Water and management precipitation input

Abstract:

One of the key issues in flood management is knowledge of the precipitation input into catchments for hydrologists knowledge of this serves to mitigate hazardous and environmental catastrophes, it is thus imperative to adequately determine precipitation input with appropriate and applicable statistical tools. The objective of this study is to determine the actual precipitation input and suggest the most appropriate method of determining precipitation input for the model catchment provided.

Standard and commonly used methods of obtaining the areal precipitation input over a catchment area from rain gauge measurements at the precipitation stations are the Arithmetic mean, Thiessen Polygon, Isohyetal, and the Hypsometric methods. These methods serve as good approximations where the topography of a catchment is flat, if the gauges are uniformly distributed and the individual gauge catches do not differ extensively from the mean.

Arithmetic mean:

This is the simplest form of giving a value of the average rainfall over a certain area, and works well under the following conditions:

1. When the catchment area is sampled by many uniformly spaced rain gauges
2. When the area has no marked diversity in topography (Davie, 2008)

Applying this measurement tool to the arithmetic mean:

There are 7 rain gauges with the mean value being 27. 14

The total catchment area is = 456km

- 456 million square meters,
- 27mm = 0. 027 meters
- So 456, 000, 000 x 0. 027m

§ = 12, 312, 000 m3

Thiessen Polygons:

The method was devised by an American engineer, the method provides for the non-uniform distribution of gauges by determining a weighting factor for each gauge. This factor is based on the size of the area within the drainage basin that is closest to a given rain gauge. These areas are otherwise known as irregular polygons.

The method is straightforward and easy to use:

- The catchment is divided into polygons by lines that are equidistant between pair of adjacent stations
- The lines/polygons are bisected
- Workout the area of each polygon by counting the squares within each
- Sums up the areas
- Compare to arithmetic method to confirm the two are the same
- Convert the individual polygonal areas to million sq meters and multiply by the converted precipitation rain gauges for example:

o 178, 000, 000 x0. 055 = 9, 790, 000

Once this is done add them altogether to derive the total volume of precipitation input within the catchment.

Isohyetal method

This considered one of the most accurate methods; however as one will often find the method is subject to individual abilities and the knowledge of the general catchment. (Shaw, 1994)

The method is more complicated than the first two:

- To derive of an accurate estimation of the rainfall input one must first find the distance between two rain gauges in mm and eventually interpolate and extrapolate the line to give the adjacent rainfall levels, which can later be plotted back onto the catchment sheet.
- i. e. method of summation:

get the equidistant line between the two rain gauges

take for example the distance in mm between gauge A and B

8. 5cm-convert to mm- 85mm

- find the difference between the two rainfall gauges 55-30= 25
- now to work out the a ¼ of 85, one would divide 85/100 and multiply this by 25

§ = 21. 25

- Which is subsequently a ¼ of the equidistant line between the two rainfall gauges
- This figure can be used to derive the 2/4 point, the ¾ point etc. By simply doubling the 21. 25 figure you arrive at the 2/4 or 50% point and then to get the 75% point adds 21. 25 to the 50% point.

One must now expand on the quartiles between the rainfall gauges:

- This is done by using the difference (25) calculated earlier.
- Half of this gives 12. 5 which when added to the first gauge, or gauge B (30mm) you get 42. 5.
- Half of 12. 5 gives 6. 25, which when added to 30 gives 36. 25, and so on until it matches against the adjacent measuring line.
- (*see supplementary sheets to see for techniques and further explanation)

-once this is done plot the rainfall values using the adjacent measurements and join lines of equal rainfall

Then progress to count the areas between the isohyets and find the average the two.

Convert the individual areas to million sq meters and multiply by the converted average precipitation values for example:

- 31, 000, 000 x 0. 059 = 1, 829, 000 cm3
- Do the same with all the values; add them to get the total volume of precipitation input.

Hypsometric Method

The method uses catchment topography and the rainfall measurements to derive of a total weighted precipitation input. It fairly accurate however is also dependant on the abilities of an individual, whilst drawing the hypsometric curve. The hypsometric curve allows for adjacent precipitation values to read from the graph. The area underneath the curve of precipitation gives the area of an individual gauge, and can be calculated thereafter in the same system as the previous two methods:

Analysis/Conclusion:

It is clear from the results that the arithmetic mean is the likely to be less accurate than the other 3 methods, this is due to the catchment having qualities, such as topography and well distributed gauges which are characteristics that prove desirable to the other three methods.

I have averaged the precipitation inputs to get a more accurate figure:

Averaged 15, 027, 250 Total volume cm3

It has been very difficult to observe a trend of between the methods, however three major patterns have been observed, the arithmetic mean varies much from the Thiessen weights and other two weights, showing that on one level the arithmetic mean is less accurate and takes the values into a much broader scale, whereas the other three methods are much more specific. The relation between the weights is very spread because the precipitation input is governed by various factors and complex activities, and each method also demands certain qualities within a catchment for it to be applied appropriately, take for example the Isohyetal method which is subjective to individual abilities and knowledge of the catchment area, which in this case is not entirely possible, given the limited background information.

References:

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