VERIFICATION OF THE ZAMBIA RAINFALL SEASONAL FORECASTS USING METEOROLOGICAL PRODUCTS FROM METEOSAT.

BY N. AIKAYO

ZAMBIAN METEOROLOGICAL DEPARTMENT
P.O. BOX, 30200 LUSAKA, ZAMBIA.
e-mail: aika_ndu01@yahoo.com

Abstract:

Rainfall Seasonal forecasts verifications have proved to be rather a difficult exercise in Zambia, given the fact that there are very few reports of surface data from the rainfall reporting stations. This is mainly attributed to poor communication facilities. The current methods being used are decadal totals and monthly rainfall totals. These methods have proved to be inadequate due to inconsistence reports or data from stations. In this paper an attempt has been done to use the Meteosat products such as: forecast surface charts, 850hpa, 700hpa, 500hpa winds, satellite images, precipitation charts etc. These products usually indicate convergence boundaries such as the Inter-Tropical Convergence Zone (ITCZ) and the moist Congo air boundaries, which are the major rain producing mechanisms in Zambia. The forecast precipitation charts also plays an important role in trying to show areas with maximum rainfall, and are related to zones whose seasonal forecasts are either above, normal or below. On the other hand when there is a persistent high-pressure cell over the southwest part of the sub-continent (southern Africa), these systems are normally pushed towards the extreme north of the country and is usually during an El-Nino season. The images are used as observed data to verify the occurrence of rainfall or storms particularly to places where the actual amounts are not reported. In addition, during the presence of a tropical cyclone in the Indian Ocean depending on its location, the low pressure belt such us the ITCZ is forced to pass through it, thus maintaining a lot of rainfall over Zambia. This is because the ITCZ will be forced to remain stationary or oscillate about and this occurs normally during the mid-season of January, February and March.

Empirical models for seasonal forecasts also make use of predictors such as sea surface temperatures and reasently introduced General Circulation Models (GCM) using the Model Output Statistics (MOS) climate predictability tool (CPT). The GCMs makes use of historical data such as precipitation, 850 and 700 hpa. Details and demonstrations explaining how this method is used will be presented with the text.

1. INTRODUCTION

Realistic verification of the seasonal rainfall forecasts in Zambia
can only be represented accurately if the initial data is whole available. Unfortunately, the network of rainfall reporting stations is insufficient to achieve an adequate density of observed data.However; Meteorological products from Meteorological Satellites (MSG1) give forecasts of pressure, winds and precipitation for five days or more. These can be used to verify with the actual amount of rainfall observed. For the past years, questions have been asked raised on the assessment of the rainfall and forecast performance, which plays a vital role if improvements are to be made.

This paper intends to produce a viable method of verifying the probabilistic approach of the seasonal rainfall forecast produced by the Zambia Meteorological Department using;

- Decadal and monthly rainfall data versus surface, upper air and rainfall estimates charts from MSG1.
- Position of the cyclone and high pressure systems
- Position of the rain belts, the InterTropical convergence Zone (ITCZ) and the Congo Air Boundary (CAB).
- Forecast precipitation charts versus actual rainfall amounts.

The four methods individually will assist to assess the forecast performance and risk value of the 2006 and 2007 rainfall forecast map which was issued in September 2006 in Lusaka, Zambia.

The major limitations of probabilistic forecast lay in the interpretation by the users especially those without any mathematical or statistical background. Furthermore, the uncertainty of the range of rainfall expected for each category or tercile has posed serious doubt in the user's mind whether to make decisions based on the forecast or resort to other means. Over the years user oriented techniques and the knowledge of the climatology of the country and its variation (extremes) with reference to the regional and global climate patterns has helped user's and scientists in the interpretation.

2. DATA MANAGEMENT

Daily rainfall records of rain gauge stations across the country are provided to the national Meteorological centre (Lusaka) on regular basis. This provides a continuous inflow of data that undergoes quality control before any analysis is undertaken.

3. METHODOLOGY

The method of forecast verification depends upon the type of information provided in the forecast.
The decadal data collected during the first week of October 2007 indicated that most stations in the country recorded almost no rainfall. Actual rainfall started in November; this rainfall was plotted on the Zambian map and compared with the surface charts and upper air charts e.g. the 850 Hpa, 700Hpa and 500Hpa charts from Meteosat. This was carried out for each decade and then compiled up to the end of each month to the end of the season. December rainfall improved and comparison was with the Tropical cyclone.As more cyclones affected the region in January through to march, the rain belt commonly known as ITCZ formed and the relationship with the rainfall amounts was determined.

The aim was focused on the synoptic systems which favor rainfall such as the convergence line, the ITCZ, CAB, Tropical cyclones, High pressure systems, cloudiness etc.Thereafter the process of verification was determined using the actual amounts for that particular period.

