THE IMPACT OF TROPICAL CYCLONE ''FUNSO'' OVER THE SOUTHERN COAST OF TANZANIA A CASE STUDY OF HEAVY RAIN AT KILWA ON 17TH JANUARY, 2012.

INTRODUCTION

Tropical cyclones form annually over warm tropical oceans. Initially they start as tropical disturbances as low pressure cells then develop and attain intensity with surface wind speed drastically increasing.

In the Southwest Indian Ocean they are called Tropical Cyclones. In other regions of the global Oceans they are called Typhoons or Hurricanes. In the South-west Indian Ocean basin where is Tanzania found, the period during which most of the Tropical disturbances and cyclones occur is between November and mid May each year; this is known as the Cyclone Season.

Tropical cyclones are among the most devastating of all natural hazards. They have potential to change wind flow and weather patterns in a short time over regions causing violent winds, torrential rainfall and floods; moreover they can also cause poor seasonal rainfall depending on their strength and position in Tanzania. In general every year several tropical disturbances and tropical cyclones cause disasters of varying scales, with loss of life, human suffering, destruction of property, severe disruption of normal agricultural activities and adversely effects to social and economic progress.

Regional Specialized Meteorological Center La Réunion (RSMC) carry out monitoring and forecasting of tropical cyclones, provide advisory information and guidance to National Meteorological Services including Tanzania. The provision of local tropical cyclone warnings over Tanzania territory and its coastal waters is the responsibility of Tanzania Meteorological Agency (TMA). TMA issues regular warnings and likely impacts social and economic activities depending on Tropical Cyclone track and intensity. The positions and strengths of tropical storms and tropical cyclones over the south-western Indian Ocean are important factors to the occurrences of particular weather in Tanzania. In most cases tropical cyclones that pass through the Mozambique Channel tend to enhance precipitation

over the country particularly coastal areas, north-eastern highlands and southern regions. Good forecasts on the tracks of these tropical cyclones and their intensities are therefore crucial and important contributions to early warning system in the country whose outputs are the issuance of warnings and advisories.

During the 2011-2012 the south-west Indian Ocean got hit by several tropical disturbance and tropical cyclone. One of them is the tropical cyclone "FUNSO". It started as a low pressure at around 15^0S of equator just off the coast of Mozambique along the Mozambique Channel.

On 16th of January 2012 a surface low pressure cell developed in the area and the convective cells were formed and get organised into intense rainband. The presence of upper level anticyclone provided favourable conditions for development, together with weak directional wind shear and good outflow (Joint Typhoon Warning Centre, 2012)

Apart from Tanzania, the impacts of tropical cyclone "FUNSO" was reported in several countries along the southern Africa like Mozambique, Malawi, South Africa and Swaziland where it caused floods, loss of lives and damage to properties(0).

During the period of 16th January to 20th January, 2012 several stations in southern, central and coastal Tanzania reported heavy precipitation. On the 16th of January, 2012 Dodoma station reported 33.4mm of rain, Mtwara 26.1mm and Igeri 26.9mm. On the 17th of January, 2012 Songea station reported 27.9mm and Zanzibar 22.1mm. The next day 18th of January, 2012, Morogoro station reported 29.3mm of rain and Kilwa station which is along the southern coast of Tanzania reported 131.4mm of rain in 24 hours. This precipitation was actually happened on the previous day i.e. the 17th of January between 0900 and 1600EAT, but as the precipitation accumulation normally reported at 0600Z each day that is why it was reported on the next day, the 18th of January 2012. After the 18th day of January, 2012 the activities was ending to decrease as on the 19th Igeri station (south-western highlands of the country) reported 14.2mm and on the 20th Morogoro station reported 26.8mm of rain.

In this case study, the synoptic situation and the resulting effects of tropical depression/cyclone "FUNSO" on the 17th of January 2012 to Tanzania is detailed discussed.

