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Subject and Section: ABE137 Hydrometeorology KL1-3
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ABE 137: Hydrometeorology Laboratory Exercise No. 5

Spatial Distribution of Precipitation

I.

1. Rain station X was inoperable for about a month (October 2010). The rainfall totals for the four surrounding stations A, B, C, D for the same month are 107, 89 and 122, and 95 mm, respectively. The normal annual precipitation amounts at Station X, A, B, C, and D are 1829, 2235, 1880, 2159, and 2438 mm, respectively. Estimate the precipitation for October 2010 for station X.

2. A Rain Gage was inoperable during the month of June 2004. The rainfall totals for the three surrounding stations X, Y, Z during the same month are 5.50, 6.25 and 5.85 inches, respectively. The normal annual precipitation amounts of the station and of X, Y, Z are 80, 73, 79, and 86 inches, respectively. Estimate the amount of rainfall for the station on June 2004. *(15 pts)*

JOANNA FAYE AZORES DATE ..... NO. .....

I.1

Rain Station	P	Annual P	Annual P Difference
X	Missing	1829	
A	107	2235	22.20%
B	89	1880	2.79%
C	122	2159	18.04%
D	95	2438	33.30%

$$P_X = \frac{1}{4}\left[\frac{N_X}{N_A}P_A + \frac{N_X}{N_B}P_B + \frac{N_X}{N_C}P_C + \frac{N_X}{N_D}P_D\right]$$

$$= \frac{1}{4}\left[\frac{1829 \times 107}{2235} + \frac{1829 \times 89}{1880} + \frac{1829 \times 122}{2159} + \frac{1829 \times 95}{2438}\right]$$

$$= 87.19 \text{ mm}$$

∴ The estimated precipitation for Station X for October 2010 is 87.19 mm

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I.2

let: Rain Gage = W

Station	P (in)	Annual P	Annual P Difference
W	Missing	80	
X	5.50	73	8.75%
Y	6.25	79	1.25%
Z	5.85	86	7.5%

Since the normal precipitation of the three index stations is within 10% of that for station W, we will use arithmetic average to compute for the estimated amount of rainfall for station W.

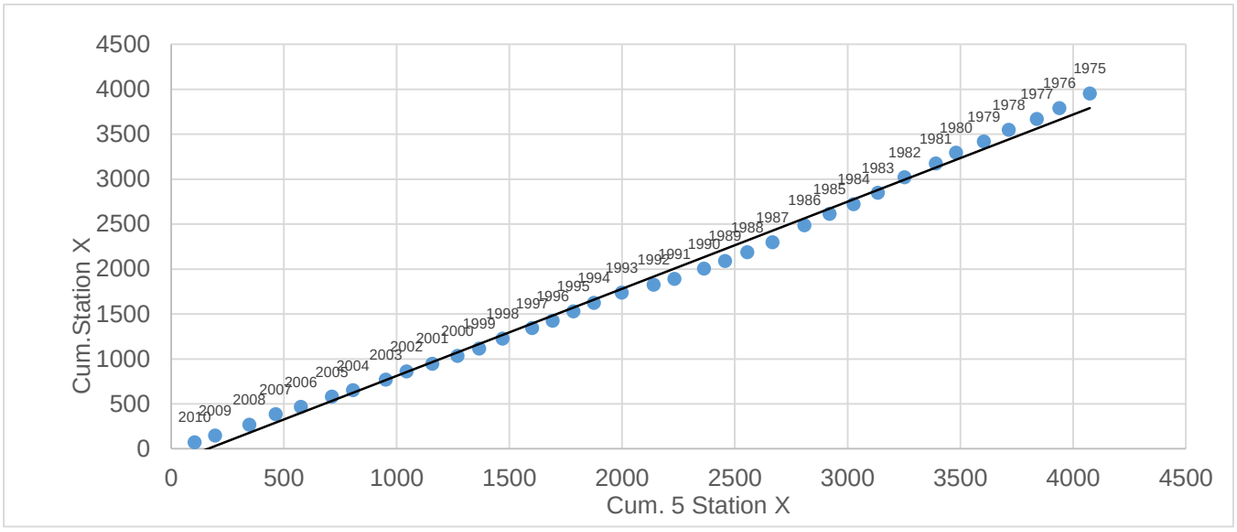
$$\text{Arithmetic Average} = \frac{\text{sum of values P}}{\text{number of values}}$$