4. RESULTS AND DISCUSSION

Generally speaking October was dry; therefore the rainfall map was blank. November rainfall was mainly below normal as can be seen from fig.1. The rainfall was almost blank except for very very few places over the western parts of the country. The surface chart showed high pressure cells controlling dry easterly airflow over the country and thus no or less rainfall activities. The global forecast for ENSO events indicated LA-NINOconditions during the season in question. This was almost evidenced during OND season, but things improved throughout the JFM season and this was due to the occurrence of tropical cyclones which occurred most frequently. These cyclones influenced rainfall activities over Zambia by maintaining the convergence zones oscillating about the country. The results can be seen from the rainfall map versus Rainfall estimate from msg1,

February which had a lot of cyclone affecting the region induced a lot of rainfall as can be seen on the map of February versus Tropical cyclone and the ITCZ. In the case of March, the cyclones induced thick cloudy bands which caused a lot of rains and storms.

4.1 2007/2008Rainfall Summary

October 2006

In the first dekad of October many stations had not received enough rainfall . Only the extreme northern parts of Zambia received amounts up to 30mm. see fig.1.

By the end of October stations had received amounts less than 60mm,except the extreme northwestern parts of Zambia which got 60mm.

November 2007

During this month most rainfall reportin stations got substaintial amounts of more than 30mm, with some up to 60mm throughout the
Three dekads.

December 2007

By Middle of December, most areas of the country had received rainfall of over 120mm. By the last dekad rainfall was pounding nearly everyday and this resulted into flash floods over most parts of Zambia. The most hit was the southern parts of the country which experienced floods which even washed the bridges, (see figs.annex)

January 2008

Heavy to moderate rainfall spread over Zambia. Most places in the Southern half had received Normal to above Normal Rainfall Recorded.
The flood situation in western ,southern,central,lusaka and part of eastern provinces increased. As a result crops along the banks of the rivers were submerged in water.

February 2008

Rainfall over Zambia by the 1st and 2nd Deakd of February,started decreasing. The flood situation along the river banks that had sources in the northern part of the country had reached its peak level.

Towards the end of February a reduction in rainfall activities over Southern Half Zambia experienced, with places such as Lusaka, Mt Makulu and Livingstone, crops were alresdy destroyed by the floods.

March 2008

Moderate to heavy rainfall continue being experienced over the northern half of the country while light to moderate rainfall was experienced over the southern half of the country. Normal to above normal rainfall had been received over Northern parts of Zambia with some stations such as Chipata, Ndola, Kasama ,Misamfu and Mwinilunga, had recorded cummulative rainfall above 1500mm. The general picture in March was that normal to above normal rainfall was recorded over most parts of Zambia. At the end of the Month rainfall activities shifted to the northern parts of the country leaving the southern part with very light showers.

Hazards

Flood situation experienced in southrn,central,lusaka,western,and along the valleys of eastern provinces had destroyed some crops, and displaced human beings and live- stocks.

Heavy rains experienced over southern and central parts of the country had caused damage to public infrustructure such as roads, Schools and clinics.

They were reports of cattle diseases in western and southern provinces which had since claimed life of animals. In some instances animal and man competed over land in places that are near by game reserves. As a result few deaths were recorded.

5. C ONCLUSIONS

From the figures of the observed rainfall versus the products from the MSG1, it can be clearly being seen that the forecast products came out in agreement with the observed rainfall. The set back is that, the archiving system for our PUMA workstation is not available. I would like to further this research using more products from MSG1 for this coming season and the ones to come in future. The Country had received rainfall normal to above normal throughout the country.

The just ended rainfall season (2007/2008) had not been better than the 2006/2007 season in terms of agriculture production. There are likely to be reduction in food production in the southern parts of Zambia while the northern part of the country is expected to have bumper harvest. The flood situation in some parts of the country, may threaten house food security in affected areas.

6. ACKNOWLEDGEMENT AND REFERENCES

MSG1 (METEOSAT) Meteorological products from EUMETSAT

Dr. David Grimes:TAMSAT- University of Reading

Dr. S.J. Mason: Definition of Technical Terms in Forecasting Verification and Examples of Forecast verification scores.

Professor C.Oludhe: Verification of September to December 2003 consensus climate outlook.

Theodore M.Marguerite: Verification of the 2002/2003 SARCOF Season Rainfall outlook Maps.

Zambia Meteorological Department: Crop weather Bulletins-Decadal Rainfall maps.

ANNEX: Observed dekadal rainfall totals versus dekadal rainfall estimates from satellite Tamsat MSG1.