SATELLITE IMAGERY

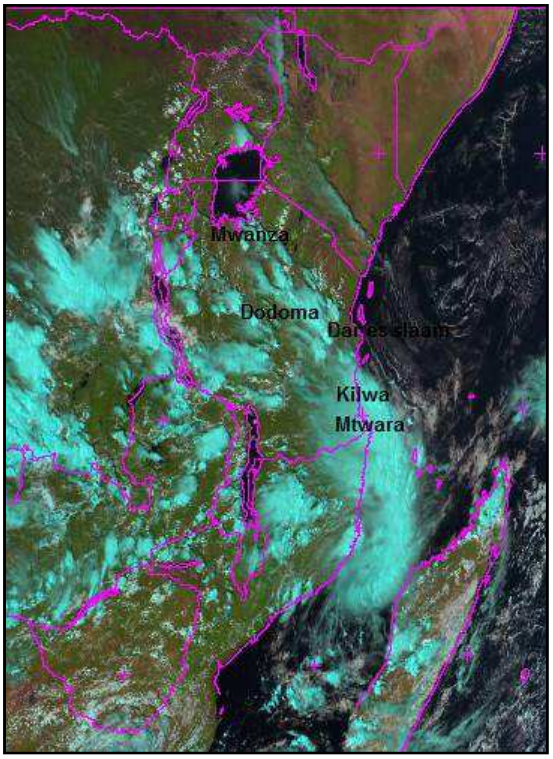

Fig 1(a): MSG satellite imagery RGB 321 of 1300Z 17th January 2012

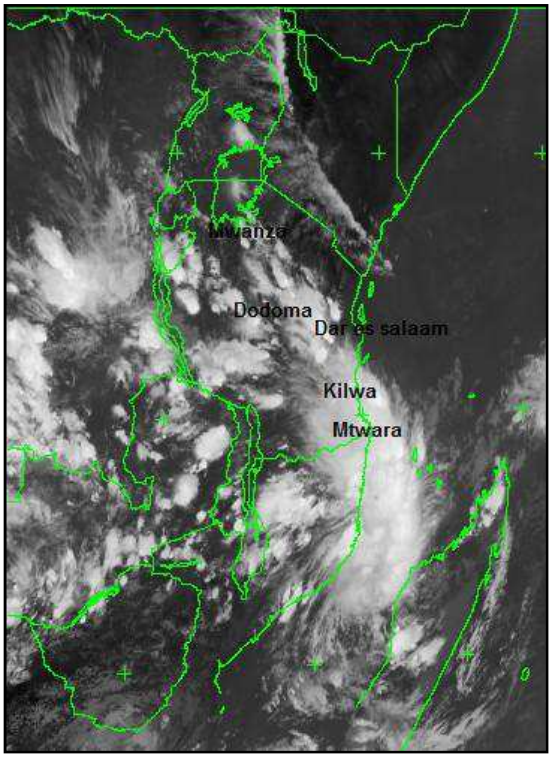

Fig 1(b): MSG satellite imagery IR 10.8 of 1300Z 17th January 2012

In the figure 1 above at both RGB 321 and IR 10.8 satellite imagery there is a line of convective clouds (rainband) extending from the depression in the Mozambique channel to the southern coast of Tanzania. Kilwa station can be clearly seen covered by those clouds at their decaying stage and actually at 1300Z i.e. 1600 hours EAT is a time where heavy precipitation stopped. Over some other places in Tanzania and nearby countries there are convective cells clearly oriented themselves in a cyclonic manner around the tropical depression. This shows how the positioning of the tropical depression/cyclone affects areas in the south-eastern Africa mainland.

SYNOPTIC SCALE ANALYSIS

During the 16th day of January, 2012 surface synoptic scale pressure analysis showed a low pressure cell just off the coast of Mozambique at around Latitude 15^0S. NWP analyses showed a low level cyclonic flow at almost the same position.

Figure 2 below shows 0600Z 850hpa level wind flow pattern of 17th January, 2012 by ARPEGE and WAFS (WRF) models. All of these models show a cyclonic flow just off the coast

of Mozambique. The cyclone pulls westerly wind from the DRC and Zambia towards it. Further to the north along the Tanzania southern coast there is a convergence zone between westerly flows pulled by the tropical depression off the Mozambique coast and the northerly monsoon flow. This configuration might be one of the reasons for heavy precipitation observed at Kilwa station.

