INVESTIGATION OF THE RELATIONSHIP BETWEEN DAILY TEMPERATURES AND RAINFALL OBTAINED FROM THE AUTOMATIC WEATHER OBSERVING SYSTEM (AWOS) AND THE CONVENTIONAL SURFACE AT SOROTI METEOROLOGICAL STATION – UGANDA.

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Abstract

Climate is Uganda's most valuable natural resource and a key determinant of the status of other natural resources. The frequency and intensity of extreme weather events such as floods, droughts, mudslides, disease and pests outbreak have increased in most parts of the country over the recent years and this has caused public outcry for adequate meteorological information for Research, Planning and Development purposes. The Department of Meteorology installed the Automatic Weather Observing Systems (AWOS) at several Synoptic and Agro-Meteorological Stations in Uganda, so as to improve the weather observations. The aim of this study therefore is to ensure/establish reliable and adequate Meteorological observing instruments that provide information, which supports the livelihood of most socio-economic communities in Uganda. The specific objective was to investigate the relationship between daily maximum, minimum temperatures, and rainfall obtained from the WAGTECH Automatic Weather Observing System and the Conventional Surface for Soroti Meteorological Station. The daily temperatures and rainfall for the month of December 2009 was obtained and analyzed to determine the relationship. Correlation and graphical analyses were conducted for the data sets. Correlation revealed positives, maximum temperature had (r=0.9887), minimum temperature (r=0.8016) and rainfall (r= 0.9917). However, more research is still required to determine the relationship in different weather/climatic elements like the upper air observations, wind and radiation among others since it can also be used to determine the standards and quality of observing systems.

INTRODUCTION

Climate is Uganda's most valuable natural resource and a key determinant of the status of other natural resources such as land, water, plants and animals on which the social and economic development depends. The changes of Uganda's climate are translated directly to its socio-economic performance.

In the past, communities knew their local climate well and it was predictable, particularly the onset and cessation of the rains were minimal. Therefore, weather and seasonal forecasts did not make any difference and indeed climate prediction could be based on relatively few climate-observing stations. Today Uganda faces serious socio-economic losses including deaths, disease and pests' outbreak, famine, food insecurity and political problems compounded by recurrences of devastating natural disasters; the frequency and intensity of extreme weather events such as floods, severe droughts, and mudslides increased in many parts of the country clearly giving some magnitude of the impacts of climate change (MWLE, 2002). This has caused public outcry for strengthened and adequate meteorological services to provide weather and climate information to the vulnerable communities is crucial for Research, Planning and Development purposes.

According to WMO (2010) through its Instruments and Methods of Observation Programme, (IMOP); to set technical standards and quality control procedures and guidance for the use of Meteorological instruments and methods, the Uganda Department of Meteorology (DoM) installed the Automatic Weather Observing Systems (AWOS) like the WAGTECH at several Synoptic and Agro-Meteorological Stations in order to improve the weather observation systems which information provided by these services clearly helps to reduce disaster losses, meet the users needs for data and is providing a basis for planning for a better future. It also ensures the effective and economic use of instruments and methods of observations under varying working conditions and in different technical infrastructures.

However, the data is not always continuous as the units occasionally stop for a month or two then starts up on its own making information obtained insufficient to some users because of lag/gaps between the observations in different times/days. This is a problem that has been experienced by AWOS- WAGTECH that continuously collects data round the clock and time is set for data storage. The logger was programmed to receive daily weather summaries and at real-time. And that from the manned surface observation system is limited due to few recording stations, fault instruments and under staff, therefore recordings are made during day.

Therefore, there is need for personnel to monitor the performance of the WAGTECH automatic observing system, store the information in the local data storage such as flash memory to avoid overlap of data for retrieval at a later stage such that data is available and can be compared

with that from the manned systems in order to ensure the quality data which is applied to check the risk of extreme climatic events and their damage can be reliable to assess.

***Key words**: Automatic, conventional, adequate, reliable, Standards, Quality, Observing systems*

Objectives of this study

The specific objective of this study is to investigate the relationship between daily maximum, minimum temperatures and rainfall obtained from the automatic observing system (AWOS-WAGTECH) and the Conventional manned observations.

