**Chapter 1**

*The Problem*

**INTRODUCTION**

Precipitation is any form of humidity that falls from the clouds in the air to the exterior of the Earth. Since precipitation refers to the liquid quantity and how much of it is isolated on the Earth within a given time, it is measured in volumes and concentration of precipitation on specific areas where the study is focused on. (Ramsey, 1998)

Rain is a group of droplets that tends to fall towards the land of the Earth. The cloud cannot already include the amount of cloud droplets present within it that is why the cloud needs to release these droplets and when they are released, these droplets are already called as rain. Rain is the only type of liquid precipitation, as opposed to non-liquid types of precipitation, which are sleet, snow, and hail. A presence of a thick layer of our atmosphere is needed by rain to maintain temperatures above the melting point of water on the surface of the Earth. When ice crystals within a specific cloud collide against each other, precipitation is formed. Ice crystals have different shapes. There are oblate crystals, round-shaped crystals, and crystals that look like a small sphere.

(Ramsey, 1998) The major cause of rain production is moisture contrasts that are commonly called as weather fronts and some moisture moving along the zones of temperature. Based on the location of the Philippines, this country only experiences rain, drizzle, and hail among the other types of precipitation. (“Earth Science: The Philippines in Focus,” 1983)

Since the precipitation is measured in volumes of water in a specific area, the best way to measure the amount of precipitation is to gather all fallen liquid on a specific area with the use of waterproof walls and bases to see how high the water would increase from ground level. An instrument used in this process with a similar mechanism is the rain gauge. The rain gauge is the most widely used weather instrument in measuring precipitation. The rain gauge is composed of a funnel and a cylindrical container where the water accumulates and is collected. However, a rain gauge is most effective when used in a perfectly flat area with its surroundings of the same level. When used in mountainous regions or areas with uneven ground levels, either the measurements would be inaccurate or multiple rain gauges must be used for each ground level. Rainfall varies in amounts depending on the altitude. The measurements on a rain gauge are only applicable on a fairly small radius or area around it, any data that would need more information about the amount of rainfall on a specific radius would be erroneous.

The most common rain detector used in electronic weather stations is the “tipping bucket” type of rain sensor. This fascinating type of technology uses two small “buckets” mounted on a swivel. The tiny buckets are manufactured with tight tolerances to guarantee that they hold an exact quantity of precipitation. The tipping bucket assembly is to be found underneath the rain collector, which funnels the precipitation to the buckets. As rainfall fills the tiny bucket, it becomes overbalanced and tips down, emptying itself as the other bucket pivots into place for the next reading. The action of each tipping episode triggers a small control that activates the electronic circuitry to transmit the count to the indoor console. On a wireless rain gauge, records are transmitted through a radio signal. (“WW2010,” 2003)

These methods aforementioned are some methods that PAGASA Weather Station is implementing to gather records of rainfall during the entire day, where they collect data every after three hours starting at two in the morning until eleven in the evening.

The PAGASA Weather Station, also recognized as Philippine Atmospheric, Geophysical and Astronomical Services Administration, is a nationwide institution of the Philippines that provides warnings about flood and typhoon. They also provide a lot more services like public advisories and forecasts concerning the up to date weather report of the country. PAGASA furthermore provides meteorological, astronomical, and climatological information for the security of life and property of the Filipino people. This government agency started operating on the 8th of December in 1972.

This agency has a mandate that states that they need to provide protection against natural calamities to ensure the safety of the Filipino citizens, well-being and economic security of all the people, and for promotion of national progress.

