AN ANALYSIS OF THE RAINFALL AND TEMPERATURE TRENDS IN MALAWI (1960 – 2010) AND ITS IMPLICATION ON THE NATURAL RESOURCE BASE

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1. INTRODUCTION

This poster presents the results of the analyses of the mean monthly, seasonal and annual rainfall and surface air temperature dataset spanning approximately 50 years from six meteorological stations in Malawi with the aim of identifying trends. In the study, Sen's slope and Mann-Kendall rank tests are used to demonstrate any existence of possible monotonic increasing and decreasing stochastic climatic trends in Malawi. Spearman's Rank Correlation was used to determine the association between flood frequency and rainfall mean. For this study, a five-percent level of significance was selected to indicate the presence of statistically significant trends. The study revealed that climate change has impacted on the natural resources. However, most of the natural resource degradation is as a result of un- regulated human influence. Therefore, there is need to mainstream Satoyama initiatives if the forests are to benefit the communities for better management.

The study aimed at determining whether there is evidence of long term trends in rainfall and temperature by analysing trends in annual rainfall and mean annual temperatures. Furthermore, the association between rainfall trends and forest cover change with the flooding incidences was assessed.

2. DATA AND METHODOLOGY

Temperatures and rainfall time series data for six stations, two from each region of Malawi (1960 to 2010) were collected from Malawi Meteorological Department (Table 1). The data was normalised to be easily red by Time Series Analysis in Excel-based tool 'MAKESENS'. Data on flood incidences were provided by the Department of Disaster management affairs. No up to date forest cover data was available.

Table 1: Coordinates, Elevations and length of Dataset for Sampled stations in Malawi

Station Name	WMO Number	Altitude (m)	Latitude (DD)	Longitude (DD)	Rainfall Period	Temperature Period
1. Mzuzu	67489	1254	-11.43	+34.02	1960-2010	1963-2010
2. Nkhata Bay	67493	500	-11.6	+34.30	1950-2010	1965-2010
3. Chitedze	67585	1149	-13.97	+33.63	1949-2010	1956-2010
4. Nkhotakota	67591	500	-12.92	+34.28	1915-2010	1965-2010
5. Chileka	67693	767	-15.67	+34.97	1940-2010	1961-2010
6. Mangochi	67695	482	-14.47	+35.25	1907-2010	1956-2010

Statistically, Excel template 'MAKESENS' (MAnn-KEndall test for trend and SEN'S slope estimates – Salmi *et al*. (2002) was used to analyse trends in meteorological data. The software combines two nonparametric tests. First the presence of a monotonic increasing or decreasing trend is tested with Mann-Kendall test and secondly the slope of a linear trend is estimated with the Sen's method (Salmi *et al*., 2002; Gilbert 1987). Salmi *et al*. (2002) noted that this method offer many advantages thus useful in analysing atmospheric chemistry data. For example, missing values are allowed and the data need not conform to any particular distribution. Besides, the Sen's method is not greatly affected by single data errors or outliers (Salmi *et.al*, 2002). The null hypothesis of no trend, H_o, i.e. the observations x_i are randomly ordered in time, against the alternative hypothesis, H_1, where there is an increasing or decreasing monotonic trend is tested.

Spearman's Rank Correlation was used to assess the association between mean annual rainfall and flood incidences. Both flood frequency and mean rainfall data (1970 to 2008) were assigned with ranks and the R value was calculated whose significance was checked on the Spearman's correlation tables (Zar, 1972).

3. RESULTS AND DISCUSSION

Mean annual temperature anomaly revealed significant positive increasing trend for all sampled stations except Nkhatabay (Figure 1). Additionally, temperature changes in high-altitudes are more pronounced than in low-altitudes. For example Nkhatabay at an attitude of 500m had its temperature anomaly increasing at a rate of 0.019^{o}C yr^{-1}. On the other hand, those at Mzuzu (1254m), Chitedze (1149m) and Chileka (767m) were increasing by 0.061^{o}C yr^{-1}, 0.05^{o}C yr^{-1} and 0.045^{o}C yr^{-1} respectively (Figure 1). In the Northern region, the results are consistent with IPCC's model projections, although they contradict the projections in both central and southern regions of Malawi (McSweeney *et al*., 2010; IPCC, 2007). This may be attributed to the effect of the lake on the weather. Furthermore, the results agree with local communities experience as revealed in two surveys conducted by Oxfam International and Action Aid International (Action Aid International, 2006; Magrath and Sukali, 2009).