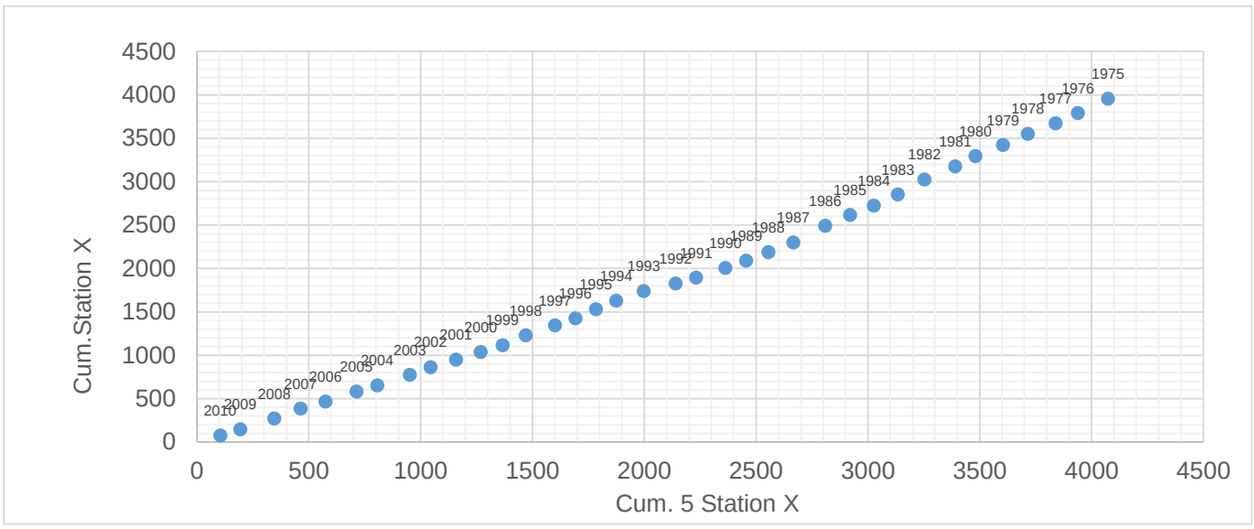
$$= \frac{5.50 \text{ in} + 6.25 \text{ in} + 5.85 \text{ in}}{3}$$

