulan	mm/hari	mm/bulan
awal pertumbuhan	0/10 april	19.40	0.45	18.95	568.50	4.05	121.45	1.96	60.72	16.99	507.78
vegetatif	11/20 april	19.40	0.70	18.70	561.00	4.05	121.45	1.96	60.72	16.74	500.28
akhir vegetatif	21/26 april	19.40	0.90	18.50	555.00	4.05	121.45	1.96	60.72	16.54	494.28
generatif	27/38 april	19.91	0.50	19.41	582.30	1.25	38.66	0.62	19.33	18.79	562.97

DISCHARGE AND SEDIMENTATION MEASUREMENTS

Fahmi Alfarabi[1)], Muh. Wahyu Apriliandi[2)] and Harvhianti Haruki[2)]

[1)] Practicum Practitioner of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

[2)] Practicum Assistant of Engineering Hydrology, Agricultural Engineering Study Program, Hasanuddin University

ABSTRACT

The utilization of flow discharge measurements in agriculture is currently widely used to estimate how much water can be utilized by an agricultural land. The flow rate is measured using units of volume per time. The objectives of the practicum of Debit and Sedimentation Measurement include being able to use a flow velocity measuring device, being able to calculate water discharge and calculate the sedimentation content contained in the river. The methods used in this practicum include measuring discharge and sedimentation directly using the floating method using a plastic ball as a flow velocity measuring device. The last stage carried out after measuring the discharge is measuring the sedimentation contained in the river. The results obtained in this practicum are the highest flow discharge obtained in the fifth segment, where these results show the velocity in the cross section, the closer to the center of the channel, the greater the velocity value obtained. In addition, it can be seen the relationship between river sedimentation through measuring the discharge of the *mid section* and *mean section* methods. The conclusion of this practicum is that in measuring the flow velocity, you can use the *current meter* and floating method, but the floating method is not effective because there are many methods that affect the accuracy of the measurement such as wind, vegetation and so on.

Keywords: Discharge, Sedimentation, River.

INTRODUCTION

Background

The measurement of stream discharge has always been used to determine the amount of water that can be utilized by both humans and plants. Erosion, sediment transport and deposition downstream occur due to interactions that occur in the area around the river. Land use management, both expanding and narrowing, can affect the erosion of rock sedimentation. One of the parameters to measure the occurrence of sedimentation that occurs is by looking at the condition of the soil around the river.

Sedimentation is generally known as the deposition of rock material that has been transported by water. When there is erosion of rocks, water will carry the rocks into the river so that under certain conditions the sediment is deposited. Disintegration includes all the processes by which rocks break into small grains without any change in chemical substance. Decomposition refers to the breakdown of the mineral components of rocks by chemical reactions. Decomposition includes carbonation, hydration, oxidation and solution processes. The characteristics of mineral grains can describe sediment properties, including size, shape, volume weight, specific gravity and falling or settling velocity. (Hambali & Apriayanti, 2016)..

Discharge is one of the coefficients that can express the amount of water flowing from a source per unit of time (liters per/second). In the measurement of flow discharge, flow velocity is known as the movement of flow allocated to the distance per unit of time. Flow velocity can be measured using a *current meter. The current meter* tool is used in measuring discharge because it has good accuracy. The *propeller* that rotates after being hit by the flow will send information to the display automatically where the flow velocity measurement can be done at a certain interval point depth. The working principle of *current meter* measurement includes measuring the flow velocity by taking data from the rotation speed of the *current* meter *propeller.* (Sasso *et al*., 2018).

Discharge measurement can use the *mid section method* or the middle section method is known as the method of measuring the discharge of the channel cross section by dividing several segments and the value of the wet cross-sectional area of the first point with the next point is averaged. *Mean section* method or average cross section method is understood as a method of measuring discharge in a channel cross section by dividing several segments and the value of the channel velocity of the first point with the next point is averaged (Ziana, & Shaskia, 2021).

Flow velocity in a cross section can generally be measured by reviewing the flow displacement that occurs by looking at the distance moved per unit time. River flow or what is known as an open channel has a process including water flowing with a free face and pressure on the water surface equal to atmospheric pressure. Flow conditions in open channels are complicated based on the fact that the position of the free surface tends to change according to time and space, flow depth, discharge and flow surface. (Sri Martini *et al.*, 2020).