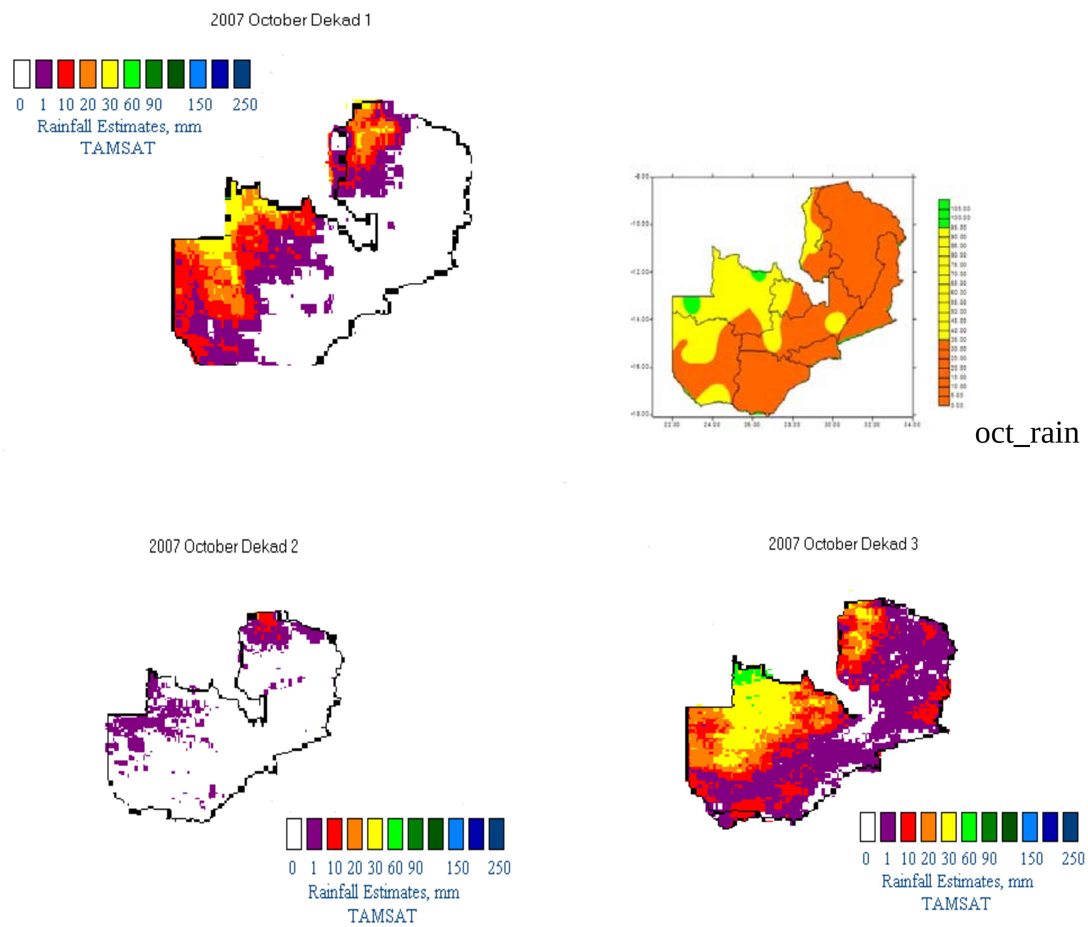
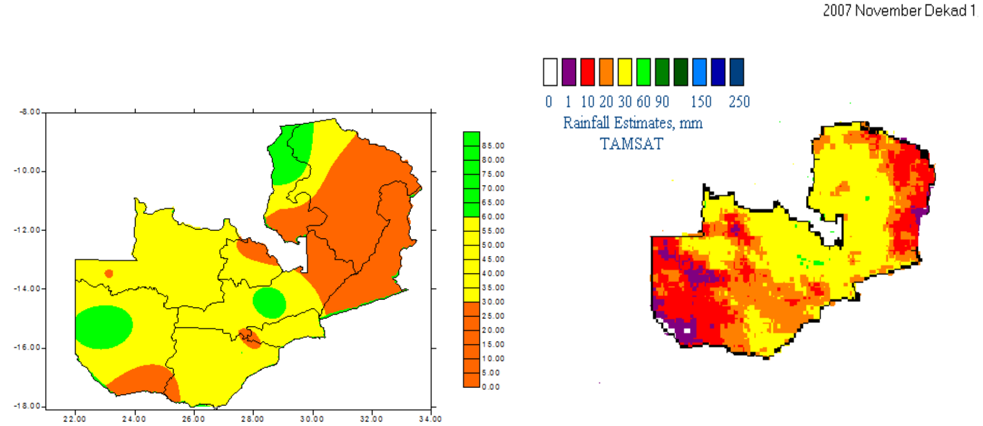
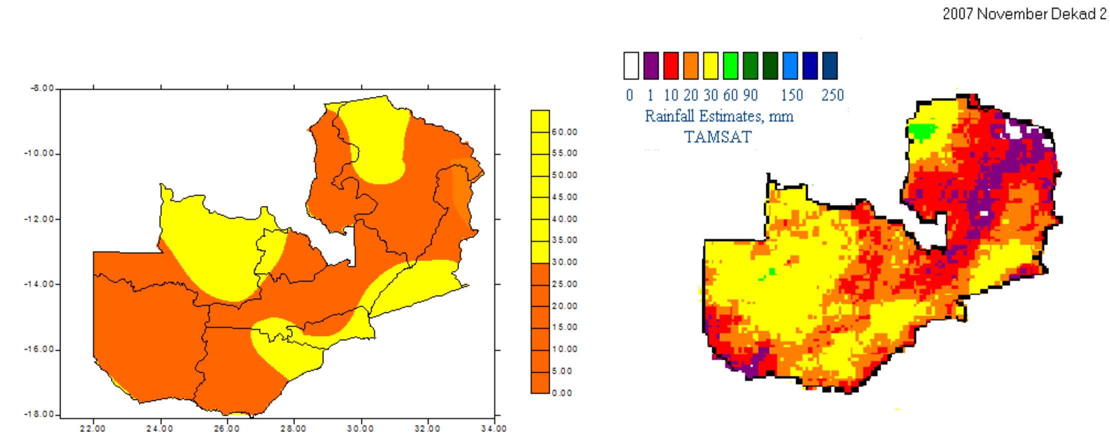