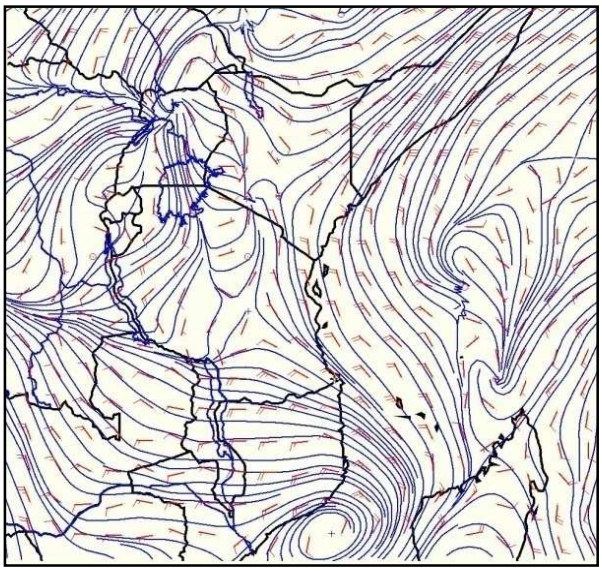

Fig 2(a): ARPEGE 0600Z 850hPa wind flow at 17th Jan, 2012

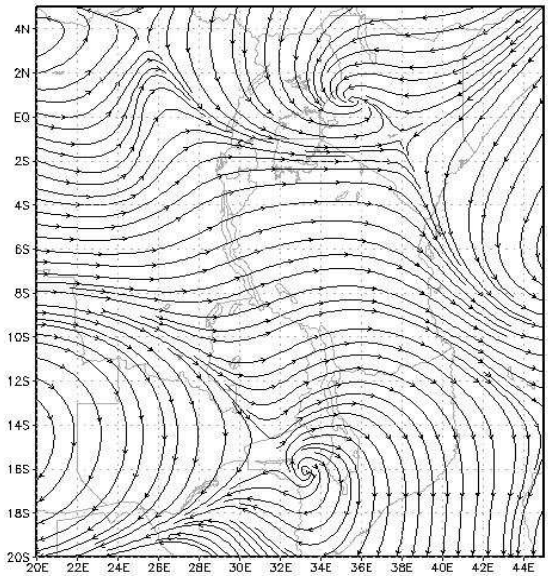

Fig 2(b): NCEP reanalysis 0600Z 850hPa wind flow at 17th Jan, 2012

Figure 3 below shows 0600Z 700hpa level wind flow pattern of 17th January, 2012 by ARPEGE model and NCEP reanalysis.