Residents in the Philippines would expect to have a huge amount of rainfall every month of the year. The rainy season starts on the end of May and ends on late November or early December. (“Earth Science: The Philippines in Focus,” 1983)

In Batanes, Northeastern Luzon, Western part of Camarines Norte, Camarines Sur, Albay, Bondoc Peninsula, Eastern Mindoro, Marinduque, Western Leyte, Northeastern Cebu, Bohol, and most of the Central and Southern Mindanao experience rainfall that us more or leass evenly distributed all throughout the year. (“Earth Science: The Philippines in Focus,” 1983)

Upon observing the rainfall pattern in Baguio City, the proponents also observed some factors that could massively affect the rainfall in our city. One factor that would affect the rainfall pattern of Baguio City is the season. According to some references, high precipitation occurs during the humid season of the year while low precipitation occurs during the dry season of the year. Since the city is located at a high altitude, the elevation could also affect the pattern of rainfall that will occur. Mountains affect the amount of rainfall. Rains fall more often on the slopes facing the wind than on the slope away from the wind. The reason is that a wind hitting the side of the mountain tends to rise along the slope reaching heights of low temperature. There, the moisture in the wind condenses to form rain. By the time it reaches the other side of the mountain there is not enough amount of moisture to further condense. The eastern coastal areas generally receive more rainfall than the western parts. The eastern areas have high rainfall from October to March when the monsoon blows over the country. For the Philippines as a whole, June to December are the rainy months while January to May are the dry months. (“Earth Science: The Philippines in Focus,” 1983)

**BACKGROUND OF THE STUDY**

Baguio City is a highly urbanized city located in the province of Benguet. It has an altitude of 1610 meters and covers a total land are of 57.5km2. Landslide and flashflood occurrences are highly unpredictable in some areas of the city because rainfall amount does not have a recognizable pattern. Thus, many parts of Baguio City are suffering from landslides and flashfloods during periods of unpredicted heavy rainfall. In order to increase the safety, awareness against such environmental disasters and an analysis regarding the rainfall patterns of Baguio City has to be done to provide basic information.

Such study has been done in different countries such as Northeastern Thailand, India, and Australia. The necessary data shall be collected from the weather station of Baguio City to produce a forecast for the amounts of rainfall every year.

**STATEMENT OF THE PROBLEM**

The amount of precipitation in Baguio City has become very unpredictable, to a point where landslides and flashfloods have become unforeseeable. The aim of the study is to provide a basic forecast about how much precipitation would fall on Baguio City on the succeeding year, based on the ten-year data gathered from PAGASA.

**SIGNIFICANCE OF THE STUDY**

This study can be a reference for preparations for certain agricultural activities like cultivating, planting, and harvesting. It can also be a reference as a precautionary measure for flash floods and landslides.

**SCOPE AND DELIMITATION**

The study is limited only to analyzing rainfall amounts and no other weather factors. The study has been limited to only analyzing the rainfall amounts in Baguio City because it ensures the safety of the researchers and it gives the easiest access to the needed data.

**DEFINITION OF TERMS**

For clearer understanding of terms used in this study, below is the meaning of some of the terms.

*Precipitation* – is a deposit on earth of hail, mist, rain, sleet, or snow. It is also the quantity of water deposited.

*Rainfall* – is the amount of precipitation usually measured by the depth in millimeters.

*Rainy Day* – refers to the period where precipitation occurs at any time of the day.

**Chapter 2**

*Review of Related Literature*

*Time Series Analysis on hourly rainfall (Cutrim et al 2000)*

Time Series Analysis was used on an average hourly precipitation. The method determined whether statistically significant differences existed from each season. The data gathered is a 20-year period consisting of 2-hour intervals per day. In a seasonal analysis it was defined that winter, spring, summer, and fall are the seasons to be used. The Box-Jenkins methodology, a sample autocorrelation function (ACF) and a partial auto correlation function (PACF) plot were employed for each of the 12 periods of the day, for both precipitation accumulations and counts. A plot of ACF values at different lags was used to find a working series of stationary time points for the precipitation parameters accumulation and counts. For both precipitation parameters, the ACF plots clearly indicated the time series to be a non-seasonal component, but the same plot showed the need for further differencing of the seasonal component of the series, which occurs every four time periods. The periods of differencing, therefore, are 1 for the seasonal component of order 4. This differencing scheme produced a stationary time series, which is a prerequisite in ARIMA Modeling.

