Droughts, Floods and Landslides Event Week 2014

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Lesson objectives

How :

- To identify the thermodynamic conditions for severe weather (Thunderstorms) developments
- To apply satellite data on the detection of Severe Weather that could cause Landslides and Flooding
- To integrate accumulated daily rainfall in landslide warning
- To apply dekad NDVI data in early detection of drought

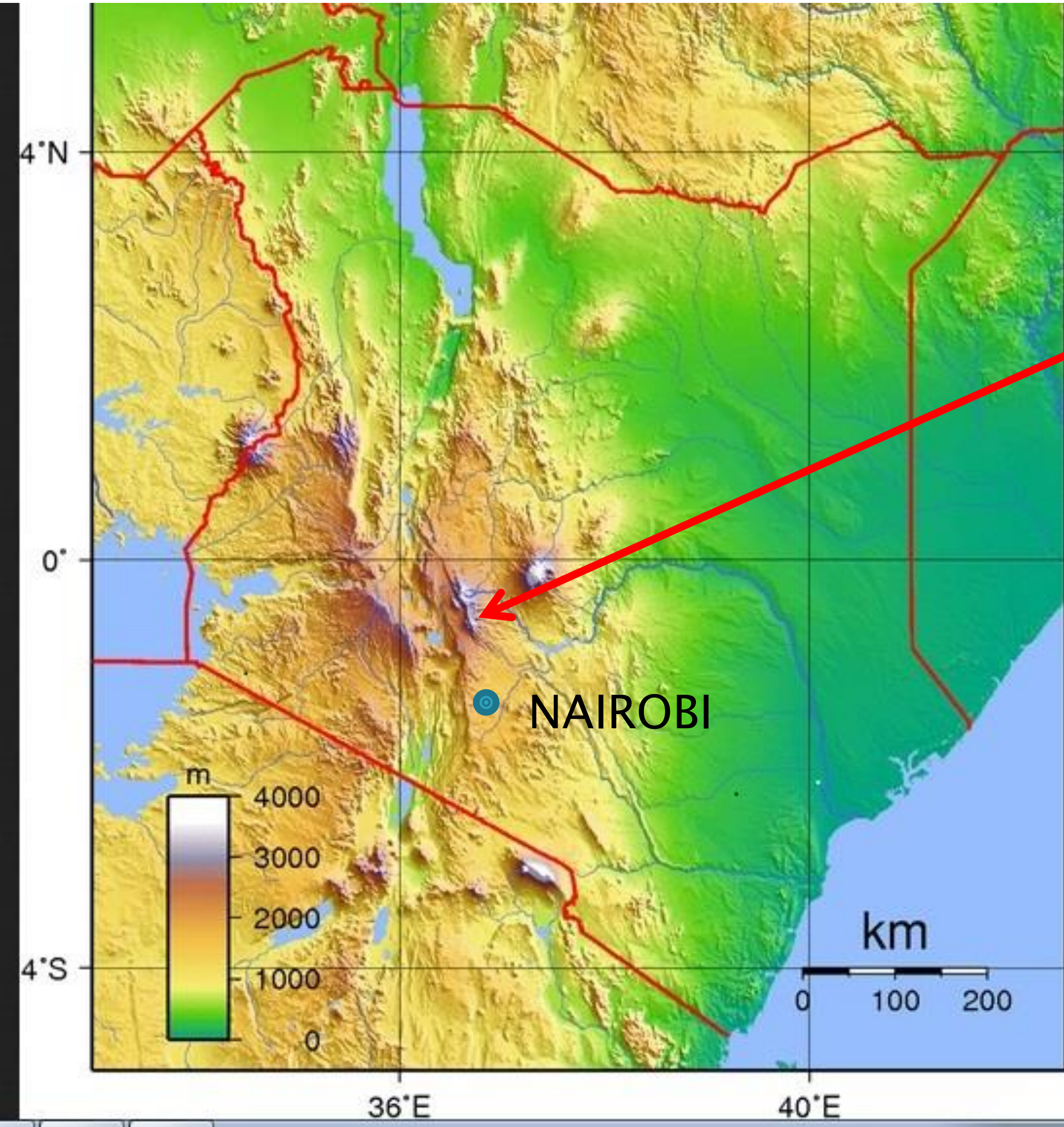
Content

- Introduction landslide, floods and Drought
- Atmospheric (thermodynamic) conditions that determine Severe Thunderstorms over tropical regions (Kenyan Highlands)
- Use of satellite data in monitoring Tropical Storms with combination with NWP products
- Use of accumulated rainfall threshold values to forecast landslides
- Use of NDVI in early drought monitoring

Introduction (landslides)

- Landslides / mudslides and flooding are a major disaster to human settlement.
- Landslides occur in the sloppy mountainous Areas that are associated with plenty of **convective** and **relief rainfall**
- Mountainous areas are favorable for human habitation since they are fertile and provide domestic water needs.
- The risks associated with landslides are great as there are no warnings in advance
- Every rainy season causes landslides at different parts of the highlands and on escarpments (RV)