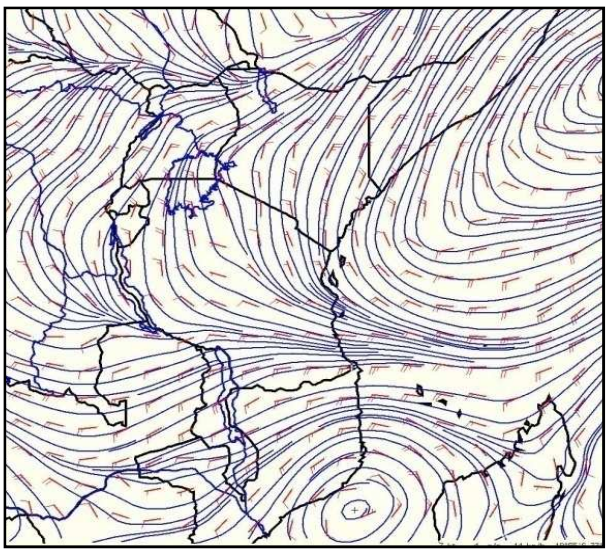

Fig 3(a): ARPEGE 0600Z 700hPa wind flow at 17th Jan, 2012

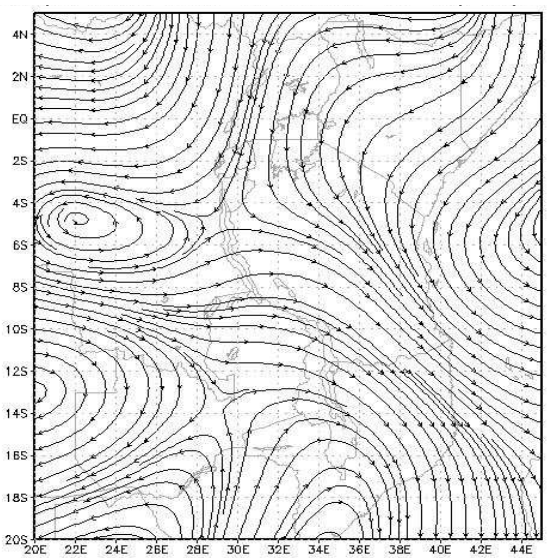

Fig 3(b): NCEP reanalysis 0600Z 700hPa wind flow at 17th Jan, 2012

At 700hpa levels there can be seen westerly flow over the northern side of the depression. Along the southern side of the coastal Tanzania there is a convergence zone between westerly flow and northerly wind. This also is in a very good agreement with the lower level (850hPa) flow as discussed above which also can trigger convective activities over the area.

Figure 4 below shows 0600Z 200hpa level wind flow pattern of 17th January, 2012 by ARPEGE model and NCEP reanalysis. In this figure the upper level anticyclone is clearly seen at those areas where there was low level cyclone. It extended up to the Tanzania coastal areas which counterbalances with the low level cyclone there by giving a lot of atmospheric instability which enhances convective activities.

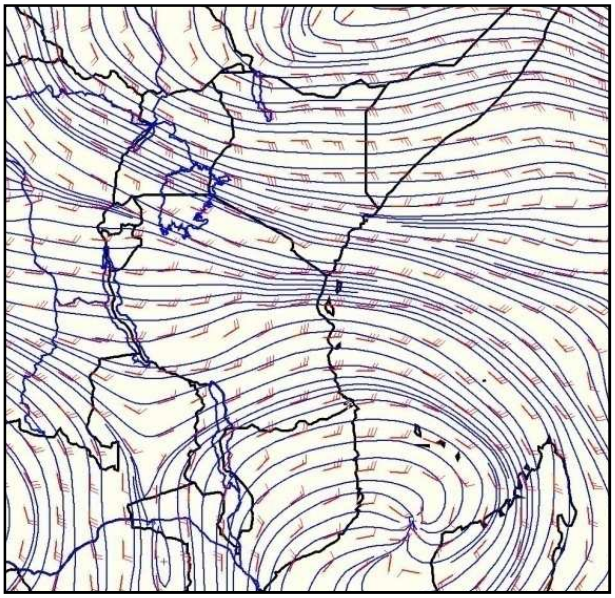

Fig 4(a): ARPEGE 0600Z 200hPa wind flow at 17th Jan, 2012

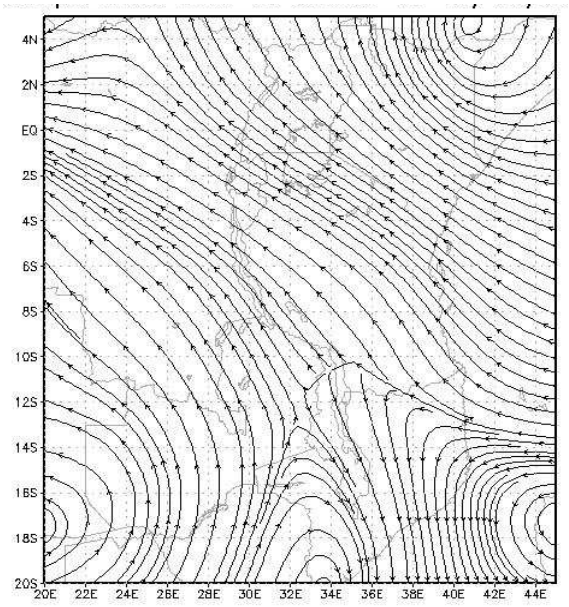

Fig 4(b): NCEP reanalysis 0600Z 200hPa wind flow at 17th Jan, 2012

The configuration shown from figure 2 to figure 4 above is very good for convective activities over the given area that is why the area was very active as can be seen in the satellite imagery figure 1 above.