Current meters are used to remotely read the rotation of the wheel contained in the *current meter,* so that the meter does not need to be close to the water source when taking measurements. The reader will communicate with the *current meter* placed in the water source using wireless communication media in the form of radio frequency, therefore the designed tool is separated into two parts, namely the water flow speed reader and the water speed counter. The water velocity reader part is assembled into one with the current meter and is in the measured water source, while the water velocity counter part is operated by the user at a distance away from the *current* meter. (Chang & Indriaty, 2017)..

Mid section method is known as a method of measuring discharge by cutting across the channel by dividing several segments and the value obtained from the wet cross-sectional area of the first point with the next point is then averaged. Unlike the *mid section*, the *mean section method* or known as the average cross section method includes a method of measuring discharge by cutting across the channel by dividing into several segments and the value of the channel velocity of the first point with the next point is averaged. In the two-point method, the flow velocity can be measured at a depth of 0.2d and 0.8d from the surface of the channel water level after the river length is divided into several segments. (Hidayatullah *et al.,* 2021).

Based on the description above, it is necessary to conduct a practicum Measurement of Discharge and Sedimentation in order to be able to use a flow velocity meter, calculate water discharge and calculate the sedimentation content in river water and be able to use a velocity meter so that it can be applied in agriculture to find out the amount of water in a river or irrigation channel.

Purpose and Usefulness of Practicum

The purpose of the Debit and Sedimentation Measurement practicum is for students to be able to use a flow velocity measuring device, calculate water discharge and calculate sedimentation content in river water.

The purpose of the practicum of Debit and Sedimentation Measurement is to be able to use a speed measuring device so that it can be applied in agriculture to determine the amount of water in a river or irrigation channel.

PRACTICUM METHODOLOGY

Time and Place

The Practicum of Discharge and Sedimentation Measurement was held on Sunday, May 22, 2022 at 08.00 WITA until completion at Antang river, Makassar. Data processing of Discharge and Sedimentation Measurement was carried out on Saturday, April 28, 2022 at 14.50 WITA until completion at the Soil and Water Engineering Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, Makassar.

Tools

The tools used in the practicum of Discharge and Sedimentation Measurement are *current meters,* ropes, stakes, meters, scissors, balls, mineral water bottles, petridish cups, measuring cups, *ovens,* writing instruments and *mobile* cameras.

Material

The materials used in the practicum of Debit and Sedimentation Measurement are water samples from the measurement of flow velocity.

Practical Procedures

The practicum procedure for measuring discharge and sedimentation is as follows:

A. Buoy method discharge measurement
1. Prepare tools and materials.
2. Stretch the rope along the width of the river.
3. Measure the width of the river at a predetermined position using a meter.
4. Divide the river width into 6 segments with the same width in each segment.
5. Install stakes at each segment boundary.
6. Measure the depth of each installed stake.
7. Stretching the rope between the front stakes of the previous stakes
8. Measuring the velocity of the discharge using a ball used as a float.
9. Documenting the practicum.

B. *Current meter* method discharge measurement
1. Set up a *current meter*.
2. Attaching the propeller to the probe stick.
3. Install the contact cable on the propeller sensor.
4. Connecting the contact cable to the CDU (*Control Display Unit*)
5. Turn on the CDU (*Control Display Unit*) by pressing the *on* button.
6. Calibrate the CDU (Control Display Unit).

7. Determine the discharge measurement point.
8. Reading the water level with a dipstick.
9. Record measurement data on the CDU (*Control Display Unit*) display.
10. Documenting the practicum.

C. Sedimentation

1. Prepare tools and materials.
2. Taking river water samples at each measurement point using mineral water bottles.
3. Weigh the petridish dish.
4. Homogenize the sample in the bottle.
5. Pour 40 ml of water sample into a Petri dish.
6. Conducting an oven for 2 hours at 105°C until all the water in the cewin petridis evaporates.
7. Weigh the petridish dish again after frying.
8. Record sedimentation results.

Formula Used

The formula used in the practicum of Debit and Sedimentation Measurement is:

a. Flow velocity

$$v = \frac{s}{t}$$

Description:
v = average speed of each segment (m/s),
s= distance (m),
t= time (s).

b. Cross-sectional area of each segment

Triangle

$$A_n = \frac{1}{2} \times l \times d$$

Description:
A_n = surface area (m^2 /s),
l= width (m),
d= depth (m).