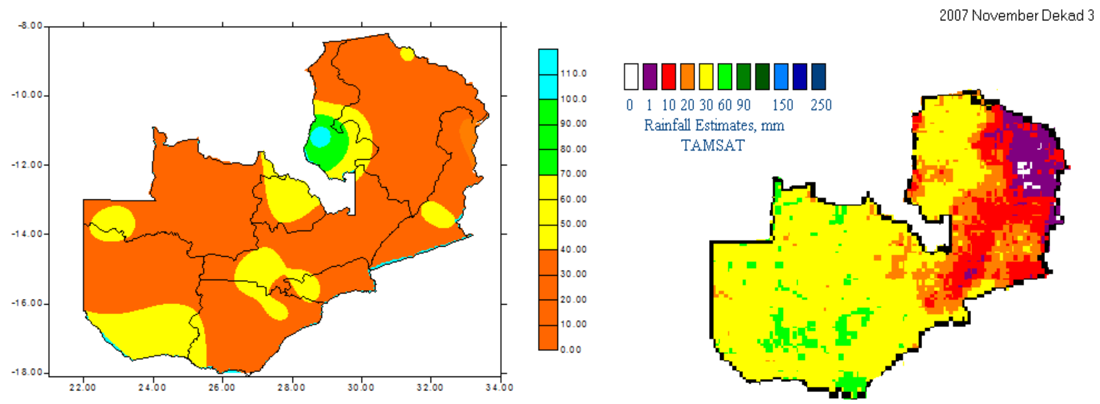
Fig.1 October rainfall vs. Dekadal rainfall estimates from MSG1 2007