Study Area:

Soroti Meteorological Station was used to carry out the study. Located in the Eastern part of Uganda at Latitude 01'43^{o} N, Longitude 033'37^{o} E and Altitude 1,132 Meters above mean sea level. The type of climate is Savannah tropical with a bimodal type of rainfall, the season is centered on April for (March-April-May season) and short rain season around October for (September-October-November season). The annual amount of rainfall over this area is 1352mm and annual average maximum temperature of 30.1^{O}Celsius and minimum of 18.0^{o}C. It's marked with a dry period in January and February. Because of its type of climate, the major activity carried out is both crop growing and livestock keeping (mixed farming).

Fig.1 AWOS- WAGTECH

Fig.2 Conventional Surface, (Thermometer screen)

Fig.3 Standard rain gauge

Fig.4 AWOS - Rain gauge

Methods:

The daily data for the month of December year 2009 was downloaded from the logger of the WAGTECH automatic observing system and that obtained by conventional surface was checked for data quality control and compared. Correlation analysis was used to examine the relation-ship. The spearman correlation analysis was used to investigate the relationship between the data obtained by the two observational systems.

$$R_s=1-(6\sum d^2/ n (n^2-1))$$

Where; Rs is the Spearman's Rank correlation coefficient.

d is the rank difference between manual and WAGTECH observations. The significance of Rs was tested using the formula t-statistic at 95% confidence level.

$$t = \sqrt{(n-2)/ (1-R_s^2)}$$

Where; t is the student t distribution

(n-2) is the degree of freedom

Results and Discussions

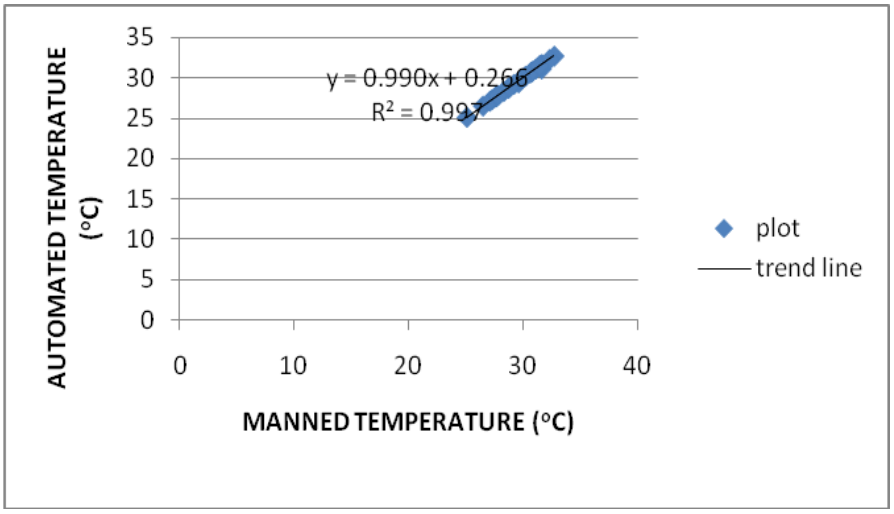

Fig.1 Scatter diagram showing maximum temperature for manned and automatic obsevations-December2009

Results from the scatter diagram show maximum temperatures with a strong positive trend for the observational systems at R^2 = 0.997, with all days falling on the trendline.