Trapezoid

$$A_n = \frac{1}{2} \times (d + d_{nn+1}) \times l$$

Description:
A_n = surface area (m^2 /s),
d_n = depth (m),
l= width (m).

c. Segment flow discharge

$$Q\ v_{=}\ x\ A$$

Description:
Q = flow discharge at each segment n (m^3 /s),
v= average velocity of each segment (m/s),
A = surface area of the segment (m^2).

d. Amount of sediment

$$C_{total} = C_1 + C_2 + C_3 + C_4 + C_5 + C_6$$

Description:

C_{total} = total sediment (gr/m^3)

e. Total sediment discharge

$$Q_t = C_r \times Q_s$$

Description:

Q_t = total sediment discharge value (gr/s),

C_t = amount of sediment (gr/m^3),

Q_s = river discharge (m^3 /s).

f. Total flow discharge

$$Q_T = \sum_{i=1}^{n} Q_n$$

Description:

Q_r = total flow discharge (m^3 /s),

Q_n = flow discharge at segment n (m^3 /s),

n= river segment.

g. *Mean section*

$$q_x = \left(\frac{V_x + V_{x+1}}{2}\right)\left(\frac{d_x + d_{x+1}}{2}\right)$$

Description:

q_x = discharge of each segment x (m^3 /s),

V_x = average velocity at segment x (m/s),

d_x = depth at segment x (m).

x= segment between vertical n-1 to vertical n (m/s).

h. Mid section

$$q_x = V_x \left(\frac{b_{x+1} + b_{x-1}}{2}\right) d_x$$

Description:

q_x = discharge of each segment x (m^3 /s),

V_x = average velocity at segment x (m/s),

b_x = width at segment x (m),

d_x = segment depth (m).

x= segment between vertical n-1 to vertical n (m/s).

RESULTS AND DISCUSSION

Results

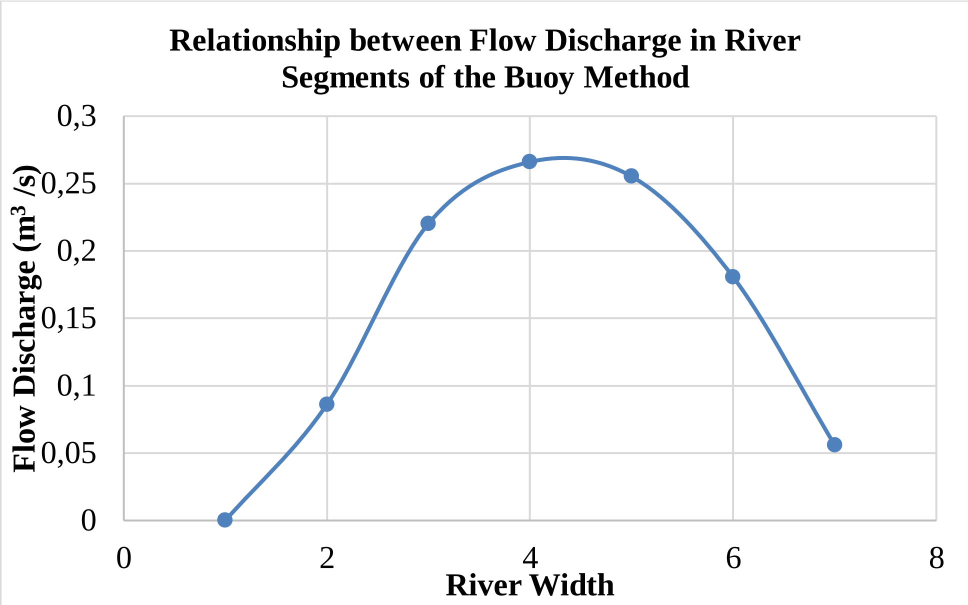

Image 93. Relationship Graph of Flow Discharge on the River of the Buoy Method.

Table 18. Sediment Measurement

Segment	Sediment Amount (g/m^)^3	Sediment Discharge (g/s)
1	250	
2	500	
3	750	2313.57
4	500	
5	250	
6	250	
Total	**2500**	