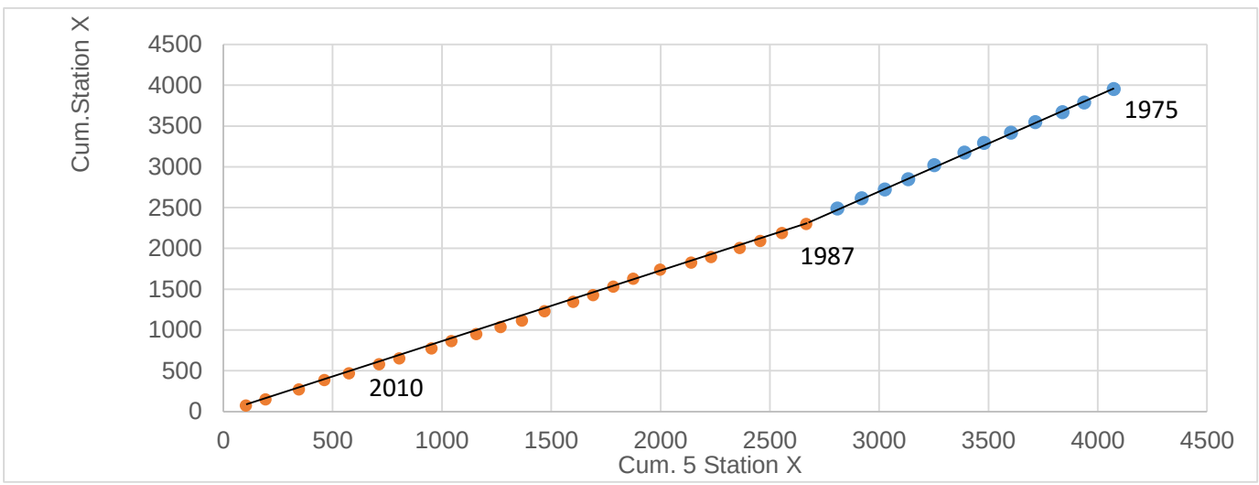
$$= 5.87 \text{ in}$$

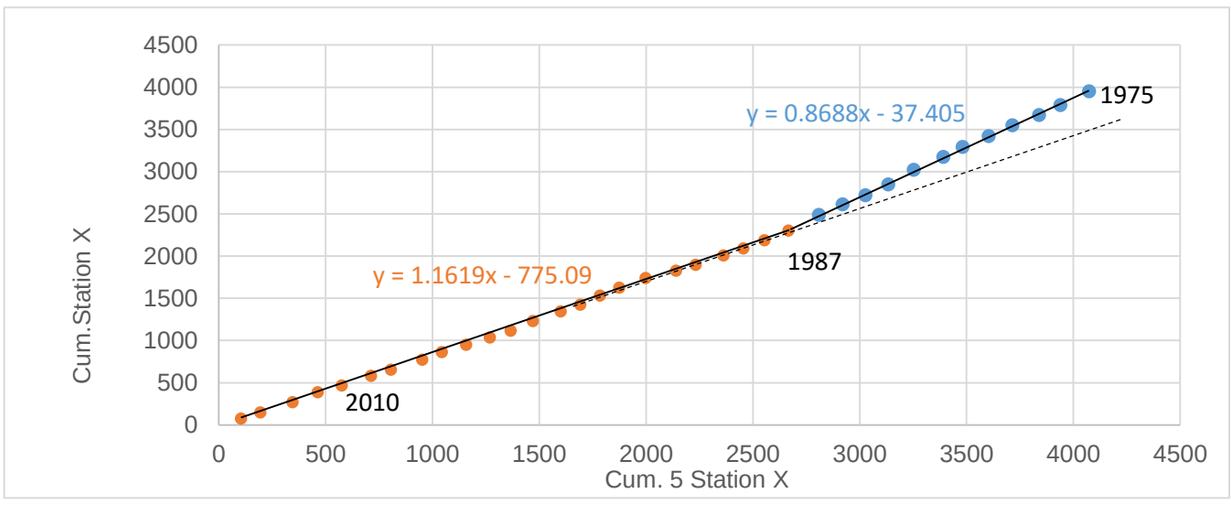
∴ The estimated amount of rainfall for station W in June 2004 is 5.87 in.

II. The 36-year annual precipitation for station X and the average annual precipitation at 5 surrounding stations are shown on Table 1. In what year is a change in regime indicated? Assuming that the change in regime is due to the rain gage's change of location, compute the mean annual rainfall for station X at its present site with adjustment of the previous location's data. *(20 pts)*


Cum.Station X
Cum. 5 Station X
0
500
1000
1500
2000
2500
3000
3500
4000
4500
2010
2009
2008
2007
2006
2005
2004
2003
2002
2001
2000
1999
1998
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1985
1984
1983
1982
1981
1980
1979
1978
1977
1976
1975


Cum.Station X
Cum. 5 Station X
0
500
1000
1500
2000
2500
3000
3500
4000
4500
2010
2009
2008
2007
2006
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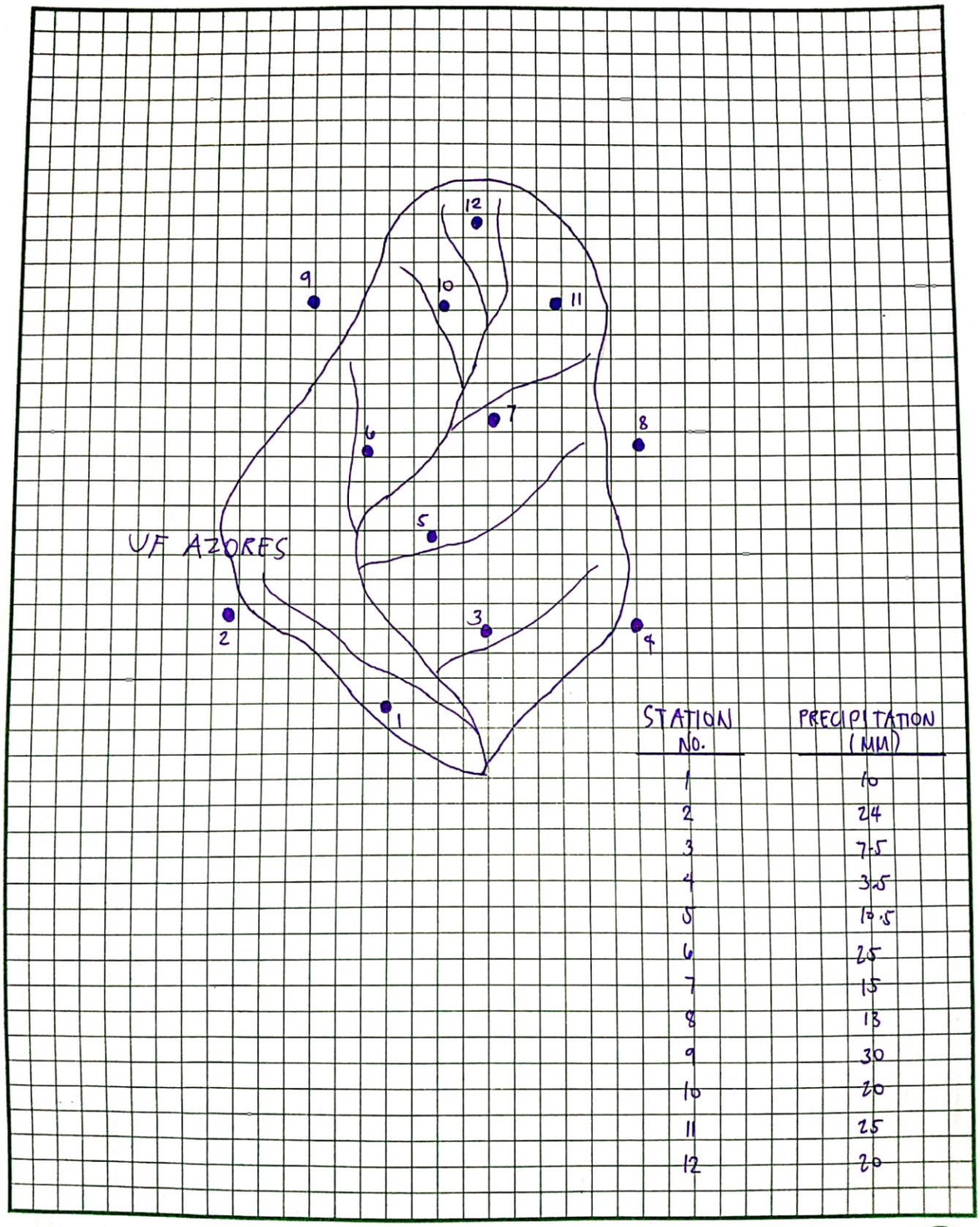