Case study from Central Kenya near the Equator



Murang'a in Central Kenya

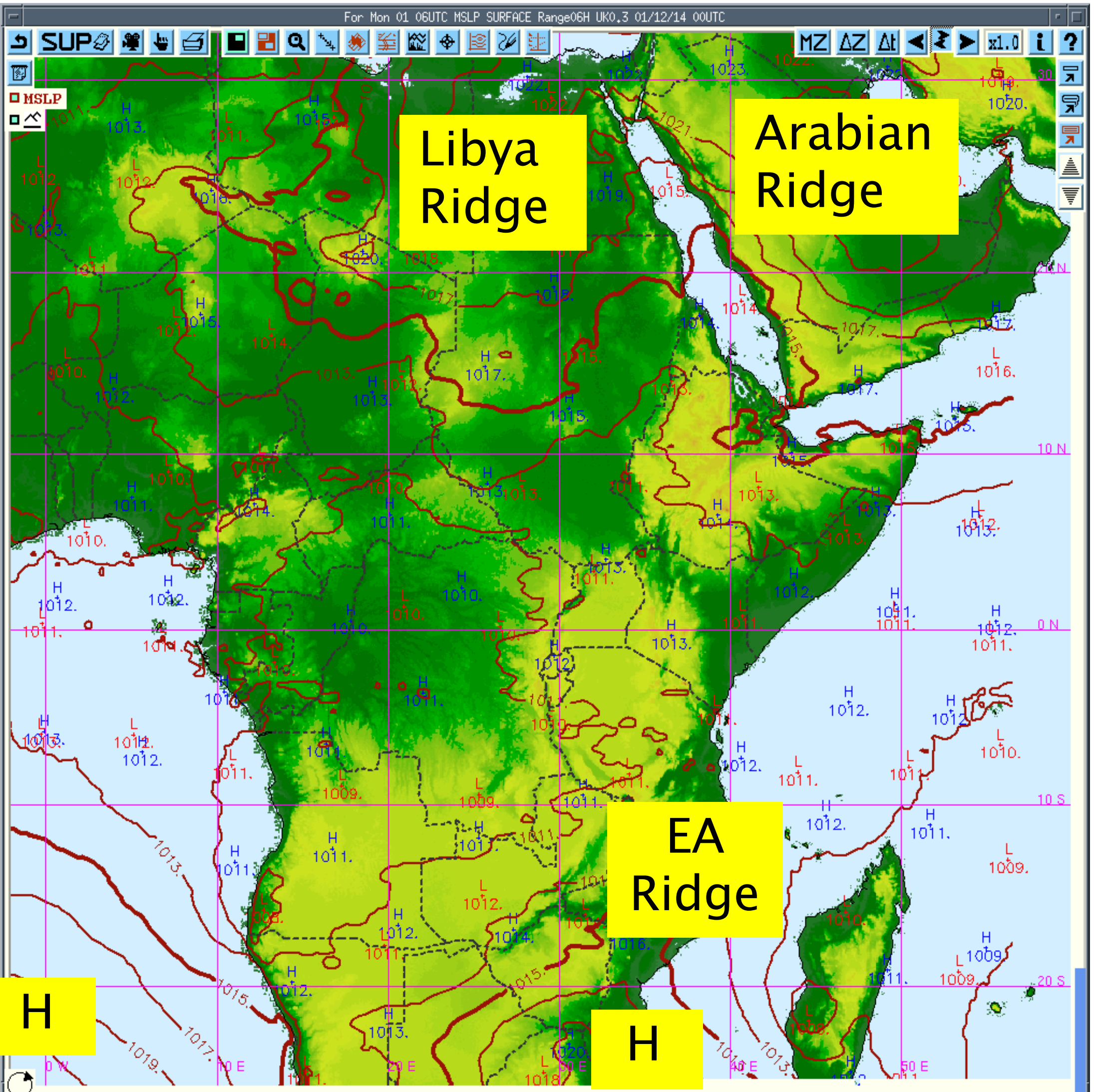
Landscape over this region

Effects of the landslide on 1/4/13

Thermodynamic conditions for Severe Thunderstorms

- The presence of an active Inter Tropical convergence zone (ITCZ)
- The Vertical Instability due to the sun radiations in the region ($T\Phi$)/satellite GII
- The presence of Easterly flow over lower levels up to 700 hPa (Deep convection) direction) and strong westerly flow at 200-300 hPa
- Strong Updrafts as supported by upper level out flows visible on (WV5-WV6>0) satellite imagery product