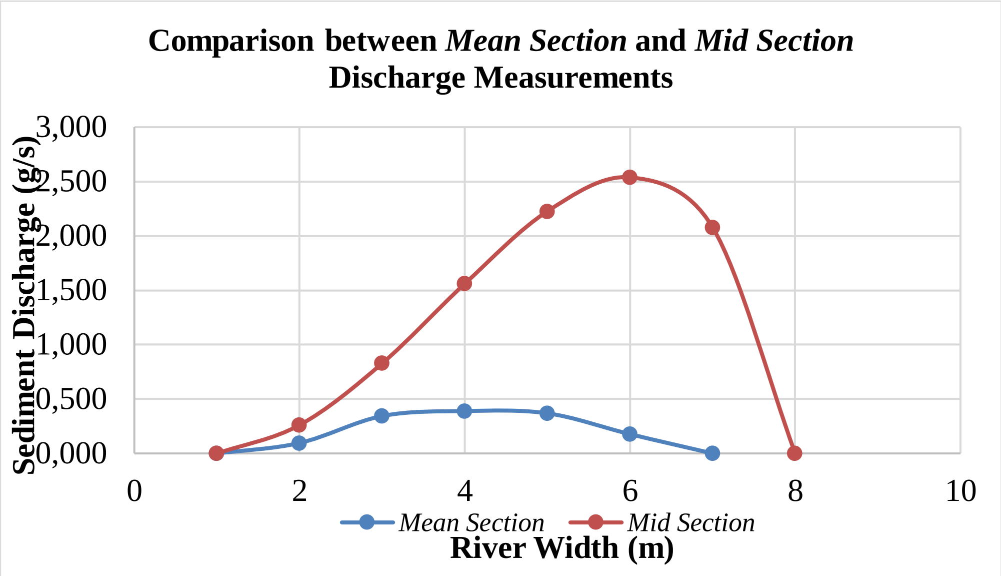

Image 94. Comparison Chart between *Mid Section* and *Mean Section* Method Discharge Measurement.

Discussion

Based on the practicum of Debit and Sedimentation Measurement, it can be seen that the relationship between flow discharge in river segments can be measured by means of the float method. How to calculate the discharge is to review the time it takes to arrive at the segment that has been made. In the discharge measurement method, the buoy does not require special equipment, only uses a floating object such as a ball. Discharge measurements can also use a *current meter*, the tool is much better used because it has a high level of accuracy. This is in accordance with the statement of Ziana *et al.* (2021), state that measuring water discharge in rivers can use several methods such as the floating method and using a *current meter*. The floating method has a working principle, namely measuring the flow velocity by measuring the time it takes for the floating object to pass a predetermined distance in a river flow.

Based on the graph obtained, it can be seen that the speed in the cross section if the closer to the center of the channel, the greater the speed value obtained. Conversely, the closer to the edge of the channel, the smaller the velocity value obtained, this happens because it is influenced by the depth of the segment where the depth of the river can affect the flow velocity. The increase in sediment contained in each river segment also affects the discharge, it is known that sediment has a relationship with river depth. The accumulation of large amounts of sediment at the bottom of the river generally causes the river discharge to decrease. This is in accordance with the statement of Hambali & Apriyanti (2016), stating that the sedimentation rate is influenced by the size of sediment particles, influenced by the discharge passing through the cross section which can be reviewed from the depth of flow (d), river width (b) and energy slope (S0).

The practicum activity of Debit and Sedimentation Measurement also obtained information on the relationship between the *mean section* and *mid section* methods. *The* information obtained is that the *mid section* flow discharge is greater than the *mean section* measurement. This is because the flow discharge is influenced by the depth where the highest depth is in the *mid section* area. The division of the *mean* *section* segment is done to determine the middle value and average velocity in the river segment while the *mid section is* done to measure the amount of river discharge. This is in accordance with the statement of Hidayatullah (2021), stating that the *mid section method is* known as the measurement of discharge in the cross section of the channel by dividing several segments and the value of the wet cross-sectional area of the first point with the next point is averaged while the *mean section method is* known as the average cross *section* divided into several segments where the first point with the next point is then averaged.

CONCLUSIONS

Based on the practicum of Debit and Sedimentation Measurement that has been done, it can be concluded that the measurement of flow discharge can be done using the float method and the *current meter* tool. As for getting more accurate results, it is recommended to use a *current meter* tool. The value of river flow discharge in the middle section is greater than the edge of the river indicating that the middle of the segment has a higher depth with a low level of sedimentation. The sediment content found is in the first and last segment where the segment has a small depth. Therefore, it can be seen that sediment can affect the depth and speed of a flow.