NWP MODELS PROGNOSIS

Most of the global and regional models captured very well the heavy precipitation over Kilwa and southern Tanzania as a whole, associated with tropical depression over the Mozambique Channel which then deepened into an intense Tropical cyclone "FUNSO" in the 17th of January, 2012.

Limited Area models WRF (Tanzania) and ALAM (UK-MET) Figure 5 below, captured the situation and the strong signals was forecasted to happen at the same time as it was observed. This concluded that the models predicted very well the situation.

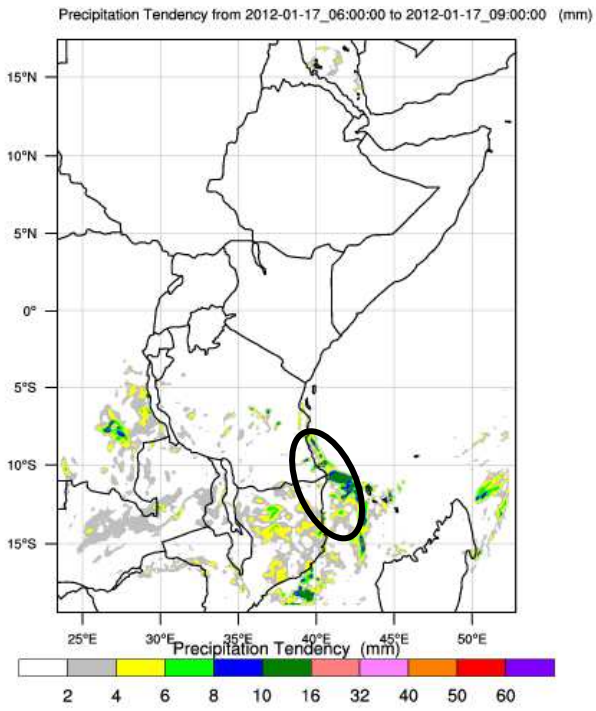

Fig 5(a): WRF (Tanzania) precipitation forecast for 0600 to 0900Z, 17th Jan, 2012 model run of 0000Z of 15th January, 2012

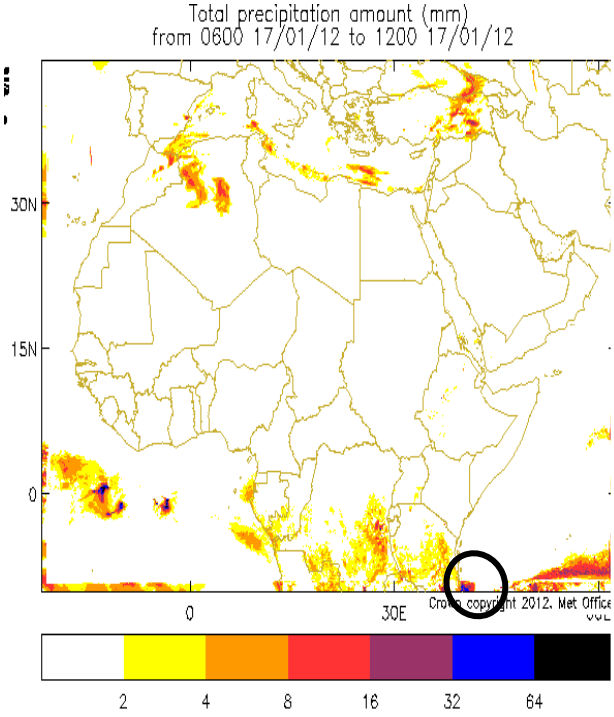

Fig 5(b): ALAM (UK-MET) precipitation forecast for 0600 to 1200Z, 17th Jan, 2012 model run of 1800Z of 15th January, 2012

As for the regional models, Global models also did very well. Here in Figure 6 below are the GFS and ECMWF deterministic forecasts. These models 15th January 2012 model run also predicted significant activities over some parts along the Tanzania southern coast.