MSL pressure: Seasonal Identity

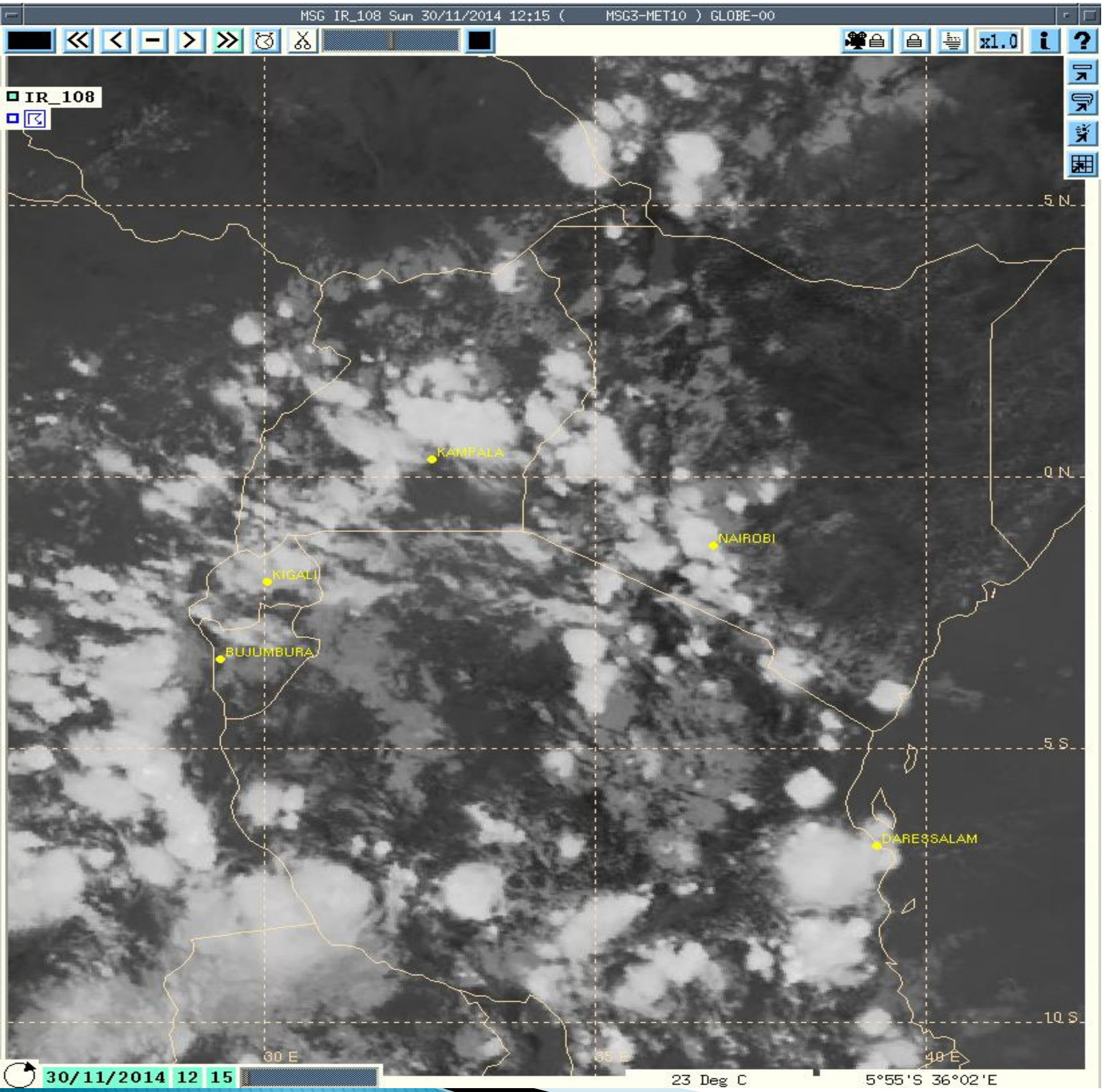


- ➢Seasonal Weather characteristics are important in forecasting heavy precipitation as the weather is dynamically controlled by the synoptic pressure patterns:
- ➢ Mascarene and St Helena highs and
- ➢the ridges (EA, Arabian, Libyan
- ➢The position & Intensity of ITCZ and
- ➢the local features (large lakes and mountains)

Use of satellite data in monitoring Tropical Storms

- Use of IR,(Brightness Temperatures < -75 º C)
- Deep convection RGB (5-6,9-4,3-1) day
- 24- hour microphysics RGB(10-9,9-4,9)
- Combination of NWP wind data with Satellite RGB products in accurate determination of areas with deep convection supported by convergence of winds
- NWP Synoptic pressure patterns (Mean Sea Level Pressure) affecting East African region (Kenya in particular)

Use of IR(10.8), BT <−75 º C)

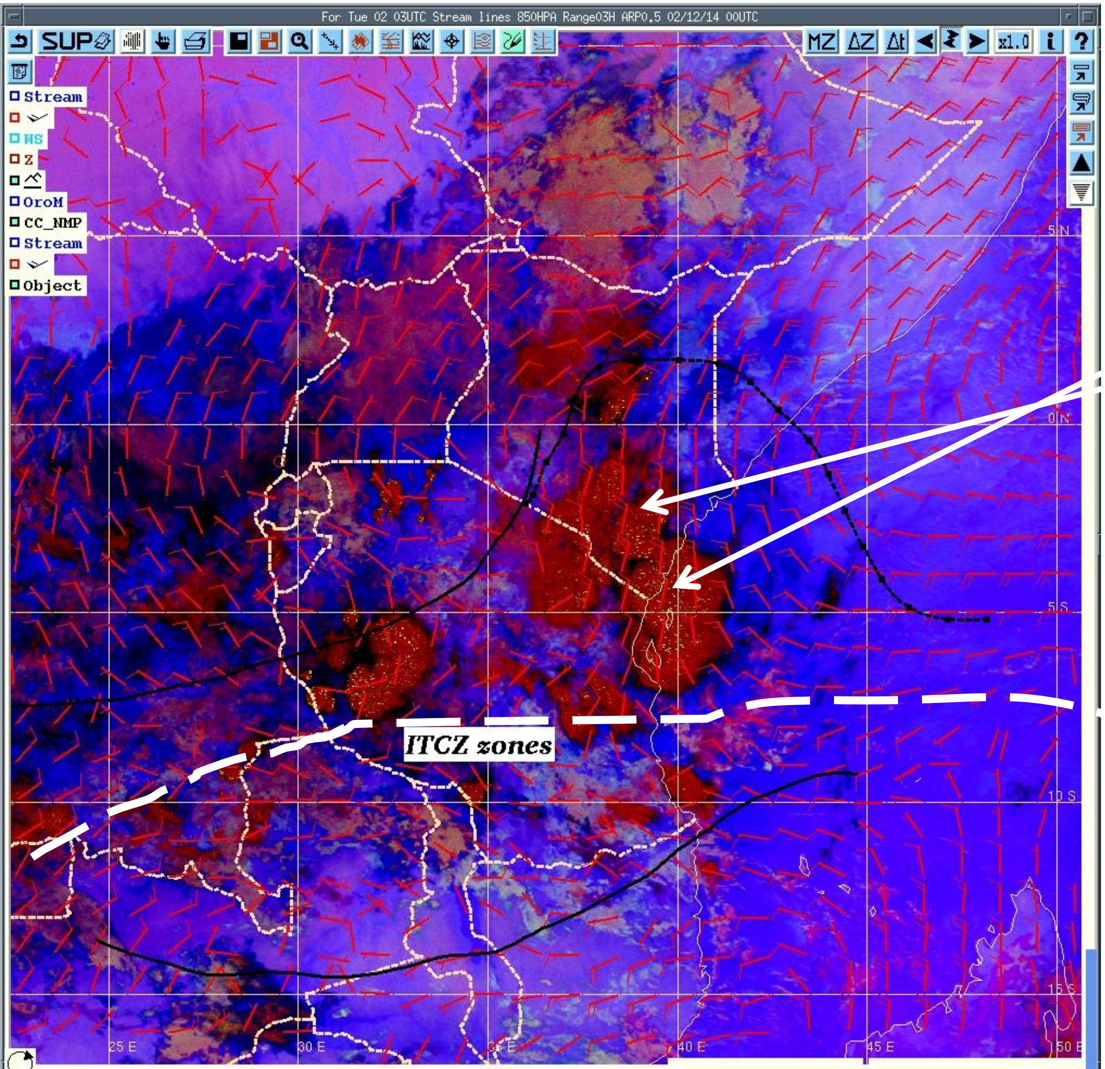


Animation for trend analysis

Areas of Deep convection are in bright white BT < −75 º C.