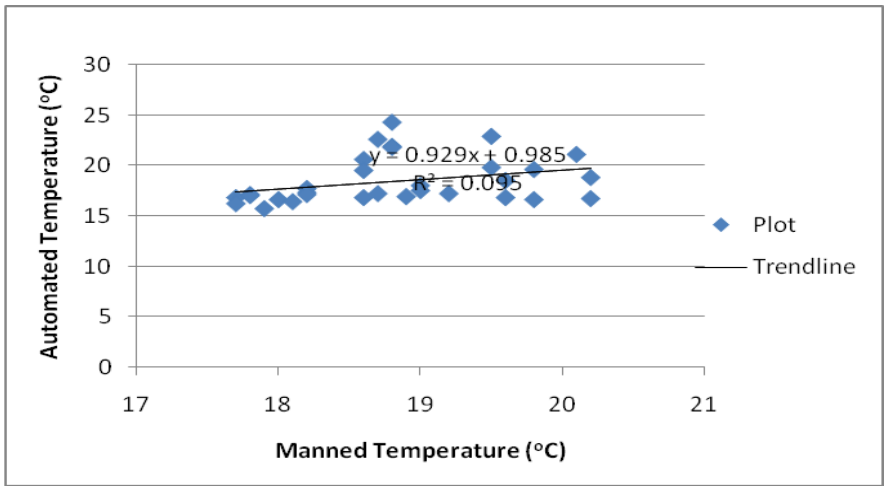

Fig.2 Scatter diagram showing minimum temperature for manned and automatic observations-December 2009. A scatter diagram of minimum temperatures indicated a weak postive trend of the plot at R^2=0.095.

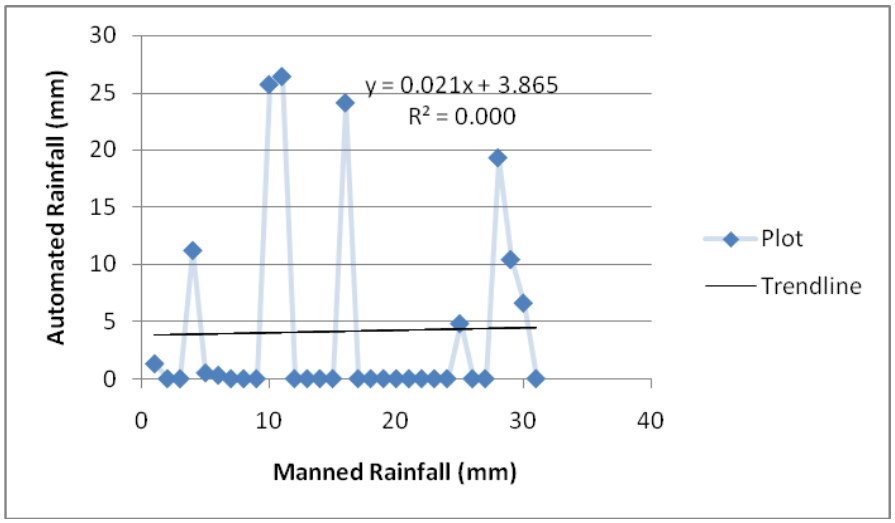

Fig.3 Scatter diagram showing rainfall variations for manned and automatic observations-December 2009

Scatter diagram of daily raifall amounts clearly show a very weak positive trend of the observational systems at R^2=0.000, with one day along the trendline.

Table 1: Spearman's rank correlation analysis and calculated t-statistic for Maximum temperature.

	Dec
r	0.9887
t	35.9385

Spearman's correlation analysis indicated that r_s = 0.98871 and t-calculated (35.63) was greater than t-tabulate (1.699)

Table 2: Spearman's rank correlation analysis and calculated t-statistic for Minimum temperature.

	Dec
r	0.8016
t	7.2206

Spearman's correlation analysis was r_s = 0.8016, t-calculated (7.22) was greater than t-tabulated (1.699).

Table 3: Spearman's rank correlation analysis and calculated t-statistic for rainfall amount.

	Dec
r	0.9917
t	41.9693

Spearman's correlation analysis r_s = 0.9917 and t-calculed (41.62) was greater than t-tabulated (1.699).

Conclussions

The regression analysis of the daily measurements of maximum temperature showed strong positive trend and a significant relationship at 95% confidence level.

Whereas the regression analysis of the daily measurements of minimum temperature indicated a weak positive and a significant relationship at 95% confidence level.

And the regression analysis of the daily rainfall amounts revealed a very weak positive trend and a significant relationship at 95% confidence level.

Recommendations

Since almost all the sector endeavors are influenced by weather and climatic events. There is still much need to improve the standard of Automatic weather observational systems by transfer of technology to the personnel involved in the observation systems, which provide information to meet the end users' needs for quality data. Regular inspection and adjustments in setting is a requirement for adequate and reliable data. Therefore it is also a requirement to set up a course unit at the National Training School on the AWOS observation technology in order for every personnel set to operate be skilled to monitor the performance of the automatic systems in addition to the conventional manual observation knowledge for regular and improved data quality.

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