Precipitation Analysis of Dallas County

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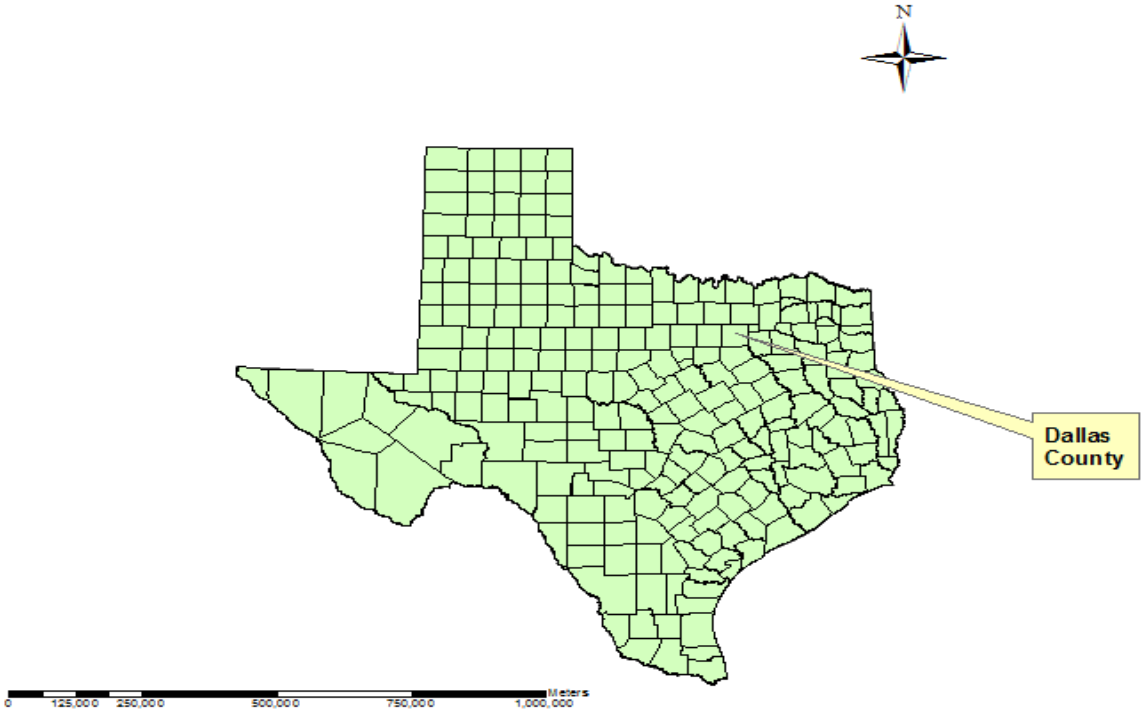
Precipitation is an important piece of climatic data. It is measured and recorded through a variety of methods. There are different units in which precipitation considered to be rainfall in most cases, is represented. The units used are inches, centimeters or millimeters. In US precipitation is measured in inches usually over a set time period. This means that if one inch of rain fell over a particular time period and if that water did not seep into the ground or ran off there should be a layer of once inch of water above the ground. There are various instruments which record rainfall one of which is a rain gauge. A simple example of a rain gauge is a funnel attached to a graduated cylinder.