The ACF and PACF plots of the differentiated series were then used to determine the autoregressive (AR) component and a moving average (MA) component of the series. Except for precipitation count at 6 a.m. the ARIMA model for cache of the differenced precipitation time series year were identified. (See Figure 1.)

Figure 1:



*Time Series Analysis on a 50 year data of rainfall and temperature*

A large set of data involving more than 50 years of rainfall and temperature data were examined using Spectral Analysis, Time Series Analysis-ARIMA Methodology to analyse climatic trends and interactions. Fourier analysis, linear regression and ARIMA based time series models were used to analyze the large data sets using Mat-lab, SPSS and SAS programs. The results that came up showed that the rainfall data was variable and appeared seasonal while the temperature data appeared stationary. Spectral analysis also showed variations in rainfall and temperature over 50-60 years but the results showed that rainfall and temperature varied coherently, with a cycle of about 2-3 years. An inverse relationship in trend was noted between rainfall and daily temperature range using linear regression among the variables. The ARIMA models showed autocorrelation and seasonality providing time series models.

It was concluded that: There is a cyclic pattern noted in both the rainfall and temperature time series and a cycle of about 3 years in the rainfall and temperature data sets suggesting a coherent variance in the relationship. This finding suggested a cyclic nature of large rainfall events over time and was confirmed by the recent large rainfalls events in 2009-10. Linear regression showed an inverse relationship in trend between rainfall and temperature range only even though the r value was around 0.27.

*Time Series Analysis on the Agricultural commodities prices*

Other than prices, the data includes variables reflecting demand and supply factors affecting agricultural prices. Series are on a monthly basis. On the demand side it has been considered that monetary aggregate will be the proxy for world real aggregate expenditure, production of ethanol and biodiesel, several proxies for trading activity in futures markets, and the U.S. dollar–Euro exchange rate. On the supply side the price of oil, price of fertilizers, and volume of exports by major world producers are used.

The data gathered was from 2002 to 2009. The end of the series was restricted due to unavailable data, and restrictions at the beginning of the series were due to the presence of structural changes based on Chow tests. All price data and other variables will be taken in log form when analyzed.

*The distribution of monthly rainfall.*

Monthly distributions of rainfall in space and time can provide guidelines for crop scheduling and for introducing better cropping patterns in the region.

To determine the periodicity of the monthly rainfall sequence at a station, the method developed by Vujica M. Yevjevich was used, in which the parameters involved are clearly defined.

It was found that monthly rainfall sequences at all the stations under consideration

have six significant harmonics, which means that the monthly rainfall has a periodic part that consists of components corresponding to the following six periods: 12, 6, 4, 3, 2.4 and 2 months. The variances of the monthly means and the monthly standard deviations are explained up to more than 90 % by these six significant harmonics. These findings show that after removing the first six periodic components, the residual rainfall sequence at a station can be considered to be stationary at least in the mean and standard deviation. (See Table 1.)

For most cases, the serial correlation coefficient between two successive monthly

rainfall sequences at a station were found not to be significantly different from zero. Nonsignificance of correlation does not necessarily imply statistical independence, monthly rainfall totals were analysed separately and a probability distribution was fitted month by month.

*This table shows provinces from Thailand where the research mentioned above was conducted.*

Table 1:

|  |  |  |
| --- | --- | --- |
| Station | Mean | Standard Deviation |
| Buriram | 0.925 | 0.917 |
| Chaiyaphum | 0.940 | 0.938 |
| Kalasin | 0.924 | 0.920 |
| Khon Kaen | 0.927 | 0.937 |
| Loei | 0.924 | 0.921 |
| Maha Sarakham | 0.935 | 0.921 |
| Nakhon Phanom | 0.924 | 0.979 |
| Nakhon Ratchasima | 0.931 | 0.920 |
| Nongkhai | 0.919 | 0.929 |
| Roi Et | 0.922 | 0.919 |
| Sakhon Nakhon | 0.917 | 0.941 |
| Ubon Ratchatani | 0.922 | 0.942 |
| Udon Thani | 0.917 | 0.927 |
| Yasothon | 0.927 | 0.939 |

It was concluded that each monthly rainfall sequence has a periodic part consisting of six constituents corresponding to the following six periods: 12, 6. 4, 3, 2.4 and 2 months.