Cum.Station X
Cum. 5 Station X
0
500
1000
1500
2000
2500
3000
3500
4000
4500
2010
1987
1975


Cum.Station X
Cum. 5 Station X
0
500
1000
1500
2000
2500
3000
3500
4000
4500
y = 1.1619x - 775.09
y = 0.8688x - 37.405
2010
1987
1975

YEAR	STA. X	STA. X Cum	5 STA. AVE.	5 STA. Cum	Station X Corrected	
2010	74	**74**	104	104		104
2009	73	**147**	90	194		90
2008	122	**269**	152	346		152
2007	116	**385**	117	463		117
2006	82	**467**	112	575		112
2005	113	**580**	138	713		138
2004	72	**652**	93	806		93
2003	120	**772**	146	952		146
2002	90	**862**	92	1044		92
2001	85	**947**	114	1158		114
2000	88	**1035**	111	1269		111
1999	80	**1115**	97	1366		97
1998	112	**1227**	104	1470		104
1997	116	**1343**	131	1601		131
1996	81	**1424**	91	1692		91
1995	106	**1530**	92	1784		92
1994	95	**1625**	91	1875		91
1993	112	**1737**	123	1998		123
1992	88	**1825**	142	2140		142
1991	68	**1893**	92	2232		92
1990	111	**2004**	131	2363		131
1989	86	**2090**	93	2456		93
1988	97	**2187**	99	2555		99
1987	112	**2299**	112	2667	2230	112
1986	190	**2489**	142	2809	2403	123
1985	126	**2615**	111	2920	2499	96
1984	108	**2723**	107	3027	2592	93
1983	127	**2850**	107	3134	2685	93
1982	172	**3022**	119	3253	2789	103
1981	153	**3175**	138	3391	2909	120
1980	120	**3295**	90	3481	2987	78
1979	126	**3421**	123	3604	3094	107
1978	129	**3550**	111	3715	3190	96
1977	121	**3671**	124	3839	3298	108
1976	119	**3790**	100	3939	3385	87
1975	163	**3953**	135	4074	3502	117
Total	3953					3889
Mean	109.805					108

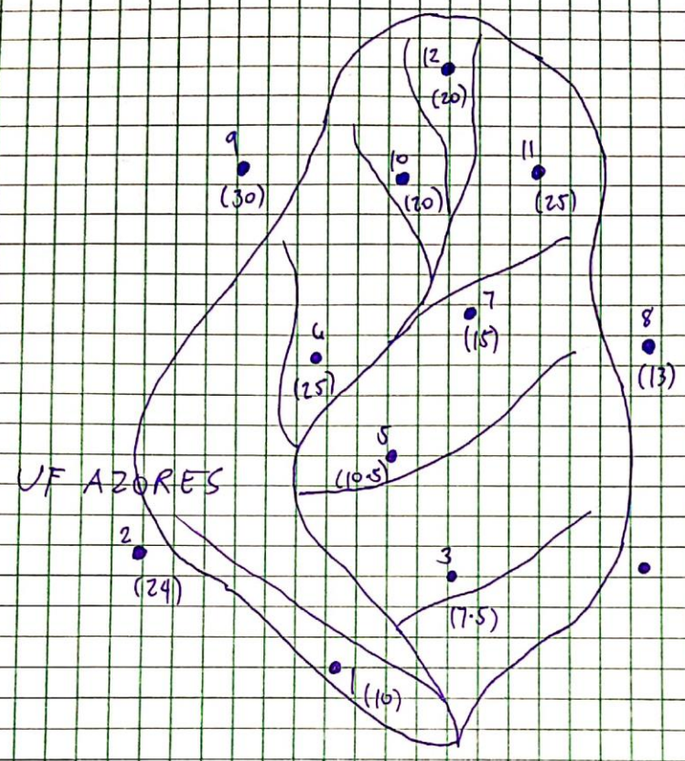
Therefore, the year in which a change in regime indicated is **1987** and the mean annual rainfall for station X at its present site with adjustment of the previous location's data is **108 in.**