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ATTACHMENT

Attachment 27. River Surface Profile Chart

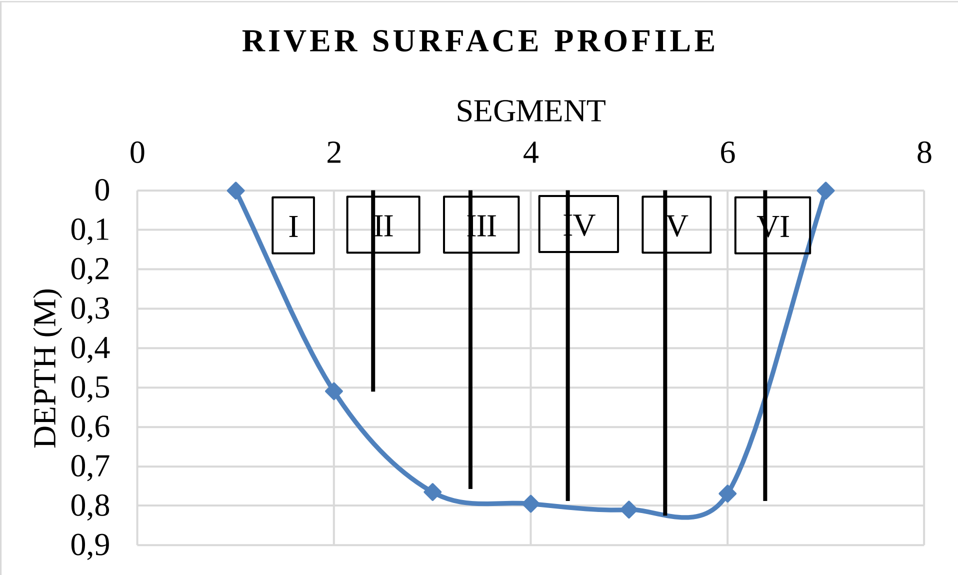

Image 95. River Surface Profile.

Attachment 28. Measurement Table

Table 19. Discharge measurement of the float method.

Patok	b (m)	d (m)	S (m)	t(s)	v (m/s)	A (m)^2	Q(m^3 /s)
1	0	0	4,8	0	0	0	0
2	1,35	0,51	4,8	34,13	0,141	0,344	0,048
3	2,7	0,77	4,8	26	0,185	1,053	0,194
4	4,05	0,80	4,8	28,84	0,166	1,083	0,180
5	5,4	0,81	4,8	22,18	0,216	1,067	0,231
6	6,75	0,77	4,8	20,44	0,235	0,520	0,122
7	8,1	0	4,8	40,34	0,119	0,520	0,062
			Total				**0,8**

Table 20. Sediment Measurement.

Segment	Petri dish weight (g)	Weight of Petri Dish and Sediment (g)	Sample Volume (m)^3	Sediment Weight (g)	Sediment Amount (g/m)^3	Sediment Discharge (g/s)
1	44,23	44,24	0,00004	0,01	250	2094,571
2	44,39	44,41	0,00004	0,02	500	
3	47,1	47,13	0,00004	0,03	750	
4	47,13	47,15	0,00004	0,02	500	
5	44,64	44,65	0,00004	0,01	250	
6	43,83	43,84	0,00004	0,01	250	
Total				**0,1**	**2500**	

Attachment 29. *Mean Section* and *Mid Section*

Table 21. *Mid Section* Method Discharge Measurement.

Patok	**b**	**d**	**velocity (m/s)**			**v average**	**(bi+1-bi-1)/2**	**qi**
			0,2 d	0,6 d	0,8 d			
1	0	0		0		0	0	0,000
2	0,6	0,29		0,87		0,87	0,9	0,261
3	1,8	0,46		1,46		1,46	1,8	0,828
4	3	0,52		1,24		1,24	3	1,560
5	4,2	0,53		1,29		1,29	4,2	2,226
6	5,4	0,47		0,86		0,86	5,4	2,538
7	6,6	0,33		0,55		0,55	6,3	2,079
8	7,2	0		0		0	0	0,000
Total								**9,492**

Table 22. *Mean Section* Method Discharge Measurement.

Patok	**b**	**d**	***Velocity* (m/s)**			**v *average***	**(vi+vi+1)/2**	**(dx+dx+1)/2**	**qi**
			0,2 d	**0,6 d**	**0,8 d**				
1	0	0		0		0	0,195	0,325	0,000
2	1,37	0,65		0,39		0,39	0,455	0,76	0,474
3	2,74	0,87		0,52		0,52	0.52	0,87	1,240
4	4,11	0,87		0,52		0,52	0.515	0,86	1,820
5	5,48	0,85		0,51		0,51	0.505	0,845	2,338
6	6,85	0,84		0,5		0,5	0,25	0,42	0,719
7	8,22	0		0		0	0	0	0,000
Total									**6,591**

Attachment 30. Practicum Documentation

Image 96. Documentation of Practical Measurement of Discharge and Sedimentation.