NOV1 DEKAD

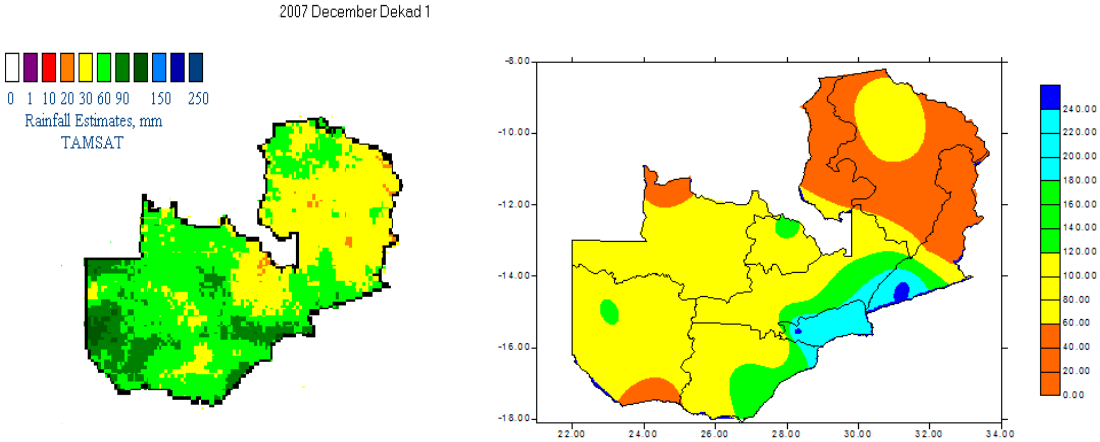


NOV2 DEKAD

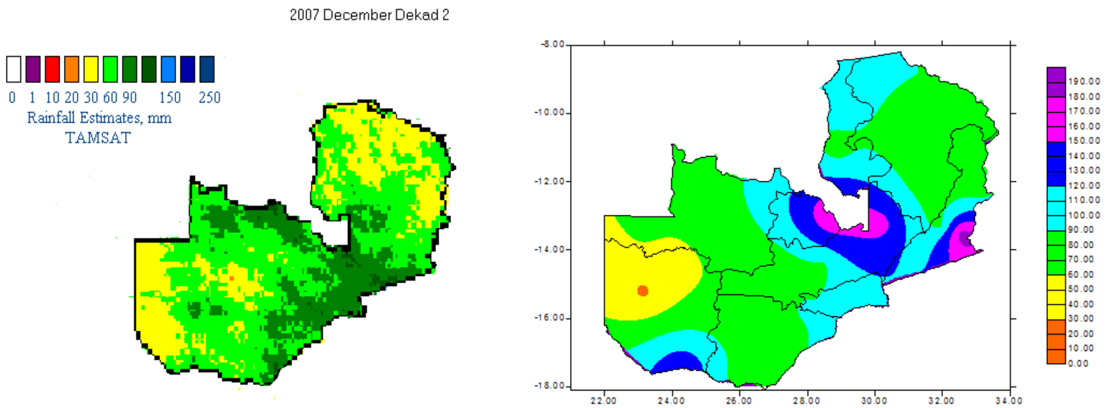


NOV3 DEKAD

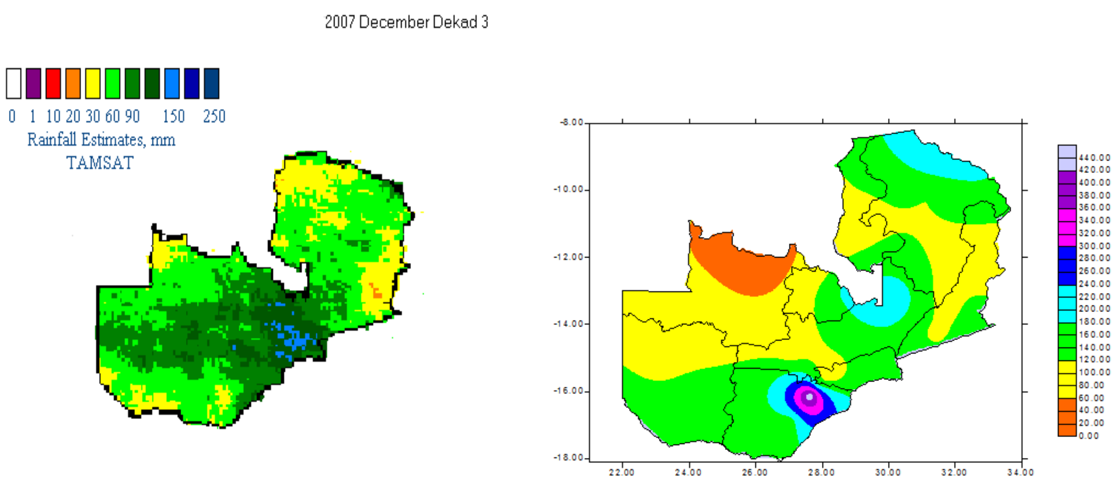
Fig.2 Nov. dekadal rainfall vs. Nov.dekadal estimates R/F from MSG1 2007



