***Averaging rain fall depth over an area:***

لتخمين كمية المطر الكلية الساقطة على مساحة كبيرة، فمن الضروري تحويل قراءات المقاييس المنفردة إلى

متوسط عمق على تلك المساحة.

**1. Arithmetic Mean Method:** distribution of gages is uniform and

the variation in the individual gages amount are not large.

 **P=(∑Pi)/n**

**2. The Thiessen Network Method: P=(∑ ai \* Pi)/ ∑ai**

37.1mm

48.8mm

39.1mm

71.6mm

16.5mm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Pi\*%total area | % total area=ai/A | ai, (km2) | Rain fall (Pi), (mm) | No. |
| 1.2 | 7 | 119 | 16.5 | 1 |
| 7 | 19 | 308 | 37.1 | 2 |
| 9.3 | 19 | 308 | 48.8 | 3 |
| 13.7 | 20 | 324 | 68.3 | 4 |
| 7.2 | 10 | 162 | 71.6 | 5 |
| 3.1 | 8 | 130 | 39.1 | 6 |
| 12.9 | 17 | 275 | 75.7 | 7 |
| ∑54.4 | 100% | 1626 | ∑P=357.1 |

P=54.4 mm

P=(357.1/7)=51 mm by arithmetic mean method

 **3. Isohytal Map method:** (most accurate method)

تتلخص هذه الطريقة في رسم خطوط تساوي المطر (Isohyts) على خريطة المنطقة الموقع عليها محطات القياس وسمك المياه المتساقطة عند كل محطة. هذه الخطوط تشكل توزيعا ذا دقة كبيرة للمياه المتساقطة على المنطقة.

16.5mm

48.8mm

37.1mm

68.3mm

71.6mm

39.1mm

75.7mm

75mm

50mm

25mm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rainfall volume (km2.mm)** | **Average rainfall****(mm)** | **Net area****(Km2)** | **Area enclosed****Km2))** | **Isohyt** |
| 6560 | 80\* | 82 | 82 | >75 |
| 50625 | 62.5 | 810 | 892 | 75-50 |
| 21262.5 | 37.5 | 567 | 1459 | 50-25 |
| 3240 | 20\* | 162 | 1621 | <25 |
| ∑81687.5 |

P=(81687.5/1621)=50.4 mm

***Estimating Missing precipitation Data:***

 Many Stations have short brakes in there record . Rainfall value are estimated from observation at three stations as close and evenly spaced around the station with the missing record as possible.

**PX= NX/3\*[PA/ NA+ PB/ NB+ PC/ NC]**

N=normal annual rainfall.

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**Example:**

 One of four monthly reading gages on a catchment area

 develops a fault in a month when the other three gages record,

 respectively(**122,89,107**)mm. If the average annual precipitation

 of these three gages are (**935,1120 ,979**)mm, respectively and

 (**1200mm**) of the broken gage. Estimate the missing monthly

 precipitation at the later station?

**Solution:**

 (NA-NX)/NX\*100=(935-1200)/1200\*100=22%

 (NB-NX)/NX\*100=(1120-1200)/1200\*100=7% **<10%**

  **> 10%** (NC-NX)/NX\*100=(979-1200)/1200\*100=18%

 PX= NX/3\*[PA/ NA+ PB/ NB+ PC/ NC]

 = 1200/3[122/935+89/1120+107/979]

 =127.7 mm

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***Double Mass Curve Analysis* [Consistency Test]:*DMC***

**DMC**: is a plot of accumulative totals for each year at the gage

against the sum of accumulative totals for the same years at a number of adjacent gages.

**DMC**: is used to check if attrened in rainfall data of a certain gage is due to Meteorological condition only.

**Example:**

 Annual precipitation at rain gage (**X**) and the annual precipitation

 at (**15**) surrounding rain gages are listed in the following table:

 a. Examine the consistency of st. (**X**) data;

 b. When did a change in regime occur?

 c. Adjust the data and determine what difference this makes to the **33** year annual average precipitation at st.(**X**).

|  |  |
| --- | --- |
| Annual precipitation (mm) | Year |
| (15) Sts. | St.(X) |
| 13.9 | 13.4 | 1938 |
| 9.9 | 10.7 | 1939 |
| 10.1 | 10.9 | 1940 |
| 13.7 | 12 | 1941 |
| 13.1 | 13.3 | 1942 |
| 13.2 | 14.6 | 1943 |
| 10.9 | 9.0 | 1944 |
| 11.4 | 11.8 | 1945 |
| 10.2 | 9.7 | 1946 |
| 13.9 | 15.4 | 1947 |
| 13.0 | 12.5 | 1948 |
| 13.1 | 11.5 | 1949 |
| 13.1 | 11.5 | 1950 |
| 10.9 | 13.9 | 1951 |
| 13.2 | 14.1 | 1952 |
| 10.0 | 10.4 | 1953 |
| 8.8 | 7.9 | 1954 |
| 9.6 | 13.3 | 1955 |
| 10.2 | 16.3 | 1956 |
| 15.9 | 22.7 | 1957 |
| 10.9 | 13.9 | 1958 |
| 10.2 | 14.7 | 1959 |
| 10.3 | 14 | 1960 |
| 10.2 | 11.4 | 1961 |
| 11.8 | 13.8 | 1962 |
| 9.2 | 10.0 | 1963 |
| 10.2 | 10.5 | 1964 |
| 14.0 | 16.7 | 1965 |
| 8.4 | 9.3 | 1966 |
| 11.5 | 18.4 | 1967 |
| 9.0 | 14.1 | 1968 |
| 13.0 | 19.8 | 1969 |
| 13.1 | 17.1 | 1970 |
| 10.7 | 16.0 | 1971 |