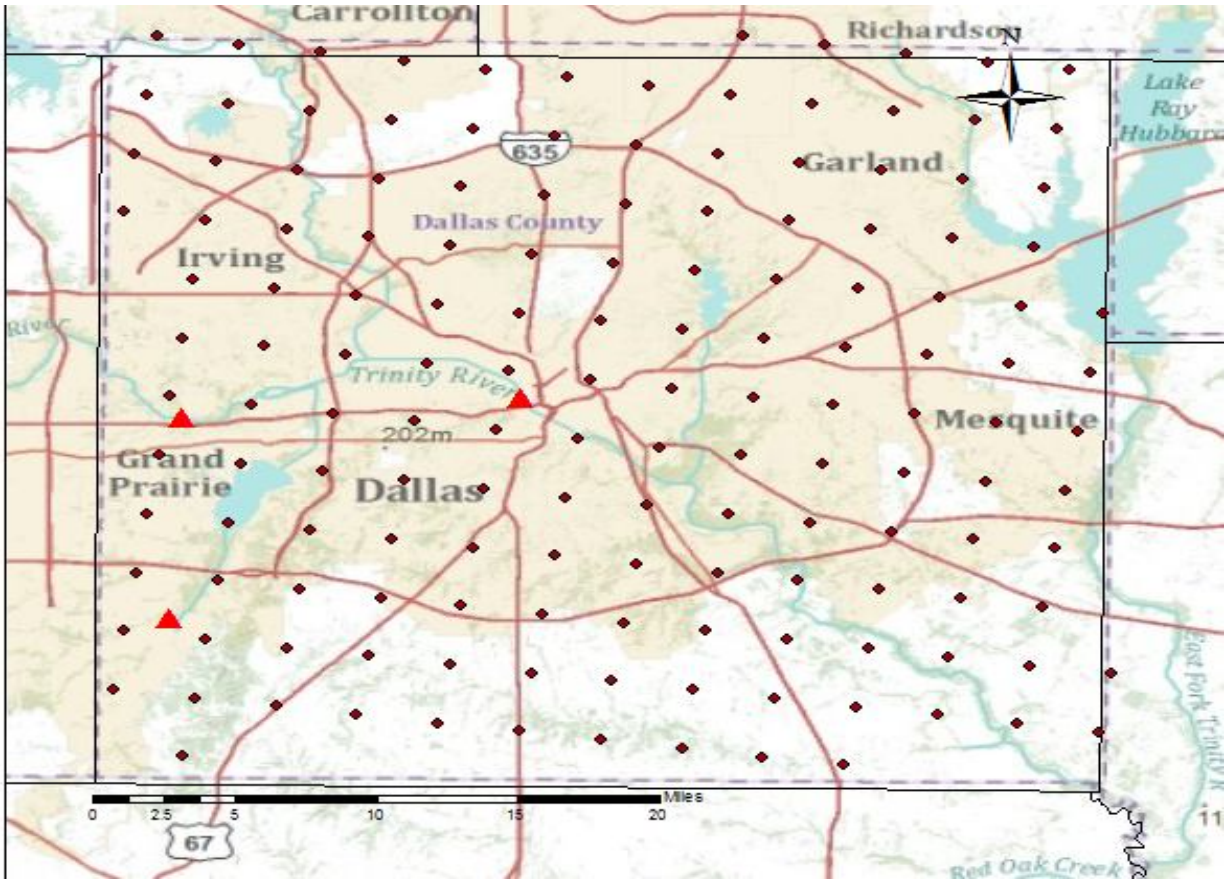
Rainfall measurement is important as its knowledge is useful in determining which areas are useful for cultivation and can produce a good harvest, to design structures for run off control, for hydrological modeling since good estimates of rainfall are needed as inputs for these models for accurate prediction, for location of the drought prone areas, flood forecasting and various other reasons. The measurement of rain falling in a watershed is based solely on the data from the rain gauges. These rain gauges are located on convenient locations near water streams which may not be a correct representative of the entire watershed since they are merely point samples, while watersheds are sensitive to the spatial distribution of rainfall [Waleed *et al*, 2009]. Another popular method of obtaining precipitation data is weather radar. This weather radar is also referred to as virtual rain gauge since there is actually no gauge at these locations. The data is derived from the radiation pulses which are emitted by these radars which calibrate the precipitation in the air based on the moisture it detects as the radar passes through a given region. Hence it is possible to get precipitation data for a series of points equidistant and uniformly spread over a given area. The potential for radar obtained rainfall data is tremendous due its high spatial and temporal resolution and large areal coverage (Borga, 2002). However it has also been proven that uncertainty in the precipitation data obtained through these virtual gauges affects the accuracy of the rainfall runoff simulations (Cluckie and Collier, 1991).

The objective of this project was to compare the rainfall data from the actual and virtual gauges for Dallas County for a given time period and to see how well these data match each other. The figure below depicts the location of the Dallas County in Texas for which the precipitation data was analyzed.