III. Compute the mean rainfall for the period June 21-25, 2010 for the Kawa River Basin as shown on Table 2 & Figure I. Using Arithmetic Average, Thiessen Polygon, and Isohyetal map - compute the mean precipitation in the watershed. Compare the three values. Which do you think is most accurate? Why? *(55 pts)*



STATION NO.	PRECIPITATION (MM)
1	10
2	24
3	7.5
4	3.5
5	10.5
6	25
7	15
8	13
9	30
10	20
11	25
12	20

A. ARITHMETIC AVERAGE



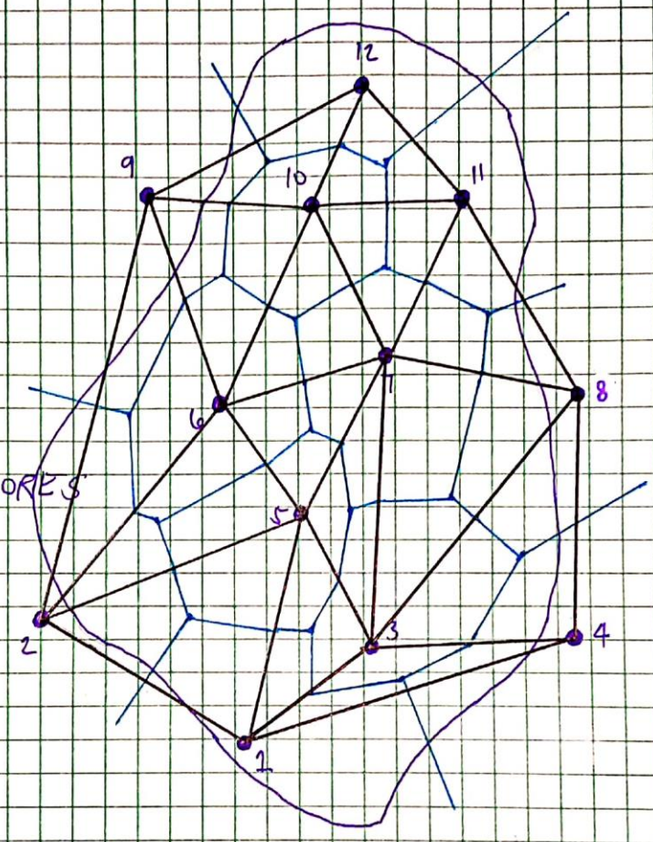
Mean Precipitation of the Kawa River Basin