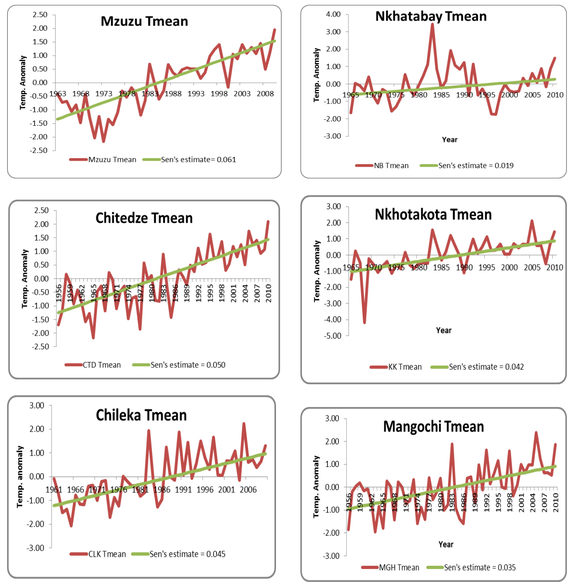

Figure 1 : Trends in Mean Annual Temperature Anomaly in Malawi

None of the annual precipitation series except for Mzuzu show significant trends (Figure 2). A significant decreasing trend at the rate of 0.018mmyr^{-1} (n = 51, p = 0.0536) was revealed in Mzuzu. Though no definite trends, clear decreasing trends were revealed by Sen's slope estimates for all stations in the Northern region and Chitedze on Central region, and increasing trend in all stations from the south and Nkhatakota on central region (Figure 2).

These results agree with the conclusion made from the study conducted by Magrath and Sukali (2009), McSweeney *et al.* (2010) and Ngongondo *et al*., (2011) that there are no significant trends in monthly and annual rainfall except in certain local places. This also agrees with IPCC (2007) which indicated that rainfall trends in the area are so uncertain.

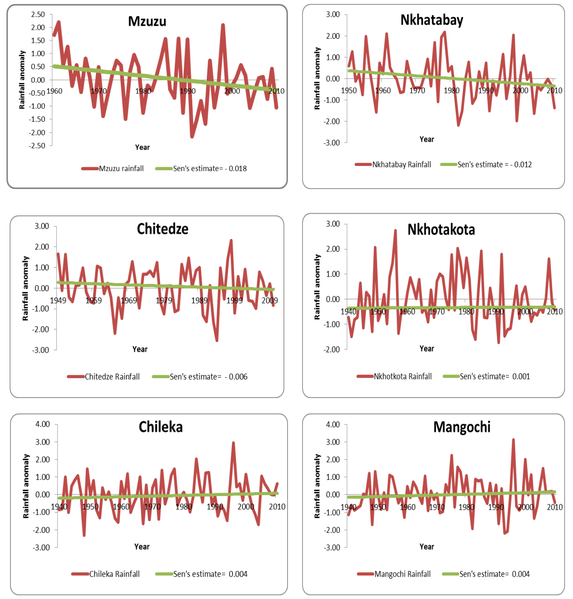

Figure 2: Trends in Mean annual rainfall anomaly in Malawi

There is a fairly strong positive correlation between the flood incidences and mean annual rainfall in Malawi (R=0.5997, p = 0.01). Thus more rainfall triggers more flood incidences. However, the scatter plot of flood incidences and mean annual rainfall (Figure 3) reveals that mean annual rainfall only accounts for 28% (R2= 0.28, P=0.05) of the flood incidences (1970 – 2008). This indicates the existence of other factors behind increasing flood incidences in Malawi.

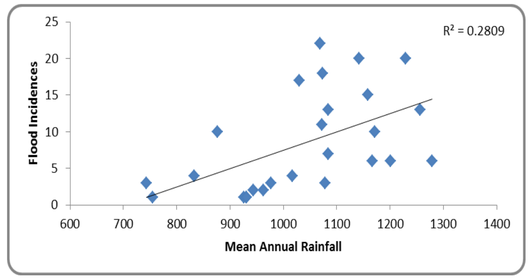

Figure 3: Scatter plot of Mean annual rainfall and flood incidences

4. CONCLUSION

Man Kendal and Sen's test were used to analyse trends in rainfall and temperature data for six stations in Malawi. Furthermore, Spearman's rank correlation was used to assess the relationship between flood incidences and mean annual rainfall. Results show significant increase in mean annual temperature anomaly for all sampled stations except for Nkhatabay. The warming is very conspicuous in high altitude areas as compared to low altitudes. No statistically significant trends have been detected in annual precipitation data for all sampled stations except Mzuzu. Generally, annual precipitation data showed a decreasing trend for all sampled stations. A fairly strong positive correlation was revealed between mean annual rainfall and the flood incidences. However, mean annual rainfall only explain 28% of the increasing flood incidences in Malawi, suggesting existence of other factors behind increasing flood incidences. The study failed to statistically analyse the relationship between forestry cover loss and flooding incidences due to forest cover data limitation. Furthermore, no daily rainfall data was available whose analysis would give meaningful results on rainfall extremes which are important in assessing rainfall as a flooding factor. As such, Satoyama Initiatives could be the best way to reduce the negative anthropogenic influence on the Natural resource base in Malawi.

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