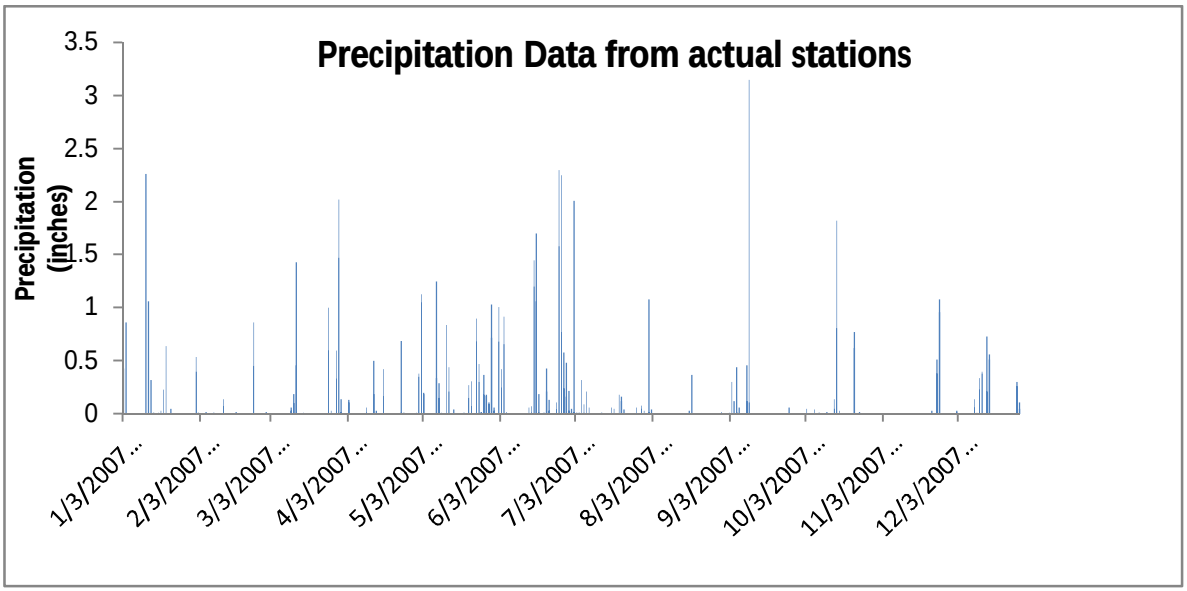
The data source for the precipitation data was HydroDesktop which is a free and open source desktop application that serves as a client for CUAHSI HIS WaterOneFlow web services data and helps in the data acquisition of the data along with data visualization and editing. HydroDesktop helped in extracting the data for the real gauges from USGS-NWIS National Water Information System and the data for the virtual gauges from NWS-WGRFC at NOAA's National Weather Service.

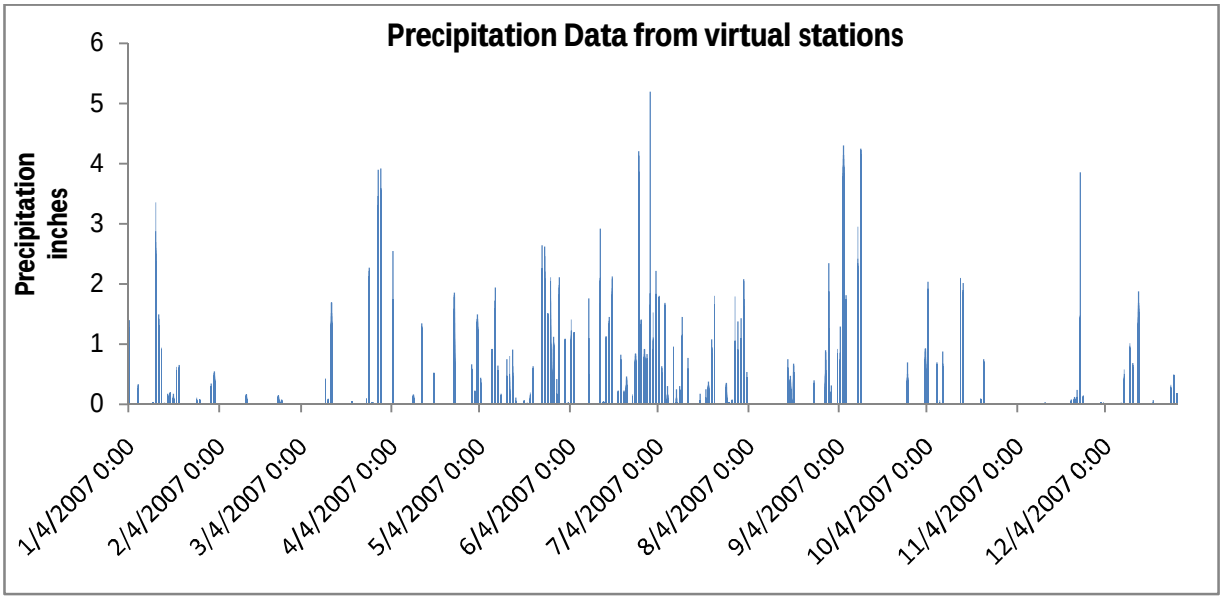
The rainfall data for various years from 2006 to present were looked at. One of the biggest challenges was to look for the data for the actual rain gauges since there are very few rain gauges located and their distribution is also uneven. Based on the data extracted from USGS-NWIS it was observed that even amongst these few actual rain gauges there are even lesser gauges which record particularly the precipitation. Compared to that data it was more convenient to obtain data for the virtual rain gauges over any given period which were more evenly distributed. Based on the availability of the data the year 2007 was chosen as a suitable time period for precipitation analysis.