$$\bar{P} = \frac{P_1 + P_3 + P_5 + P_6 + P_7 + P_{10} + P_{11} + P_{12}}{8}$$

$$= \frac{10 + 7.5 + 10.5 + 25 + 15 + 20 + 25 + 20}{8}$$

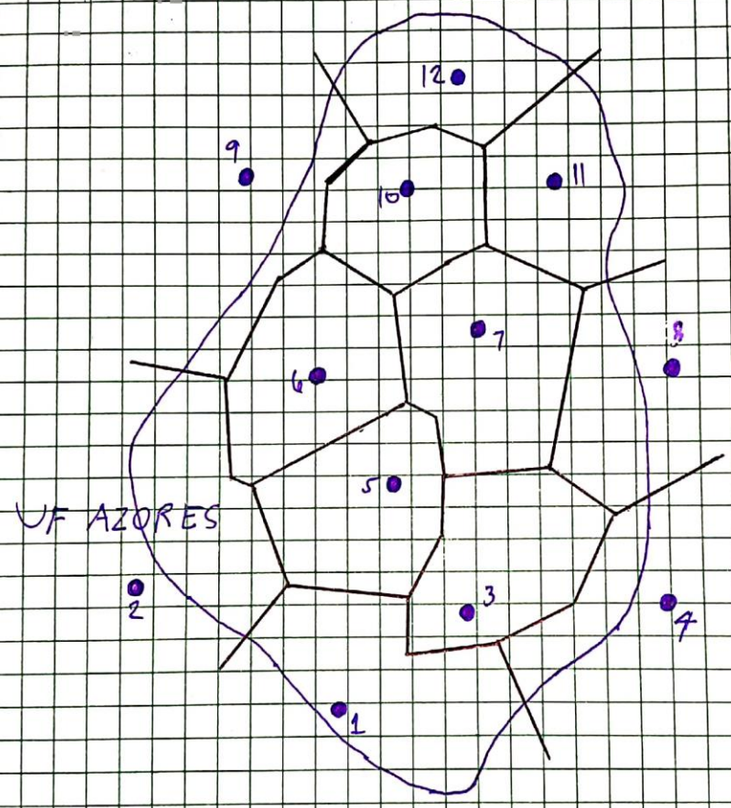
$$= 16.625 \text{ mm}$$

8. THIESSEN POLYGON - 1

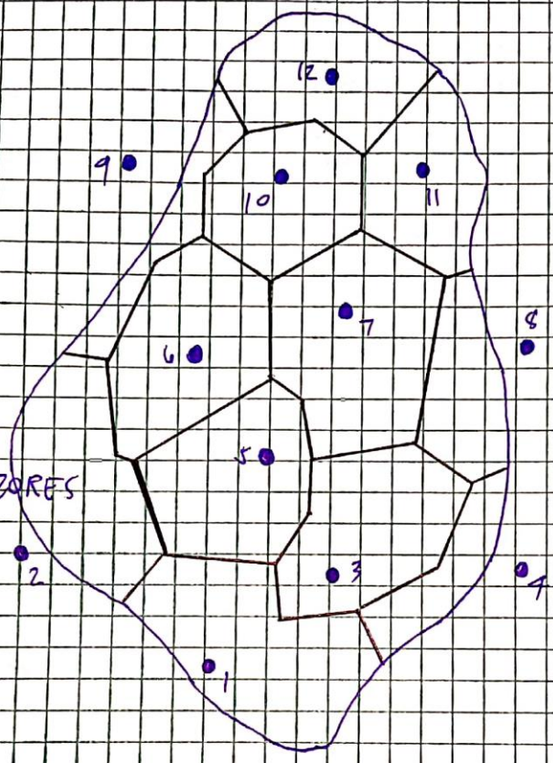


UF AZORES

B. THIESSEN POLYGON - 2



B. THIESSEN POLYGON - 3



NOTES:

a. Area in GSU (Graphing square units)

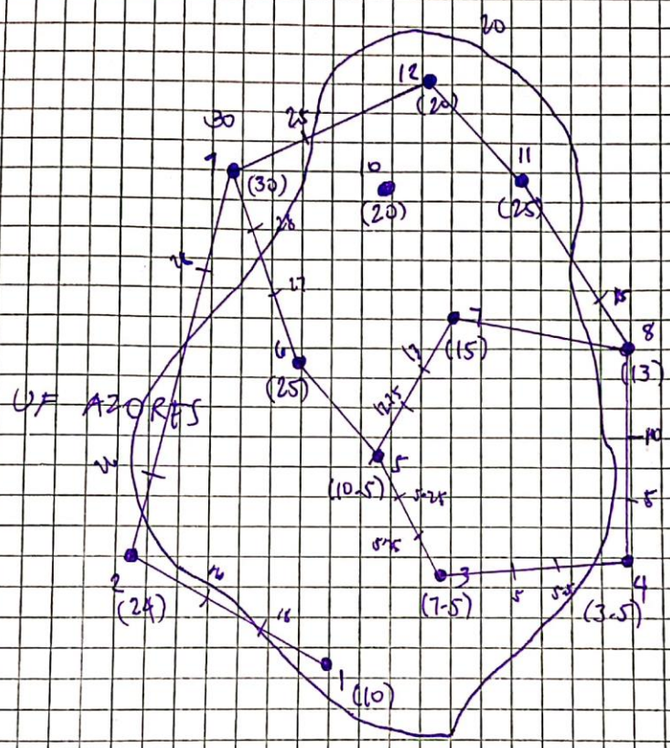
b. % Area = $\frac{\text{AREA}}{\text{Total Area}}$

c. Adj. Prec. - Adjusted Precipitation

Station	Prec.	Area	% Area	Adj. Prec.
1	16	31	12.3	1.23
2	24	23	9.1	2.18
3	7.5	24	9.5	0.71
4	3.5	10	4.0	0.14
5	10.5	22	8.7	0.91
6	25	24	10.3	2.56
7	15	32	12.7	1.91
8	13	15	6.0	0.78
9	30	10	4.0	1.2
10	20	20	7.9	1.58
11	25	19	7.5	1.86
12	20	20	7.9	1.58
		252	100%	16.64