Observation of deep convection over a period of 5 days continuous should lead to a concern for every meteorologist in office.

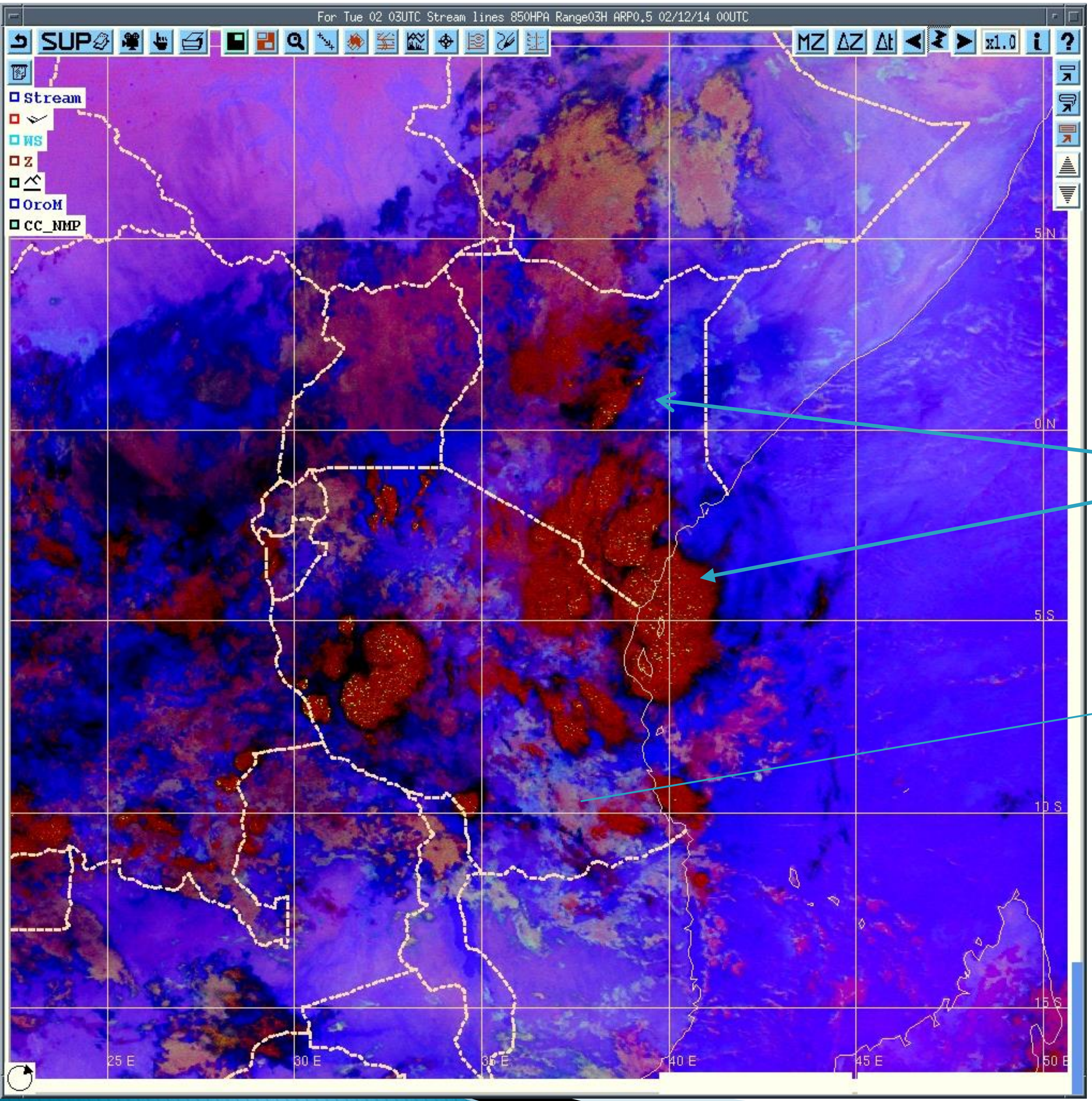
NWP wind at 850 hPa with Night convection RGB (10-9,9-4,9)



Presence of ITCZ that is associated with synoptic supply of Moisture and deep convection supports Severe weather that may lead to landslides and flooding on lower plains.