The figure above shows the location of the virtual and actual rainfall gauges. The ones marked with the little maroon dots represent the virtual gauges and the ones marked with the red triangle indicate the actual rain gauges. It is to be noted that the location of the real gauges is along the tributaries of the Trinity River in the county.

The rainfall data for the year 2007 for both the real and the actual gauges is given below.

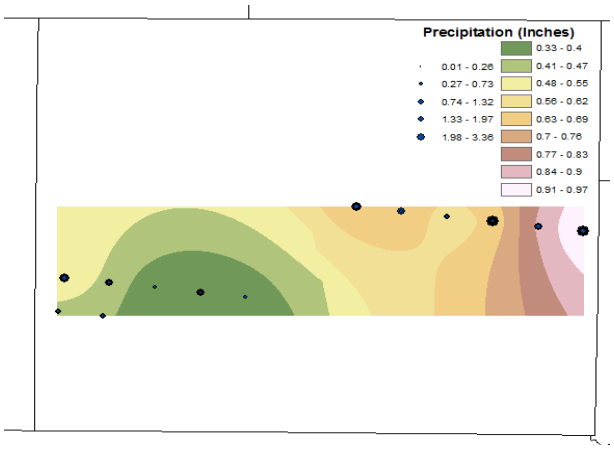




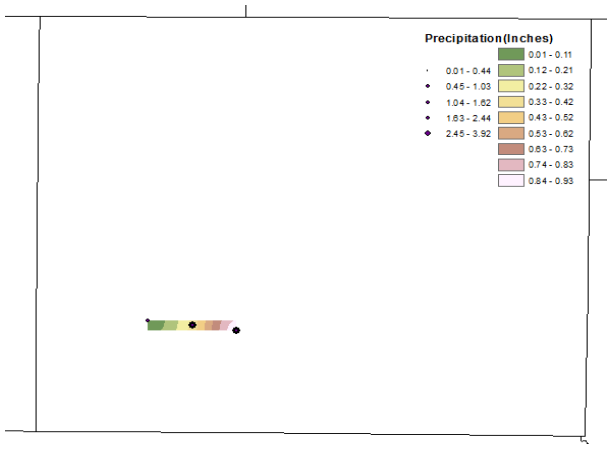
Interpolation of the Rainfall Data using GIS : -

Interpolation is a powerful tool which helps us to get intermediate continuous data values for a given set of discrete data. There are various spatial interpolation techniques available in GIS like the IDW (Inverse Distance Weighting), Spline and Krigging. Out of these Krigging technique is known to be the one of the best in interpolating rainfall data (Shi et al, 2007). The Krigging technique was applied to the monthly rainfall data for the year 2007 obtained from the virtual gauges keeping other parameters of the Krigging function as default in GIS. Hence the Krigging applied was Spherical and Ordinary. The interpolation results are given below.

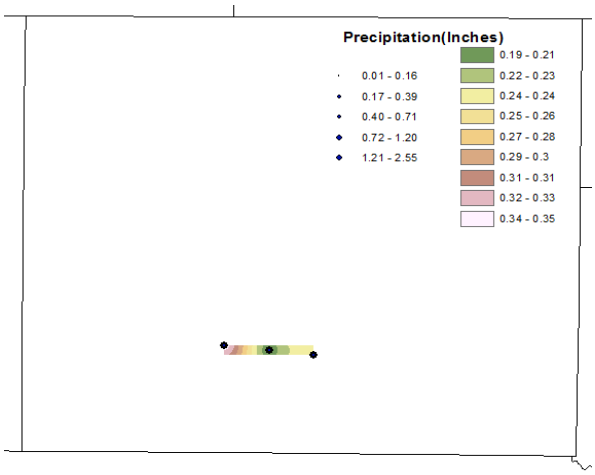
The interpolation of February rainfall data was not possible due to the precipitation values being nearly zero.