Therefore, the mean precipitation is 16.64 mm

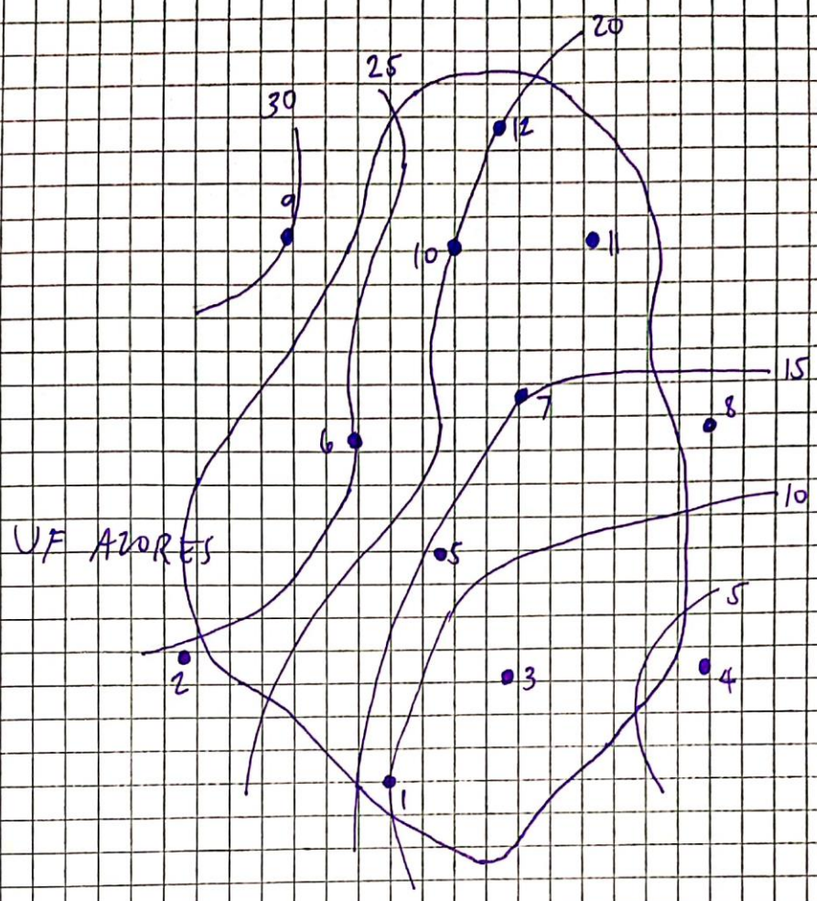
Q. ISOHYETAL - 1

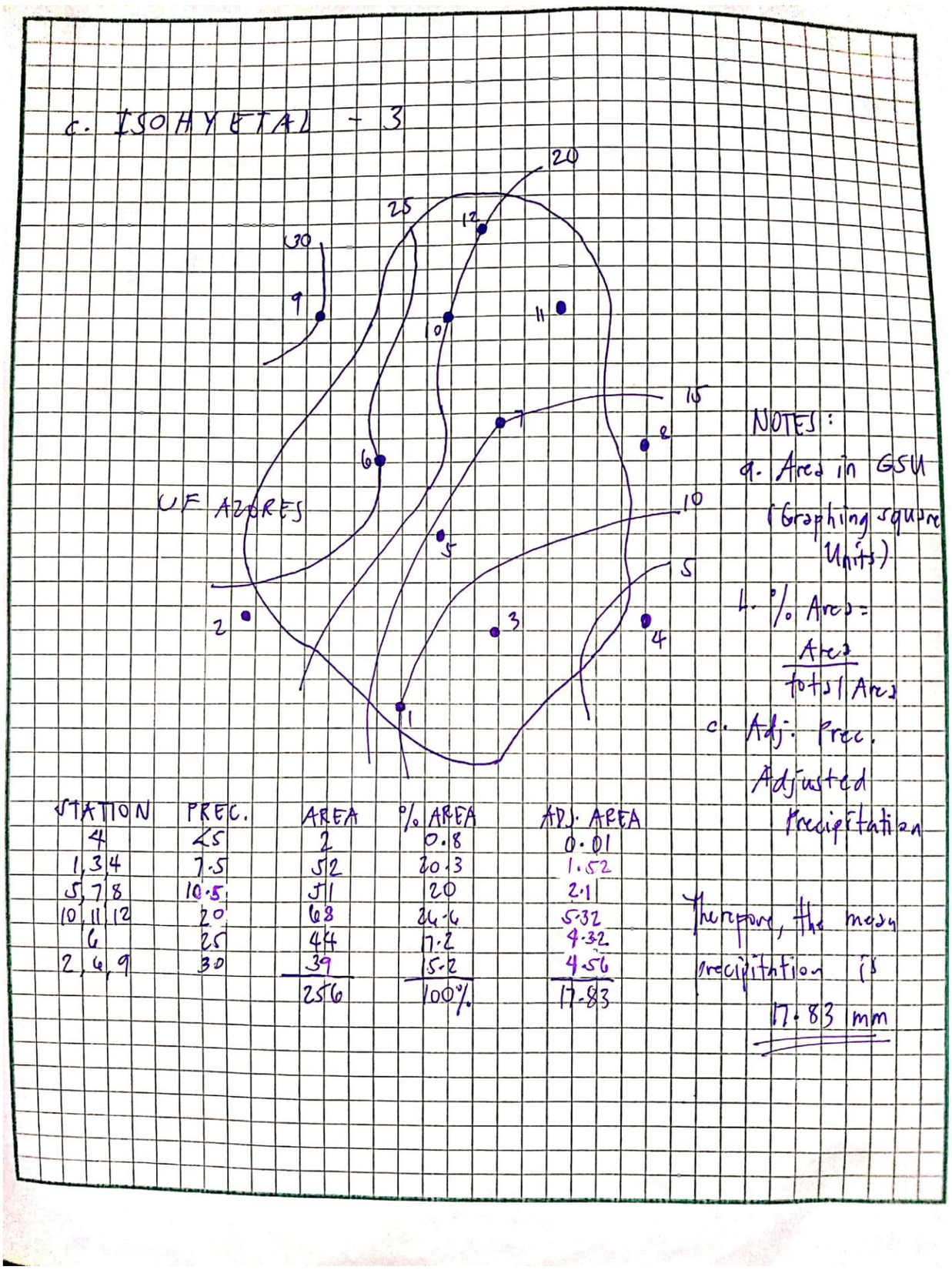


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* Target Isohytes 30, 20, 15, 10, 5 mm

c. ISOHYETAL - 2





The most accurate result is from the Thiessen Polygon because it includes the stations outside the watershed area and they were weighted according to the area controlled.

IV. Discuss the importance of rainfall information in ABE. What are the more important rainfall characteristics (discuss two) to be considered in each of the following hydrology-related projects?

a. Dam design
b. Rainfall harvesting/collection
c. Flood control and drainage system

Rainfall is one of the climatological variables that has been studied extensively for a long time. Rainfall data analysis is significant because it helps policymakers make decisions about agricultural patterns, sowing dates, road development, and providing drinking water to urban and rural areas.

a. Dam design

Long-term data needs: In most countries, streamflow records are either sparse or nonexistent at dam sites. A long-time collection of hydrological data is required to assess a dam's potential yield. If streamflow data is available, climatic data inputs such as rainfall and evaporation are used to calibrate hydrological models. The better the spatial representation of the climate data, the better the modelled hydrological time series will be. The longer the streamflow records, the better the calibration potential; the longer and better the spatial representation of the climate data, the better the modelled hydrological time series will be.

Storage simulation needs: The dam site will then undergo a storage simulation study, which will include basic factors like as monthly streamflow (inflow) and monthly evaporation. The analysis accounts for system losses due to evaporation and infiltration (see page from the bottom of the storage) and estimates the maximum amount of withdrawals that can be made (storage yield) over time. Analyses for a variety of storage sizes are performed, and a storage-yield curve is created. This curve is used to determine the optimal dam size from a supply standpoint.