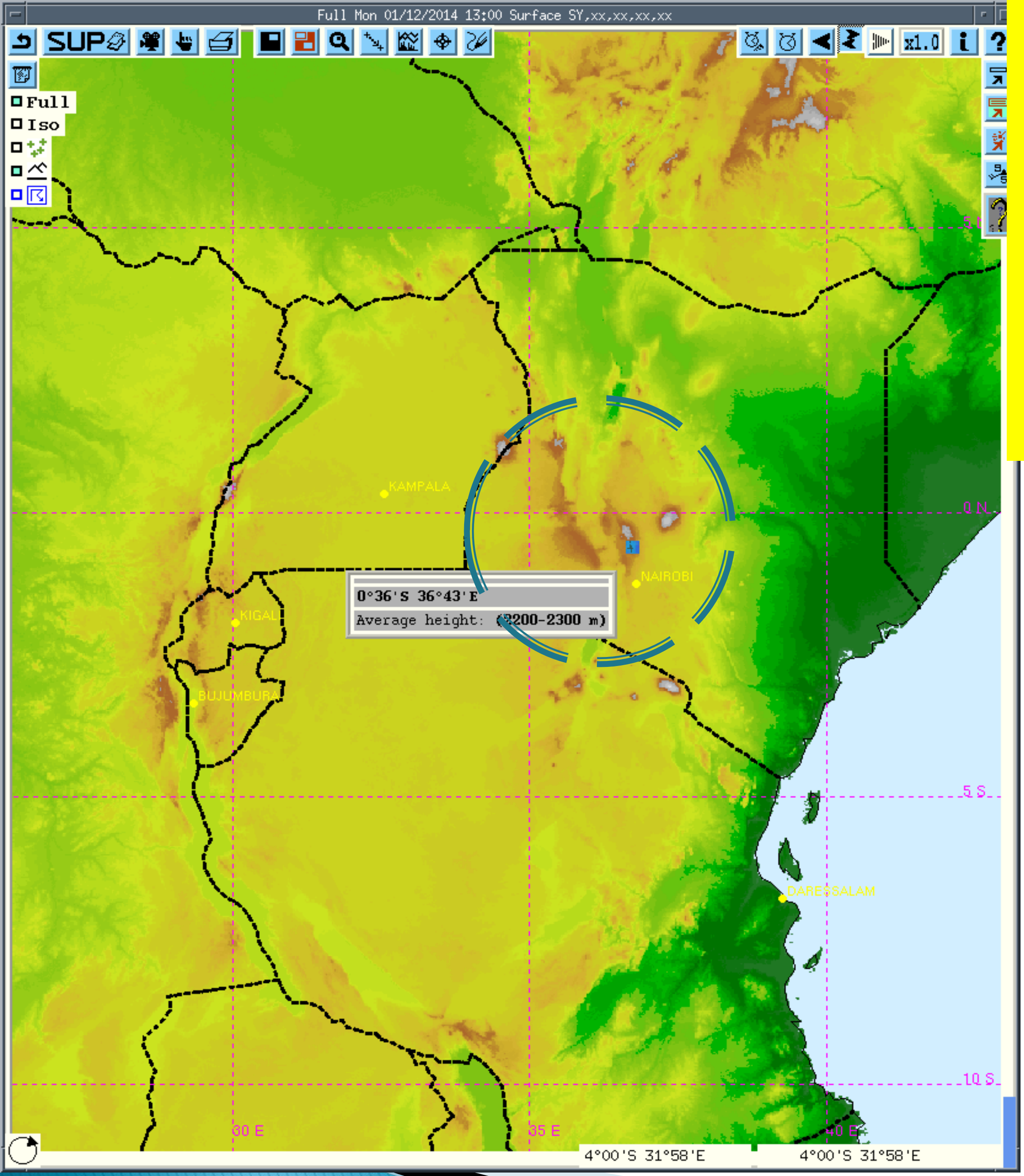
On this case heavy rainfall was received in South eastern, Mombasa and Kwale counties in the Coast regions of Kenya

Night Microphysics RGB (10-9,9-4,9)



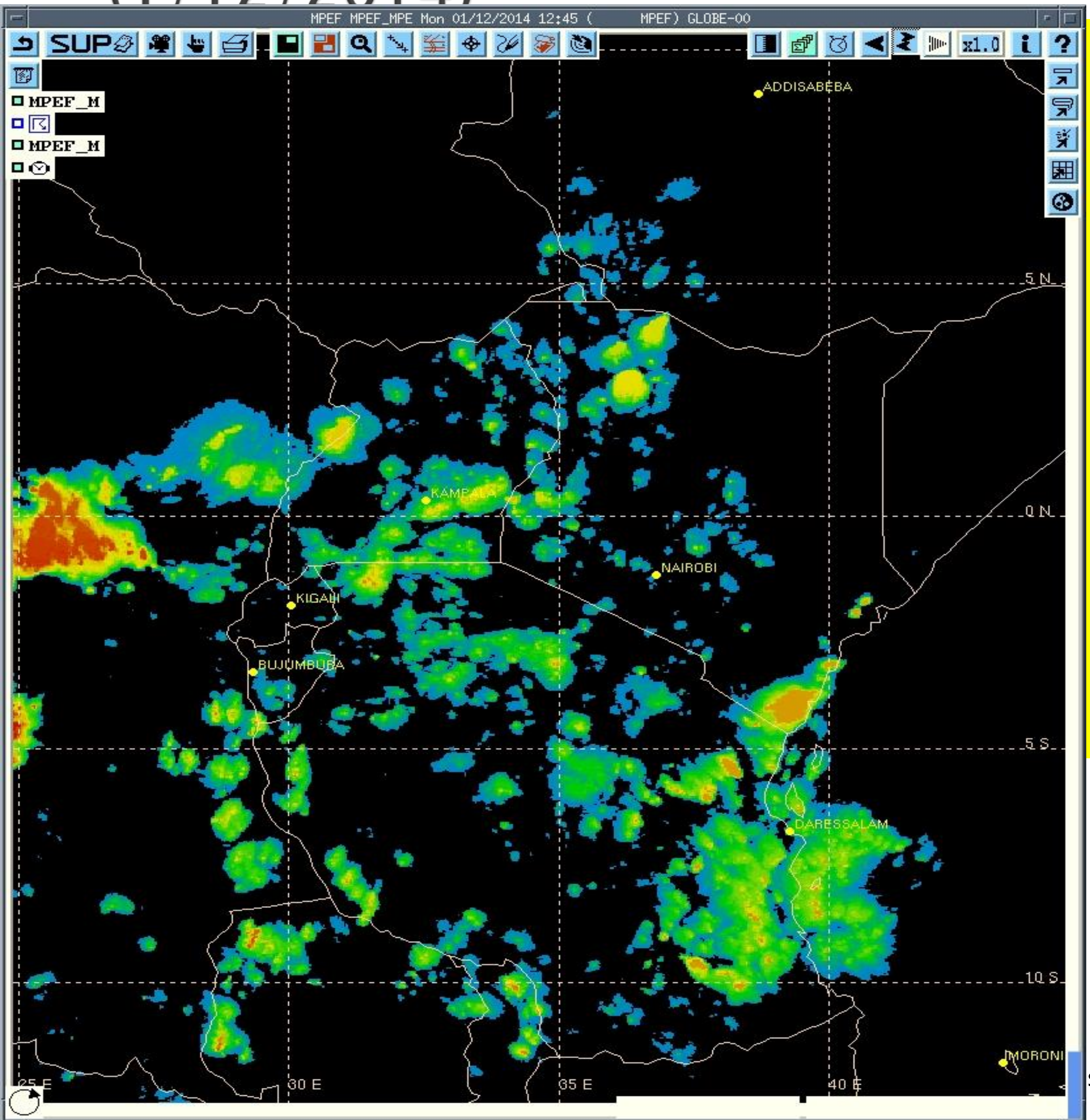
Deep convection, Heavy storms with possibility of flooding)