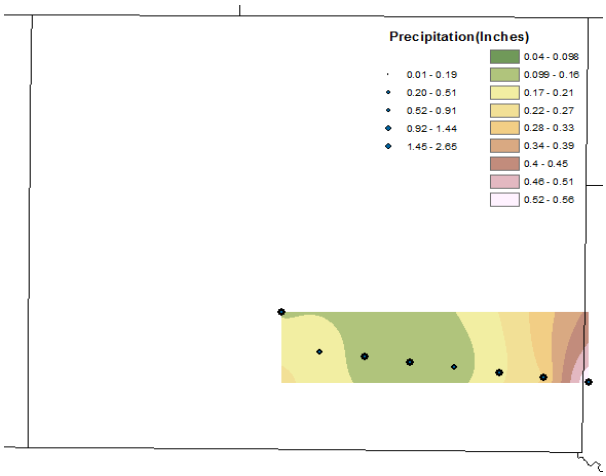
January



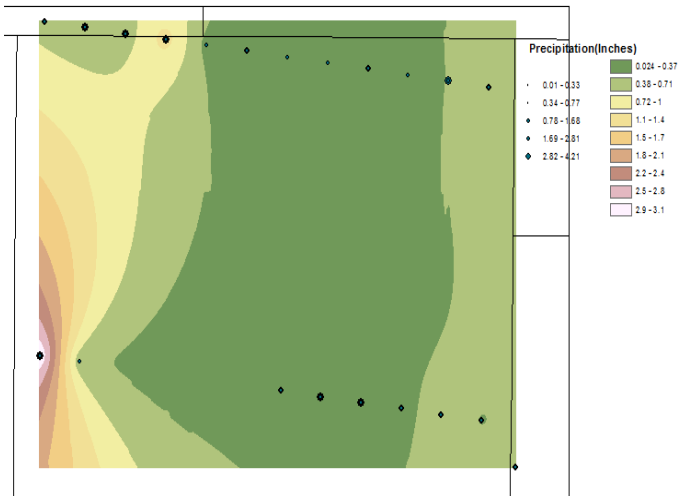
March



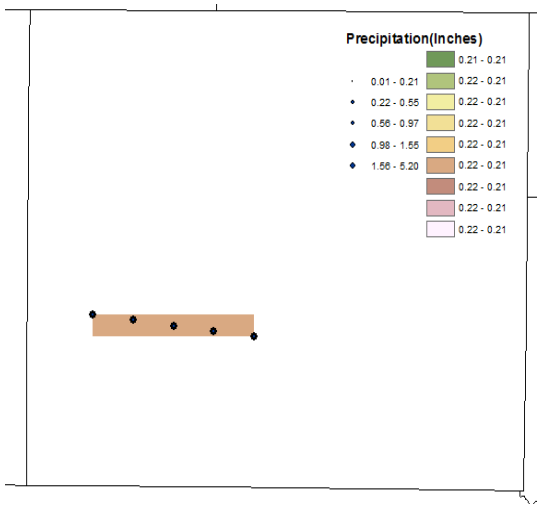
April



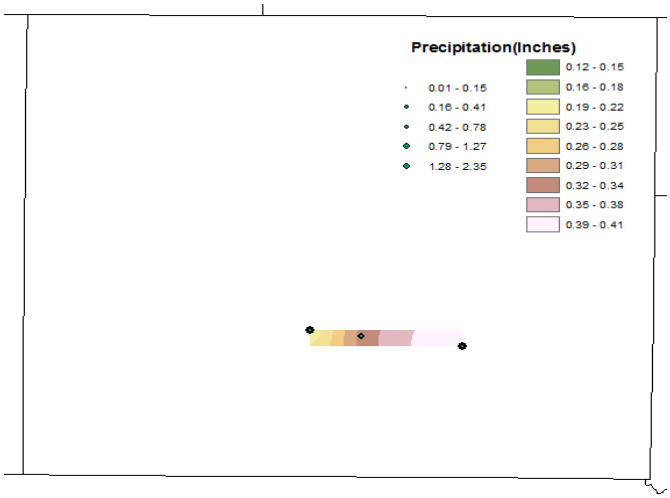
May



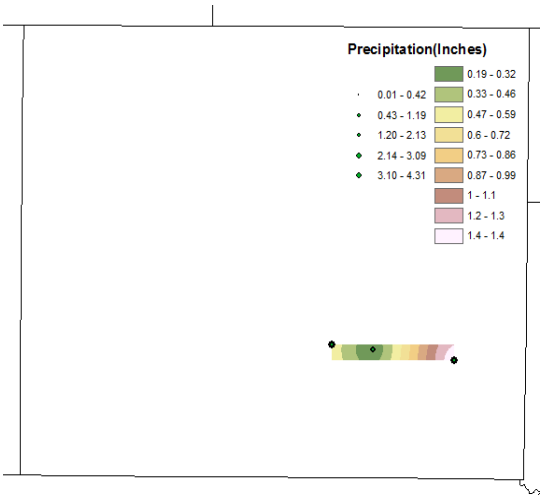
June



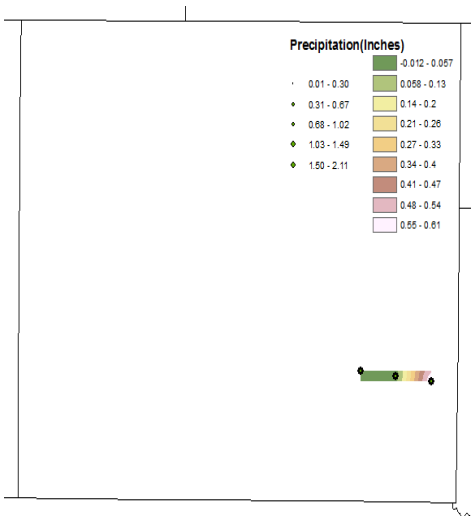
July



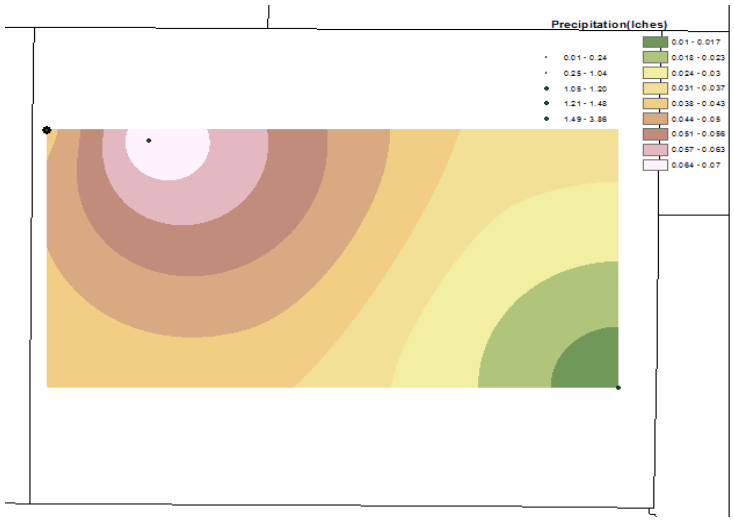
August



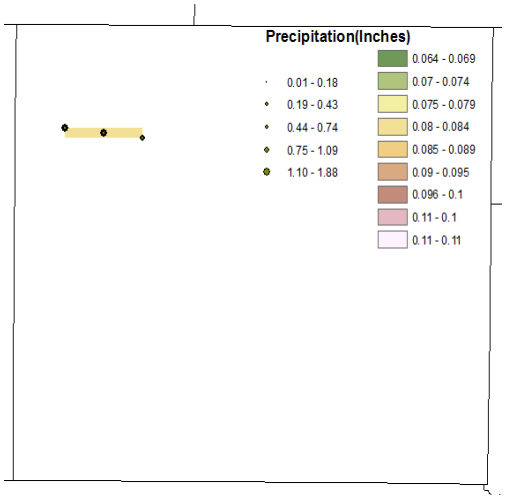
September



October



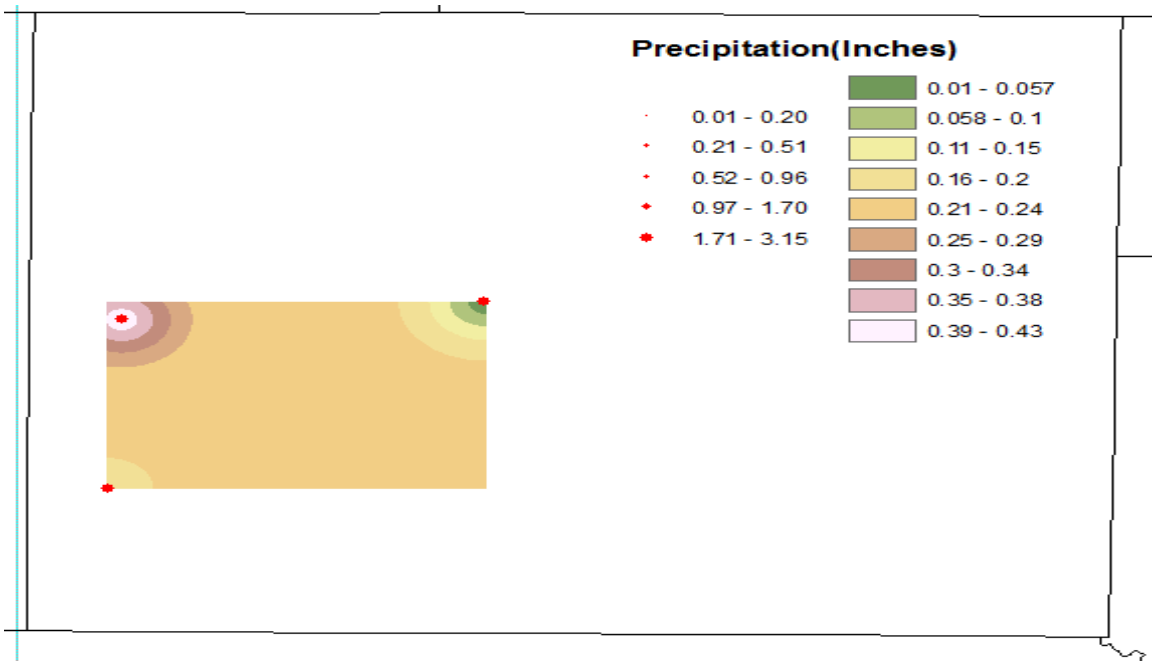