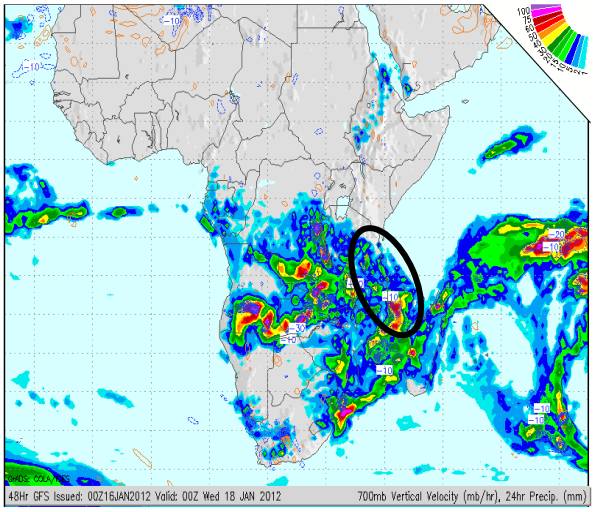

Fig 6(a): GFS (COLA) precipitation forecast for 0000 to 2400Z, 17th Jan, 2012 model run of 0000Z of 17th January, 2012

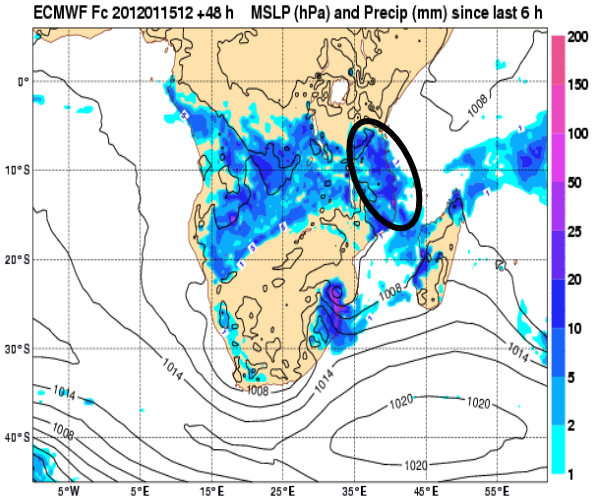

Fig 6(b): ECMWF precipitation forecast for 0600 to 1200Z, 17th Jan, 2012 model run of 1200Z of 15th January, 2012

RSMC's PRETORIA AND NAIROBI GUIDANCE PRODUCTS

RSMC Pretoria guidance product showed the likelihood of occurrence of heavy precipitation over some areas along the sub-continent which tend to be associated with the tropical depression along the Mozambique channel. Figure 7 below shows the RSMC Pretoria guidance product

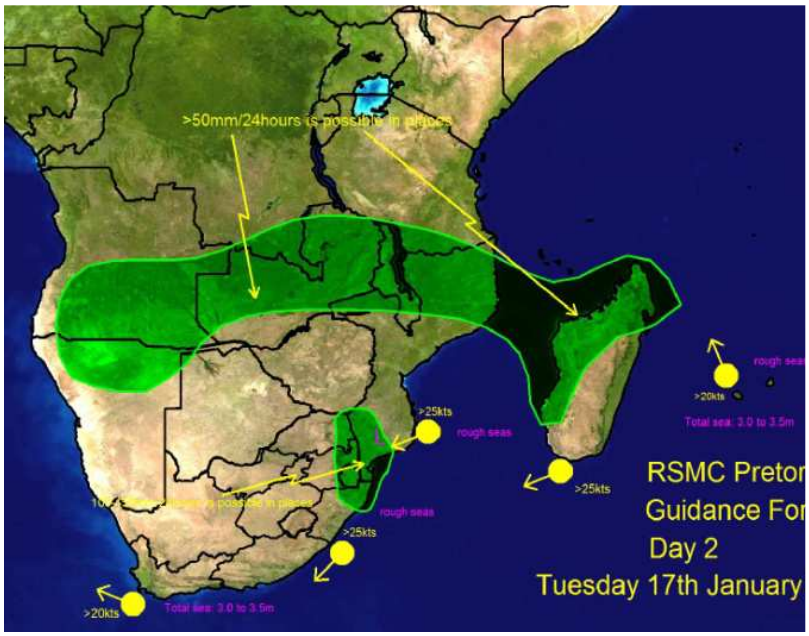

Figure 7: The RSMC Pretoria guidance product for 17th January, 2012 issued on the 16th January, 2012

TMA WEATHER FORECAST FOR 17TH JANUARY, 2012

Based on the satellite and surface observations, forecasters' analysis, good performance of the NWP models and RSMC Nairobi and RSMC Pretoria guidance products, the Tanzania meteorological Agency forecasted very well the situation and actually it gave the heavy rain Advisory to the public for the areas along the southern parts of Tanzania. Figure 8 below shows the TMA's weather forecast for the 17th January, 2012 and its outcome as reported on the 18th January, 2012 at 0600Z.