Water cloouds



Orographic map: areas of possible land-slides in Kenya

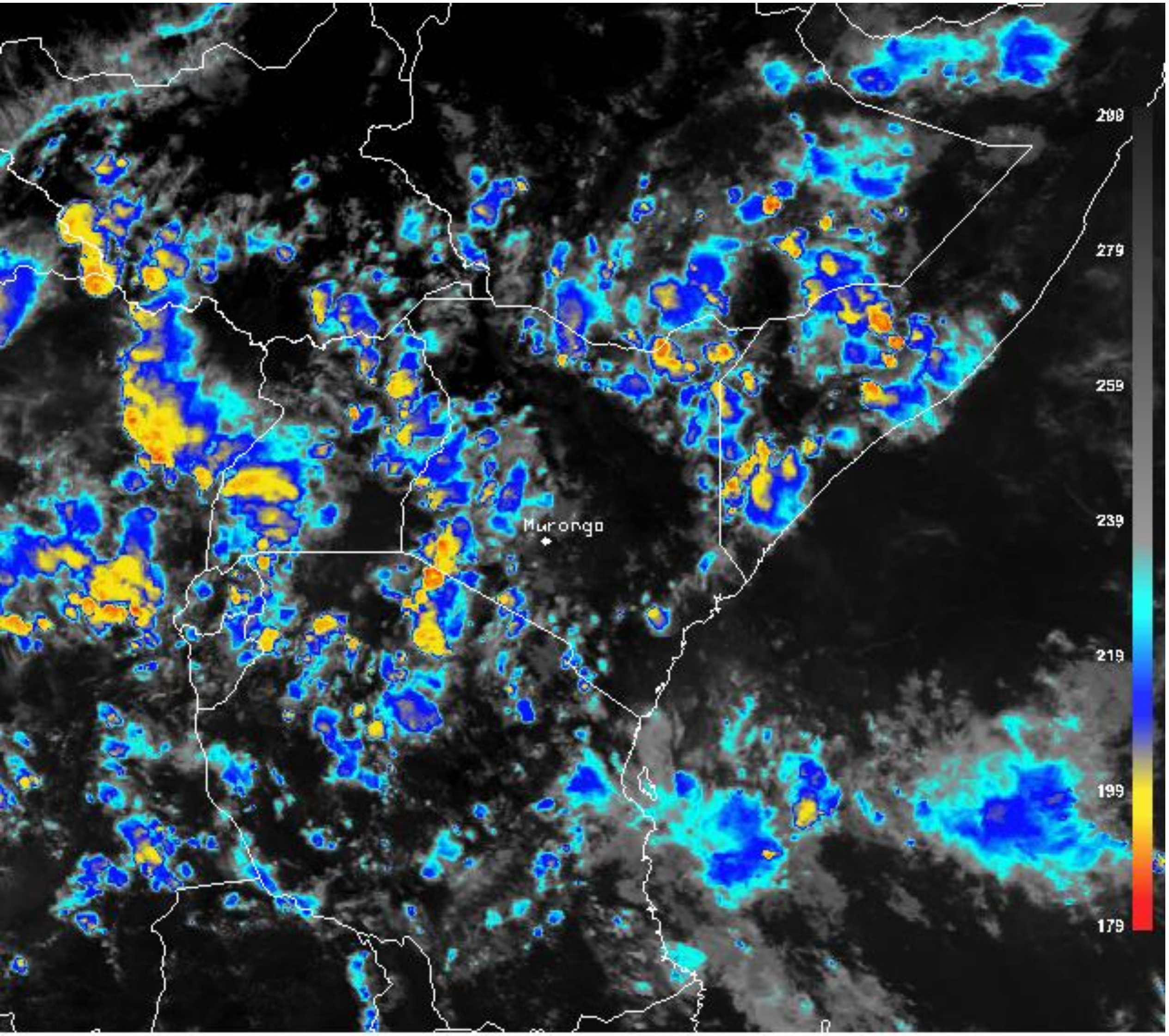
MPE rainfall estimates over 12 hrs (1/12/2014)



1. Light blue<1 mm/hr
2. Greenish yellow >12 mm/hr
3. Red >30 mm/hr
4. Max 34 mm/hr

5. Warning must be issued over areas with Red

Use of Enhanced IR(10.8)