November



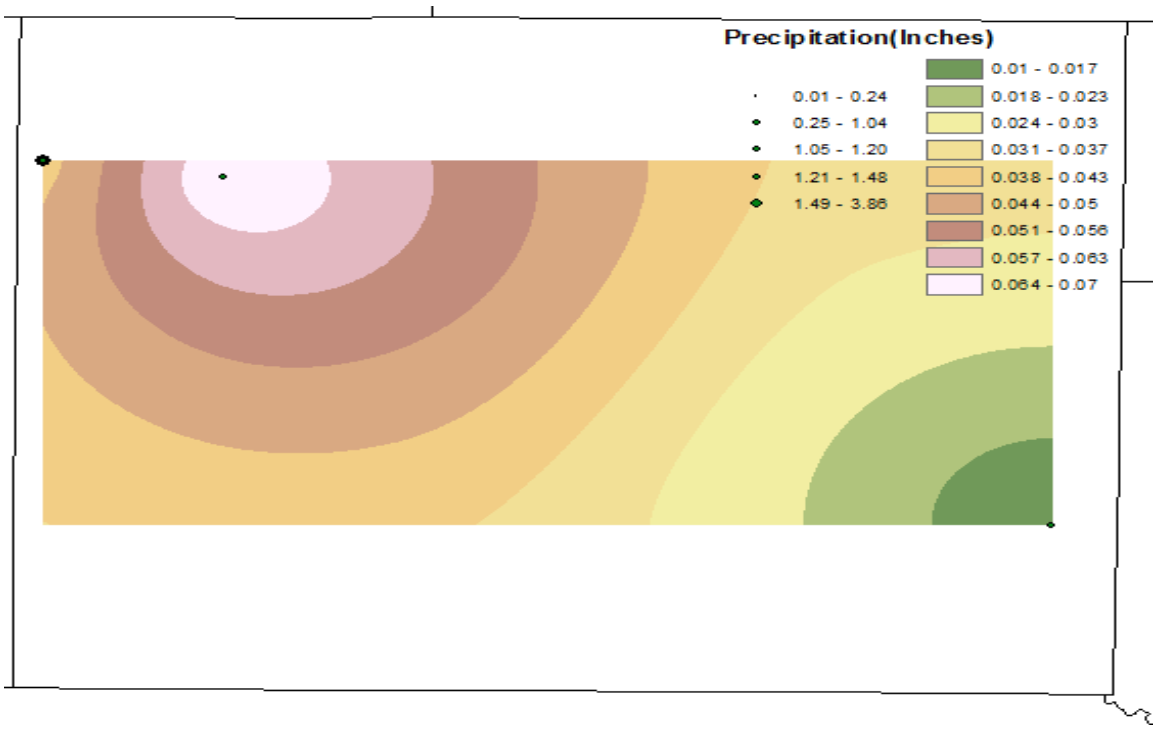
December

For interpolation of the data, only those data points which had precipitation values greater than zero were taken into consideration. Those virtual gauges which did not record any precipitation were neglected since essentially the value recorded by those gauges was zero. It can be seen from these results that the rainfall data from the virtual gauges was not substantial enough to get interpolated results over the entire county. Only very few virtual gauges were able to record data over the period of one year considering the location of the county which is in Texas which is not one of the most rainfall prone areas.

Since the interpolation of the rainfall data gave a good result over the region which contains the real gauges, interpolation of the precipitation data from the real gauges for the month of November 2007 was done to compare the results.