At each station the rainfall sequence in a month is independent of the rainfall sequences in the other months. Since many monthly rainfall sequences in the Northeast have zero values, the leakage law is most appropriate for fitting these sequences. Monthly rainfall in the region varies greatly from month to month, resulting in high degrees of irregularity, ranging from 45 to 70 per cent. Monthly rainfall also varies greatly from year to year as indicated by the high values for the coefficient of variation. The eastern and north-eastern sections of the region are the wettest areas of the Northeast from April to September but they are the driest parts from October to December. The maximum amount of rainfall for the entire region usually occurs in August or September while the minimum normally occurs in December or January.

**Chapter 3**

***Methodology***

**Research Design**

The study, which is about the rainfall patterns of Baguio, involves quantitative research on the rainfall amounts of Baguio. A statistical analysis shall be done on the gathered data, particularly a Time Series Analysis. A method for double exponential smoothing called Holt-Winters filtering will be applied to the time series data to make a smoothed data for presentation and a forecast.

**Sources of Data**

The data, which will be analyzed, is the rainfall amounts per month in Baguio City. The sample, which will be taken from the population, is the rainfall amounts ranging from January 2000 to December 2011. Rainfall amount is measured using either a tipping bucket or rain gauge. It is measured and recorded in millimeters every three hours starting from 2a.m. to 11p.m.. The data was gathered from the weather station of PAGASA located in Baguio City.

**Locale of the Study**

There have been a series of occurrences of unforeseen flashfloods and landslides in Baguio City, especially in areas such as City Camp Lagoon, so the researchers chose that the study should be done in Baguio City.

**Population/Sampling**

The study involves the analysis of rainfall amounts gathered daily by PAGASA. The research would only take into consideration the data gathered from January 2000 to December 2011.

**Research Paradigm**

Macintosh HD:Users:macbookpro:Downloads:Flowchart.jpeg

**Instrumentation and Data Collection**

The data was then summarized and classified yearly on Microsoft Excel. However, the amount of rainfall for May 2006 was missing, so a statistical method called Bootstrapping method was done to generate a forecasted value.

Bootstrapping method is a method developed by B. Efron on 1979. It is a computer-based method for assigning accurate sample estimates. This method allows estimation of the sample distribution of almost any value using only very simple methods (Varian 2005). Using R-statistics, a computer statistical software, bootstrapping method was used to generate an estimate for May 2006.

The data from January 2001 to December 2005 was used to generate an estimate for May 2006, through R-statistics.

Then, a time-series analysis was conducted. A time-series analysis is a method used to obtain an understanding of the forces, which produced the data. The time series analysis is a set of data used and collected sequentially at fixed intervals of time. The amount of rainfall , is a time series data, which is measured and recorded at successive time intervals.

First, the complete set of data, from January 2001 to December 2011, was combined through Notepad, then saved as a “.dat” file. It was then scanned and entered to R-statistics, using the command: “baguio <- scan("C:\\Users\\Computer\\Documents\\research2\\CabantacOsbucanYodong\\baguiorain.dat")” The data was assigned to a time series variable, using the command: “baguiots <- ts(baguio,frequency=12,start=c(2001,1))”

The *Baguiots*is the name of the variable, the *baguio* is the name of the variable assigned to the original data, the *frequency* refers to the frequency in a year, the *start* assigns the starting date, which is 2001, and the *1* pertains to the month January.