b. Rainfall harvesting/collection

Reduced Water Bills: Rainwater collecting systems are affordable, produce high-quality water, reduce reliance on wells, and are very simple to maintain because they are not used for drinking, cooking, or other sensitive purposes. In comparison to alternative purifying or pumping processes, the overall costs of setting up harvesting methods are substantially lower. The expense of replenishing a subterranean reservoir is also less than that of replenishing a surface reservoir.

An adequate means for Irrigation purpose: Rainwater harvesting allows vast amounts of water to be collected and drought effects to be mitigated. The majority of rooftops provide the necessary platform for water collection. Because rainwater is typically free of dangerous pollutants, it is appropriate for irrigation.

c. Flood control and drainage system

Increases the Value of Property: It is common knowledge that proper drainage can increase the value of any property, and you can expect to obtain top dollar when you sell it. Drainage problems, such as damp basements leading to mold growth, saturated soils interfering with the home sewerage system, stagnant water in the garden resulting in the formation of breeding grounds for insects such as mosquitoes, and so on, will all play a significant role in lowering the selling price of any property.

Prevents the Accumulation of Water: Perhaps the most important benefit of a good drainage system is that it allows water to flow freely and, in most cases, prevents water from accumulating, which can lead to flooding. Aside from that, drainage systems help to prevent any stagnant water from accumulating, which can be a good mosquito breeding ground.