DEC1 DEKAD

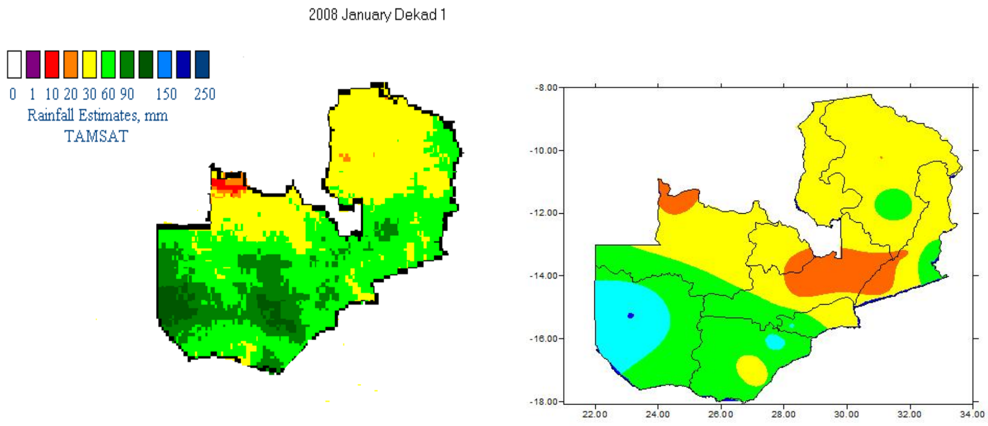


DEC2 DEKAD

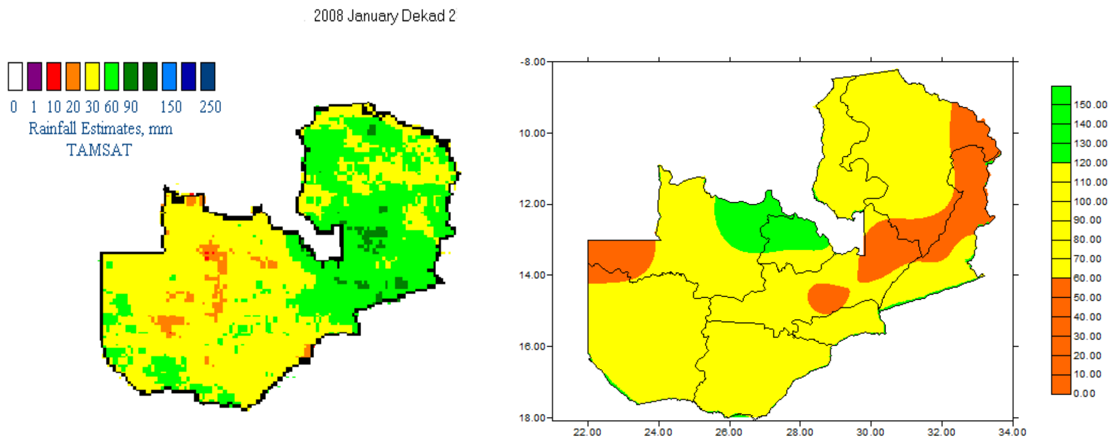


DEC3 DEKAD

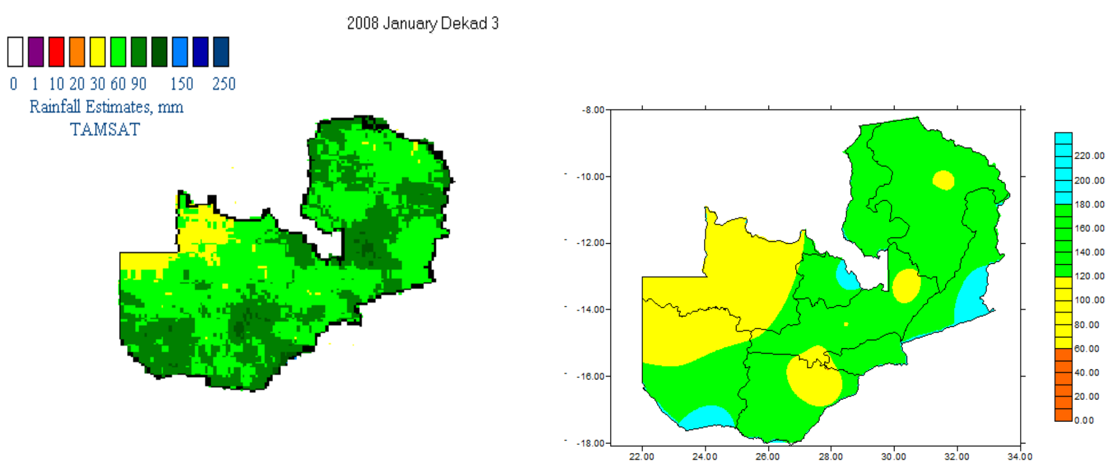
Fig 3: Decadal Dec. rainfall estimates from MSG1 vs December dekadals 2007