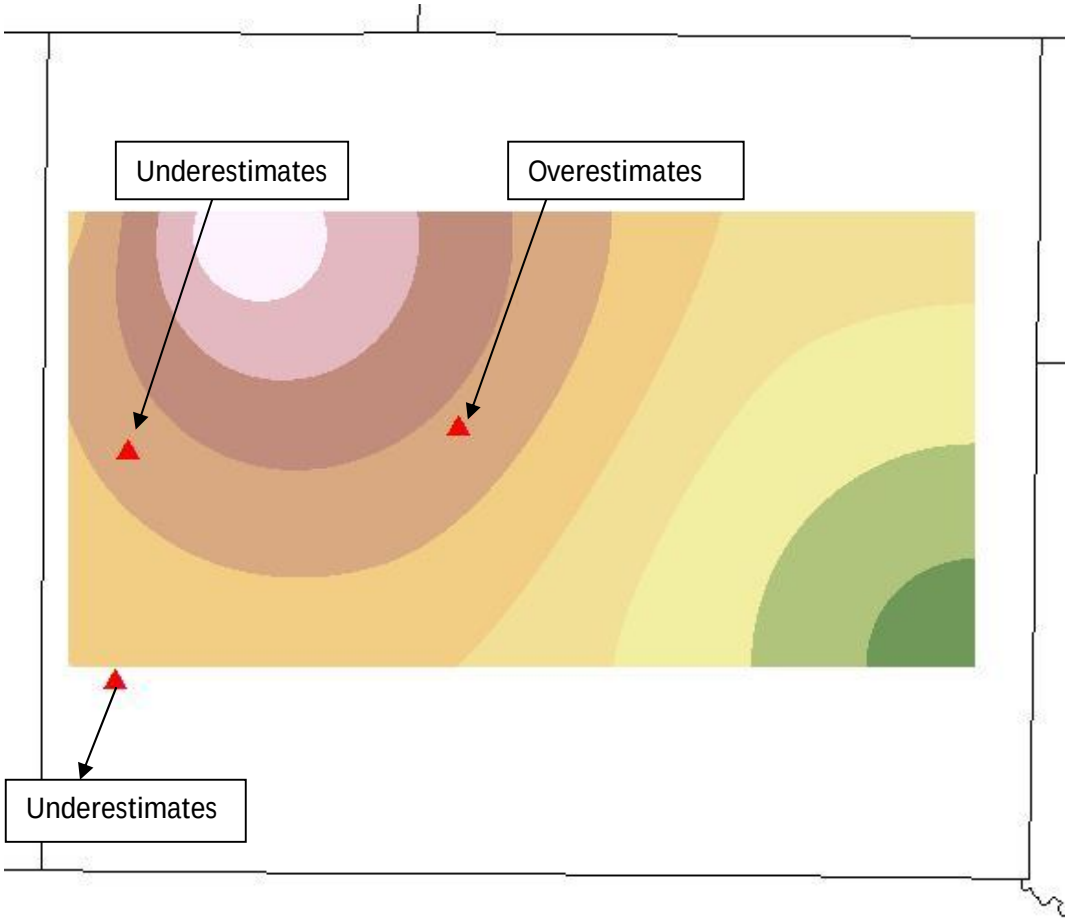


Interpolation result of precipitation data from real gauges for the month of November



Interpolation result of precipitation data from virtual real gauges for the month of November

It is seen from the above two figures that the values observed over the area from both the actual and virtual gauges do not match each other. Also, the precipitation values recorded by the actual gauge were interpolated over this month and that value was compared to the interpolated value of the precipitation recorded at that point by the virtual gauges and it was seen the virtual gauges underestimated the precipitation at two locations while it overestimated the precipitation at the third location.



Conclusion:

Radar derived precipitation data are used more often than the real gauge precipitation data owing to the fact that calibrated radar data offers the advantage of increased spatial distribution to which the water bodies are more sensitive. They are also very economical as compared to setting up actual rain gauges which is a very huge incentive for its preference over the real gauges. But it is not often that the radar derived data will match the real gauge data. This might lead to an incorrect estimation of precipitation. Although an underlying question still remains about the validity of the data comparison from two sources since the real gauges might not be in operation all the time and they merely serve as point samples. Hence it might be more useful to rely on radar derived precipitation data which has been confirmed by previous studies done on this subject.

References: -

Waleed A., MSM A., Halim G.A., Shariff A., Aimrun W., *Calibrated Radar-Derived Rainfall Data for Rainfall- Runoff Modeling,* European Journal of Scientific Research, Vol.30 No.4 (2009), pp.608-619

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Shi, Y., Li, L. Zhang, L. *Application and comparing of IDW and Kriging interpolation in spatial rainfall information.* Geospatial Information Science. Volume 6753, pp. 67531I (2007).