Before proceeding to the Holt-Winters filtering, the data was determined if it was additive in nature. Since the time series was not an additive model, it was transformed into an additive model and was decomposed to separate its components. A time series has three components, the seasonal component, the trend component, and random component. It was necessary that the time series should be transformed to an additive model because it will be undergoing a simple exponential smoothing, where the model is at a constant level and no seasonality. Simple exponential smoothing is a method of creating short-term forecasts.

Then, the data was assigned to a forecast variable, using the command: “baguiorainseriesforecasts = HoltWinters(baguiots, beta=FALSE, gamma=FALSE)”

Then plot the actual graph with the fitted data graph using Holt-Winters Filtering, a method used to produce a smooth exponential graph, using the command: “baguioforecast$fitted” and “plot(baguioforecast)”.

The fitted values contain the forecasts made by Holt-Winters. By default, Holt-Winters forecast covers the same period as the given data, from January 2001 to December 2011. The fitted were obtained by typing the command:

“baguioforecast$fitted”

To specify specific time points for the forecast, use the command: “baguiorainseries forecasts2 = forecast.HoltWinters(baguiorainseriesforecasts, h=12)”.

The variable *h* pertains to the twelve months of the year, which will be the time points Holt-Winters will be forecasting. Then plot the forecast, using the command: “plot(baguiorainseriesforecast2)”

Then, the seasonal trend was removed by inputting the command: “baguiorainseries seasonallyadjusted = baguiorainseries -baguiorainseriescomponents$seasonal”

Then, another forecast was done using the same command: “baguiorainseriesseasonallyadjustedtsforecast=HoltWinters(baguiorainseriesseasonallyadjustedts, beta=FALSE, gamma=FALSE)”

Plot the graph.

After the forecast was generated, a t-test was done to test whether a there were significant statistical differences between the forecast and the actual values. A t-test was done on both the 80% interval and the 95% interval.

**Protocol**

The time series analysis and forecasting will be done using a statistical software called R-statistics. R is a free software environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS.

**Tools for Data Analysis**

Using the R-statistics, a time-series analysis was done. A Time-Series Analysis is a method used to obtain an understanding of the forces, which produced the data. The time series data is a set of data used and collected sequentially at fixed intervals of time. Holt-Winters filtering was the method used to create a forecast and to graph that forecast. The Holt-Winters filtering function will give a forecast for a year, an 80% prediction interval for the forecast, and a 95% prediction interval for the forecast.

**Chapter 4**

*Presentation of Data, Analysis and Interpretation*

**Presentation of Data**

Table . Rainfall Amounts in Baguio City (2001-2006)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Month** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** |
| **JANUARY** | 14.6 | 5 | 0 | 17 | 0.2 | 160.6 |
| **FEBRUARY** | 39.5 | 2 | 25.4 | 128.6 | 0 | 8.8 |
| **MARCH** | 289.8 | 0.6 | 4.8 | 0 | 54.6 | 38.4 |
| **APRIL** | 76 | 71.2 | 46.8 | 37.8 | 32 | 29.6 |
| **MAY** | 291 | 264.4 | 662.7 | 428.6 | 291 | 245.5048 |
| **JUNE** | 451.4 | 411 | 792.4 | 1306.5 | 425.7 | 188.2 |
| **JULY** | 1642 | 1883.4 | 721.3 | 445.4 | 292.4 | 1769.8 |
| **AUGUST** | 274 | 525.6 | 1089.4 | 1432.9 | 690.2 | 735.8 |
| **SEPTEMBER** | 842.2 | 301.5 | 303.2 | 225.6 | 694.6 | 207.6 |
| **OCTOBER** | 97 | 224.8 | 179.7 | 42.4 | 256.6 | 316 |
| **NOVEMBER** | 61.6 | 67.3 | 60.4 | 114.5 | 55.2 | 72.4 |
| **DECEMBER** | 23.2 | 10 | 4.4 | 154.9 | 68 | 43.2 |