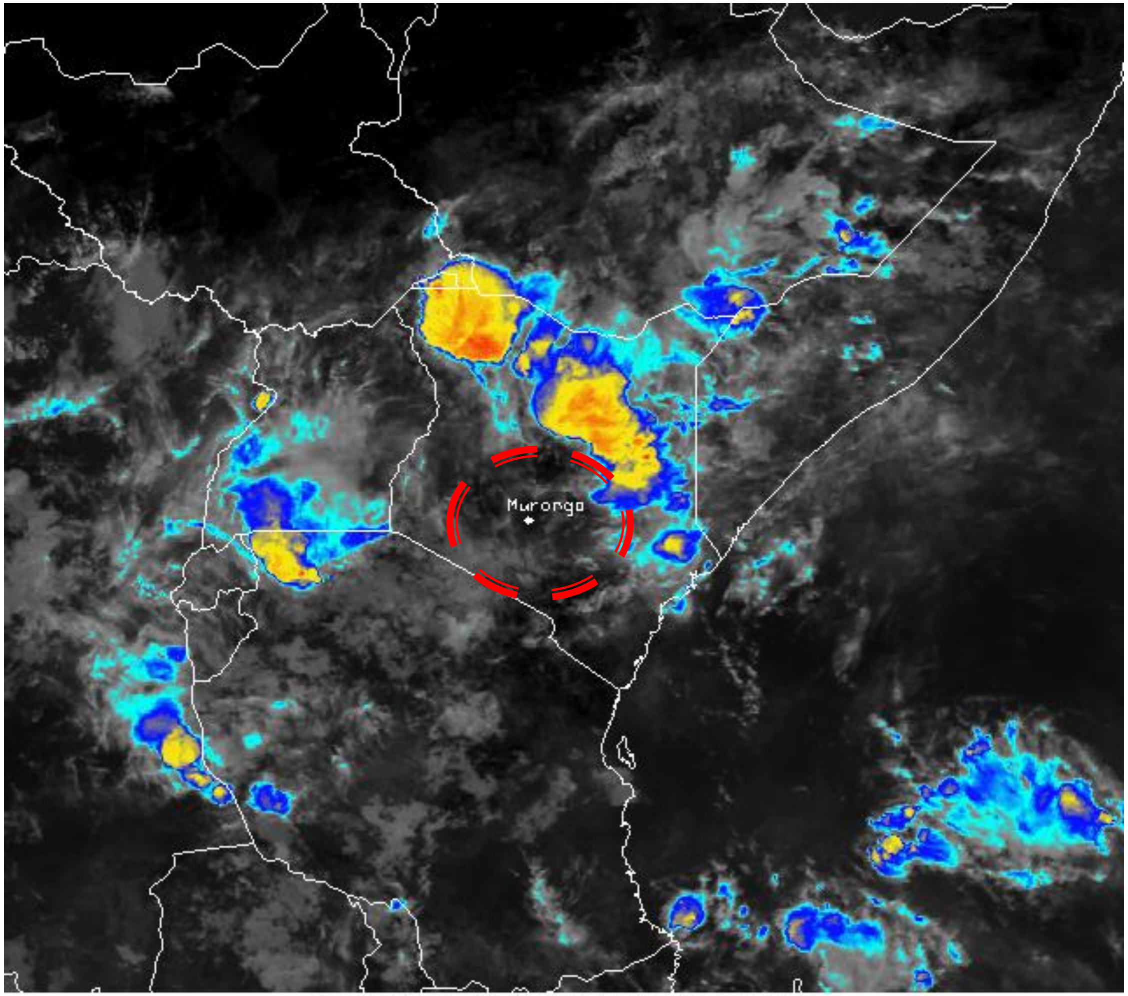


METEOSAT-10 IR 10.8 30-03-2013 14:00 UTC

Very cold clouds
-75-81° C
are associated with very deep convection over tropical regions.
12 Km above mean sea level.

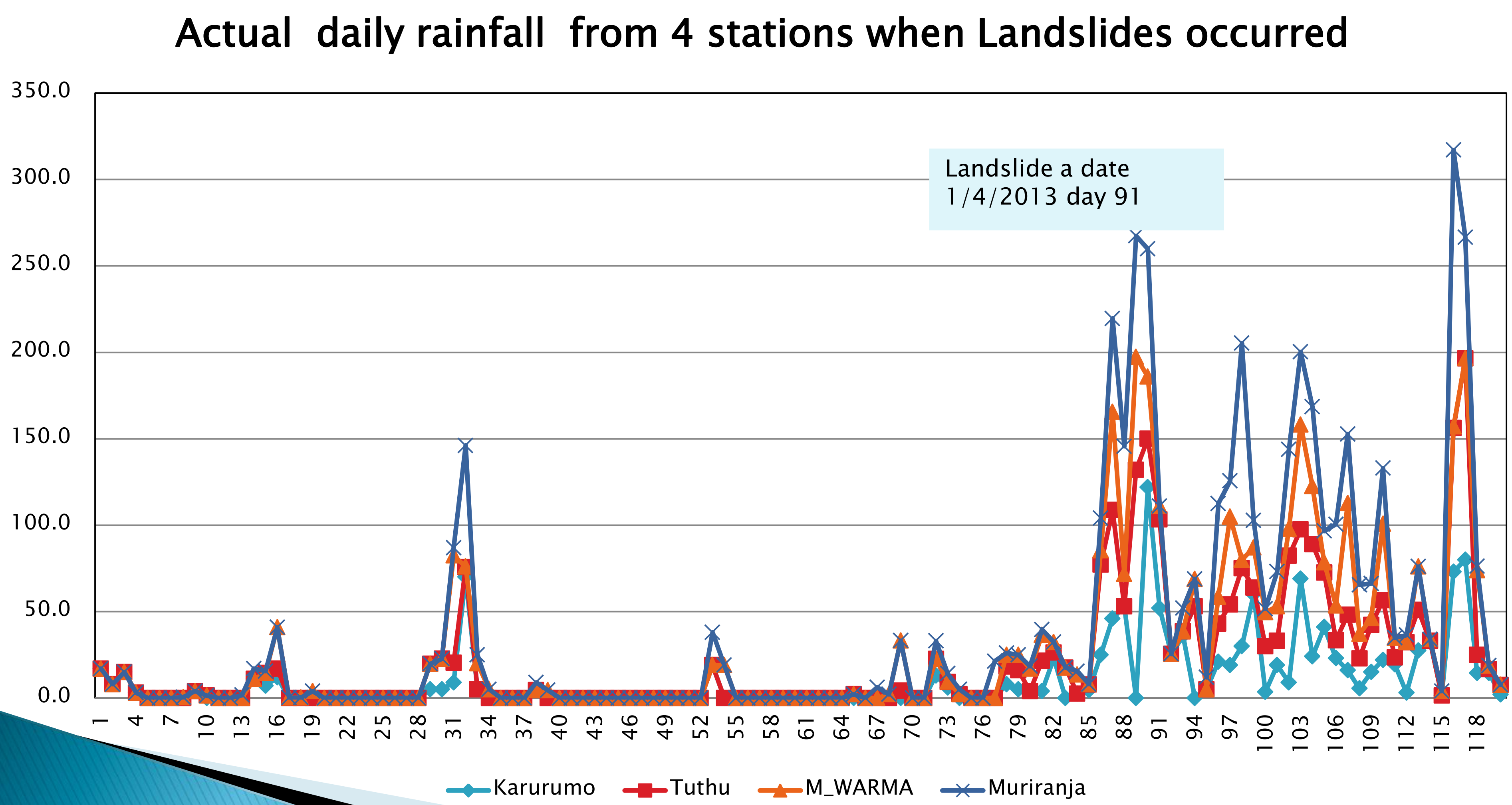
FIVE days of heavy rains: **Animation** from 27/3 -1/4/2013