JAN1 DEKAD

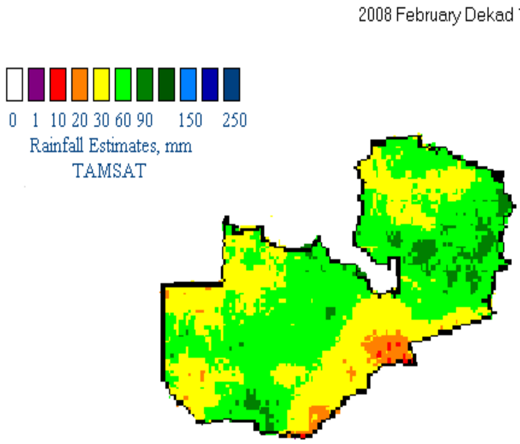


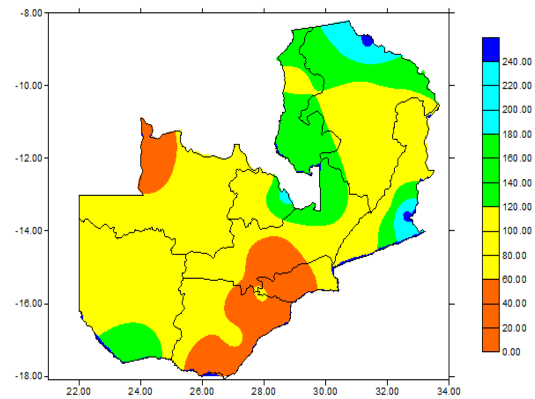
JAN2 DEKAD



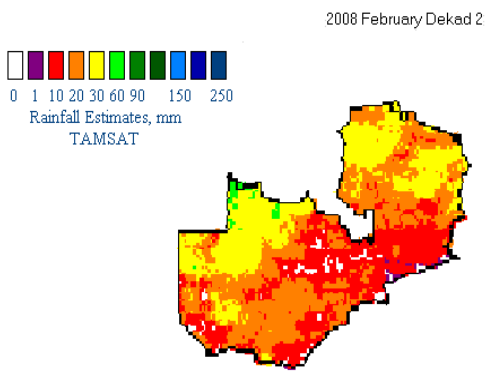
JAN3 DEKAD

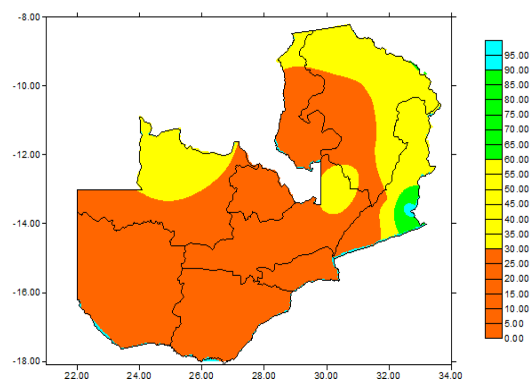
Fig.4 Jan.rainfall sat.estimations vs. Jan. dekads 2008