Table . Rainfall Amounts in Baguio City (2007-2011)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Month** | **2007** | **2008** | **2009** | **2010** | **2011** |
| **JANUARY** | 0 | 24 | 8 | 0 | 94 |
| **FEBRUARY** | 0.6 | 97 | 64.5 | 0 | 13.8 |
| **MARCH** | 31.8 | 78.7 | 82.9 | 15.3 | 88.9 |
| **APRIL** | 25.4 | 149.8 | 407.3 | 148.6 | 11.9 |
| **MAY** | 308.6 | 839.8 | 298.5 | 248.6 | 462.5 |
| **JUNE** | 358.4 | 302 | 810 | 254 | 529.1 |
| **JULY** | 219 | 681.2 | 758.4 | 543.7 | 435.9 |
| **AUGUST** | 1201.6 | 999.5 | 1087.7 | 536.6 | 1096.3 |
| **SEPTEMBER** | 408.4 | 761 | 516.9 | 296.8 | 819.2 |
| **OCTOBER** | 410.3 | 178.1 | 1981.8 | 920.1 | 332.4 |
| **NOVEMBER** | 444.8 | 82.6 | 22.2 | 226.4 | 81.6 |
| **DECEMBER** | 21.6 | 0 | 0 | 47.4 | 67.4 |

The data for rainfall amounts were collected from the PAGASA weather station located in Baguio City. The data obtained by the researchers were simplified and classified monthly every year. Table 1 and Table 2 are the total rainfall amounts summarized monthly, ranging from January 2001 to December.

**Analysis Of Data**

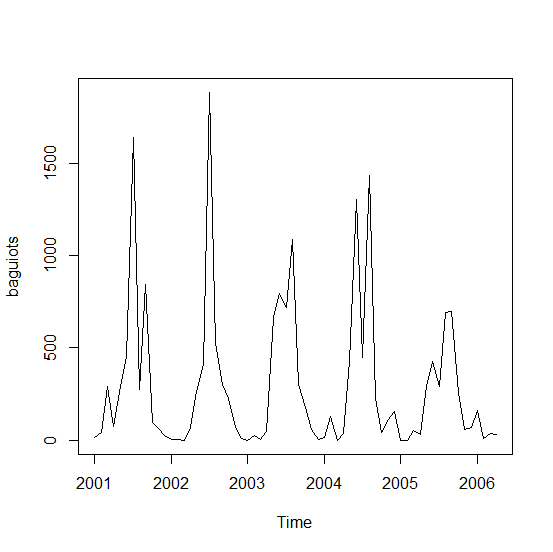
Using Bootstrapping method, the missing May 2006 data was generated. The complete set of values, from January 2001 to December 2006, was then graphed

Figure . January 2001 to May 2006

The time-series data was assigned to a forecast variable. Then, Holt-Winters filtering was used to produce a forecast. The forecast covers the same period as the given data, from January 2001 to December 2011. It was plotted along with the actual values. The red line represents the forecasted values and black line represents the actual values.

Another forecast was done, for the January 2012 to December 2012. The first forecast was with the trend component. The Holt-Winters produced a forecast, giving an 80% prediction interval and a 95% prediction interval.

Figure . Forecasted values and Actual Values (2001-2012)