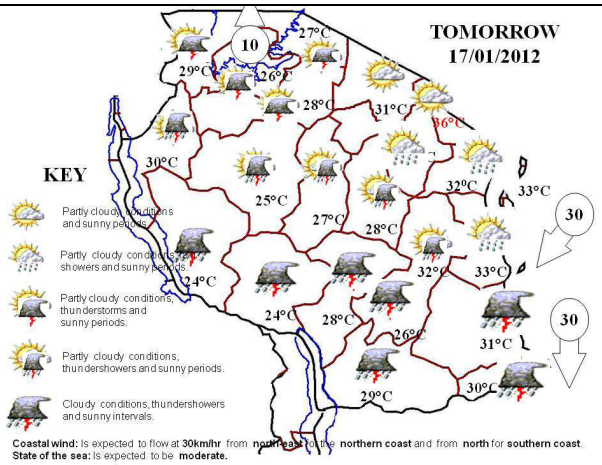

Fig 8(a): TMA weather forecast for Tanzania issued on the 16th January, 2012 valid for 17th January, 2012

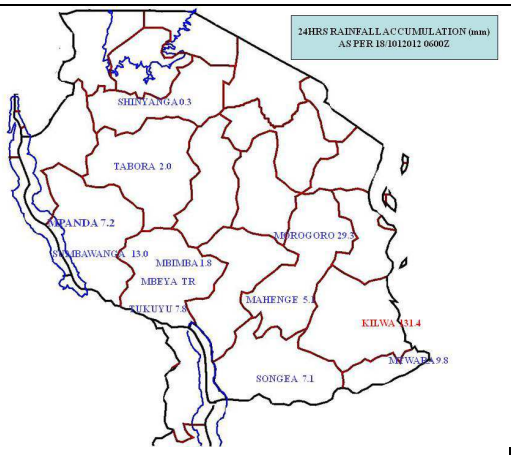

Fig 8(b): 24hrs precipitation accumulation as per 0600Z of 18th January, 2012

CONCLUSION

During the 2011-2012 the south-west Indian Ocean got hit by several tropical disturbance and tropical cyclone. One of them is the tropical cyclone "FUNSO". It started as a low pressure at around 15^0S of equator just off the coast of Mozambique along the Mozambique Channel.

On 16th of January 2012 a surface low pressure cell developed in the Mozambique channel and the convective cells were formed and get organised into intense rainband and then developed to a Tropical cyclone "FUNSO". The presence of upper level anticyclone provided favourable conditions for development, together with weak directional wind shear and good outflow. This configuration caused heavy precipitation at Kilwa station southern coast of Tanzania

Apart from Tanzania, the impacts of tropical cyclone “FUNSO” was reported in several countries along the southern Africa like Mozambique, Malawi, South Africa and Swaziland where it caused floods, loss of lives and damage to properties.

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Based on the satellite and surface observations, forecasters’ analysis, good performance of the NWP models and RSMC Nairobi and RSMC Pretoria guidance products, the Tanzania meteorological Agency forecasted very well the situation and actually it gave the heavy rain Advisory to the public for the areas along the southern parts of Tanzania..

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Desk, News (2012-01-23). " Mozambique: Floods, storms kill 22 and cut off Maputo" http://www.globalpost.com/dispatch/news/regions/afria/120123/mozambique-floods-cyclone-"FUNSO"-tropical -storms. Website Retrieved 2012-01-27

Joint Typhoon Warning Centre. 2012-01-17. http://www.webcitation.org/64l owz0CQ. Website Retrieved 2012-01-23.