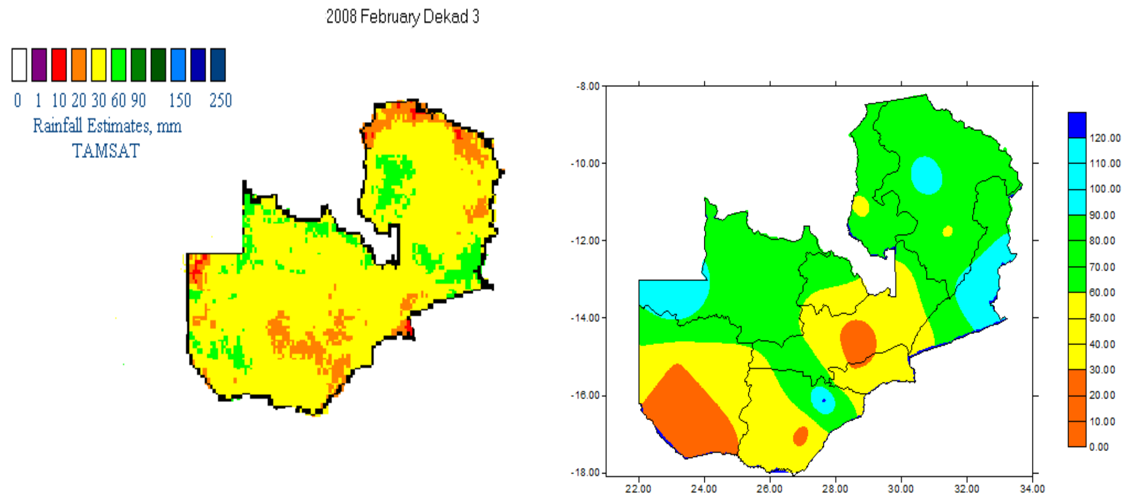


FEB1 DEKAD



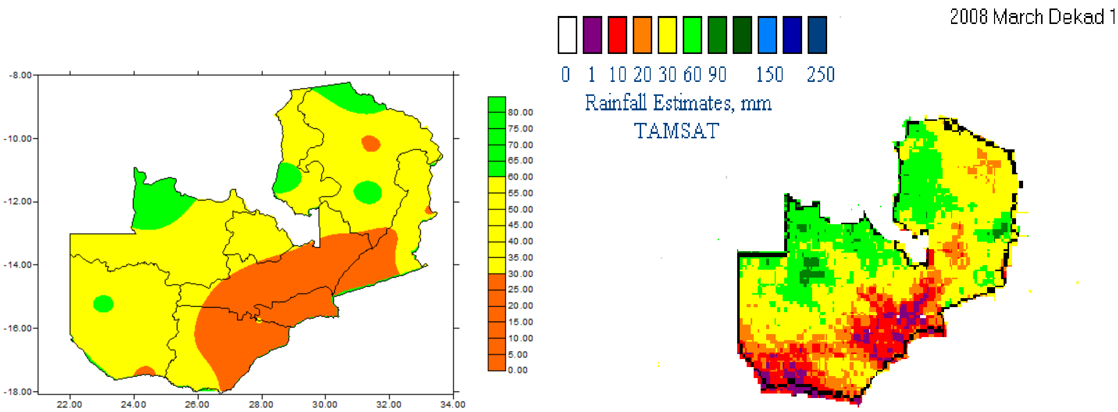


FEB2 DEKAD

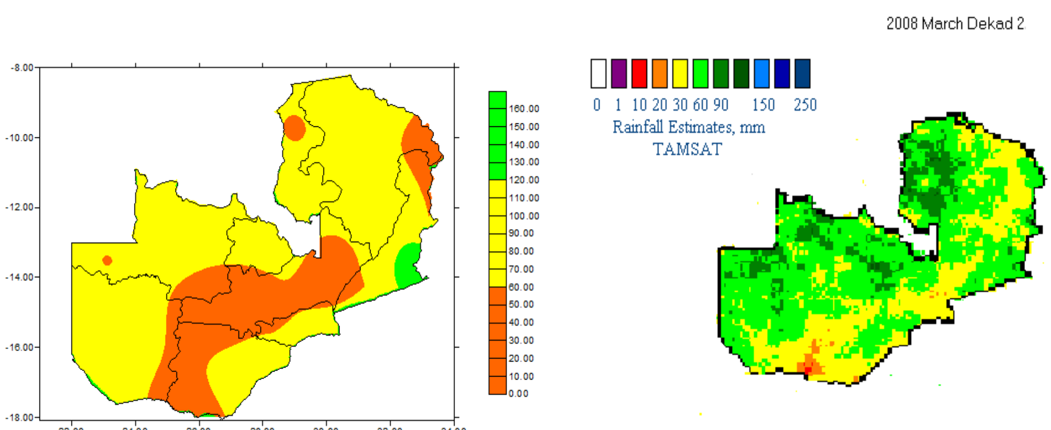


FEB3 DEKAD

Fig.5 FEB.DEKADAL RAINFALL ESTIMATES VS FEB,DEKADS 2008



MAR1 DEKAD



MAR2 DEKAD

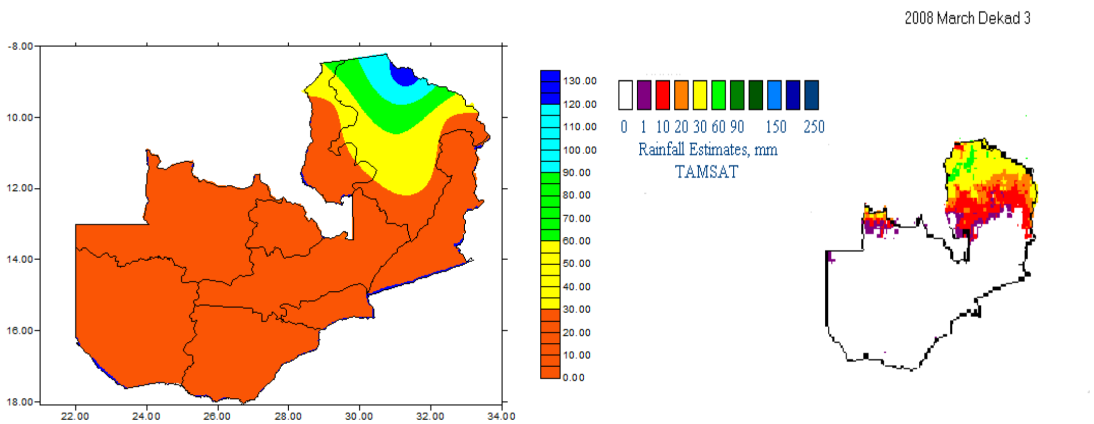


Fig.6 Mar,dekads vs. mar.dekadal rainfall estimates from msg1 2008

OCTOBER-DECEMBER 2006 **JANUARY-MARCH 2007**

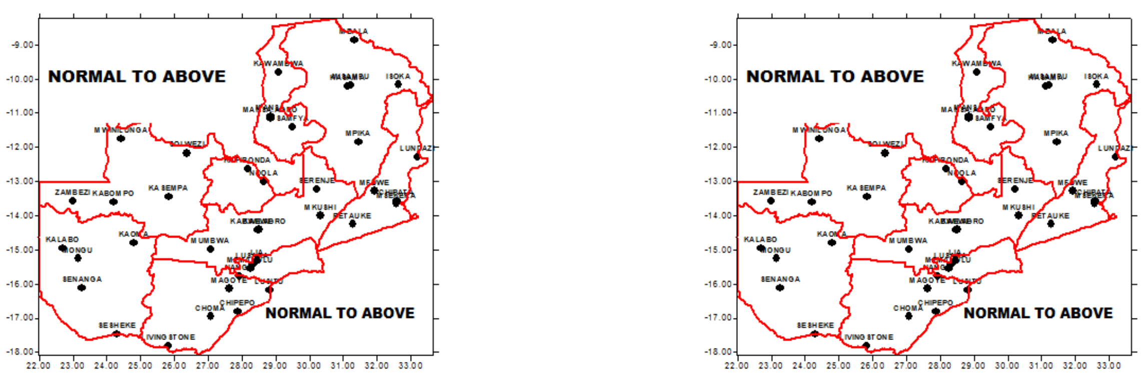


Fig.7 Forecast for OCT-DEC 2007 and JAN-MAR 2008.