Table . Forecast with Seasonal Component

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2012 | Point Forecast | LO 80 | HI 80 | LO 95 | HI 95 |
| January | 190.3247 | -369.0776 | 749.727 | -665.2072 | 1045.857 |
| February | 190.3247 | -436.8321 | 817.4815 | -768.8289 | 1149.478 |
| March | 190.3247 | -497.9489 | 878.5983 | -862.2989 | 1242.948 |
| April | 190.3247 | 554.0645 | 934.7139 | -948.1204 | 1328.77 |
| May | 190.3247 | -606.2367 | 986.8861 | -1027.9109 | 1408.56 |
| June | 190.3247 | -655.1958 | 1035.8452 | -1102.7873 | 1483.437 |
| July | 190.3247 | -701.4711 | 1082.1205 | -1173.5593 | 1554.209 |
| August | 190.3247 | -745.4608 | 1126.1102 | -1240.8357 | 1621.485 |
| September | 190.3247 | -787.4735 | 1168.1229 | -1305.0886 | 1685.738 |
| October | 190.3247 | -827.7539 | 1208.4033 | -1366.6922 | 1747.342 |
| November | 190.3247 | -866.5002 | 1247.1496 | -1425.9496 | 1806.599 |
| December | 190.3247 | -903.8753 | 1284.5247 | -1483.1099 | 1863.759 |

A third forecast was done, using the data without its trend component.

Table . Forecast without Seasonal Component

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 2012 | Point Forecast | LO 80 | HI 80 | LO 95 | HI 95 |
| January | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| February | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| March | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| April | 311.3336 | -53.88891 | 934.7139 | -247.2261 | 869.8934 |
| May | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| June | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| July | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| August | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| September | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| October | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| November | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |
| December | 311.3336 | -53.88891 | 676.5562 | -247.2261 | 869.8934 |

**DIFFERENCE OF MEASURES**

Table 1 shows the rainfall amount in Baguio City, including the Bootstrapped May 2006 data, from January 2001 to December 2006. Table 2 shows the rainfall amount in Baguio City from January 2007 to December 2011.

Table 3 and Table 4 show the forecasts. Table 3 shows the forecast using the data with its trend component, and Table 4 shows the forecast using the data without its trend component.

**INTERPRETATION OF DATA**

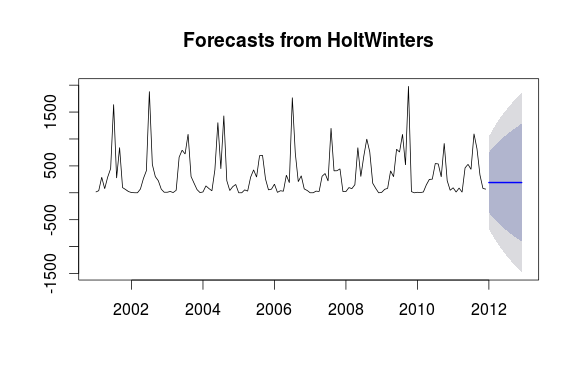


Figure . Graphical Representation of Forecast Interval

The graphical representation was obtained using R-statistics. The area from the middle blue line to the gray area(upward) represents the 95% chance prediction interval and the area from the middle blue line to the darker gray are(upward) represents the 80% change prediction interval.

For example, for the data with the trend component, the darker gray area means that there is an 80% chance that rainfall for that January 2012 would be from 0mm to 749.727mm while the lighter gray area means that there is a 95% chance that rainfall for January 2012 is 0mm to 1045.857mm. The Lo is considered 0 because it is not possible to have negative rainfall.

**Chapter 5**

*Results and Recommendations*

**SUMMARY OF FINDINGS**

The research was conducted to provide a rainfall amount forecast.

Using the statistical software R-statistics, the data gathered were used to produce a forecast for the year 2012. After producing the forecast for the year 2012, the proponents found out that the value forecasted is the average total amount of rainfall.

**CONCLUSION**

The forecasted values are of close relation to the actual values. This research proves the legitimacy of the forecasts. Therefore, this research can be a reference for future forecasts.

**RECOMMENDATIONS**

The proponents recommend that a better statistical study be done to further prove the validity of the forecasts. It is also possible that a better and more accurate forecast be produced through a more accurate and extensive statistical method. The proponents suggest that ARIMA models should be used to produce definite and accurate forecasts. The proponents also urge that this research be done on other weather factors such as temperature, air pressure, humidity, and number of rainy days. It is also recommended that the same study is conducted on a different region or location.

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