On 1/4/13 landslide occurred in the Red circle

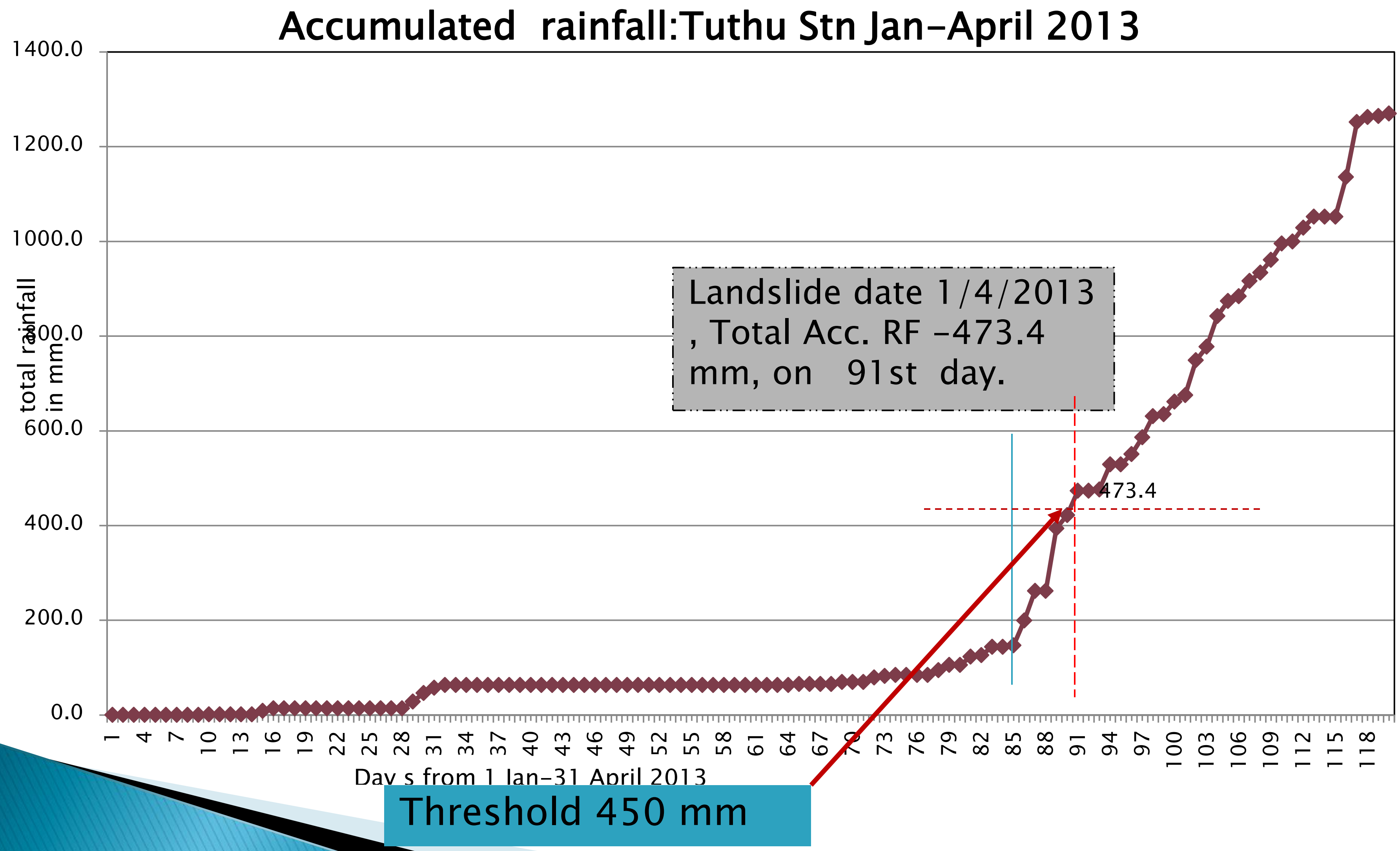


METEOSAT-10 IR 10.8 28-03-2013 07:30 UTC

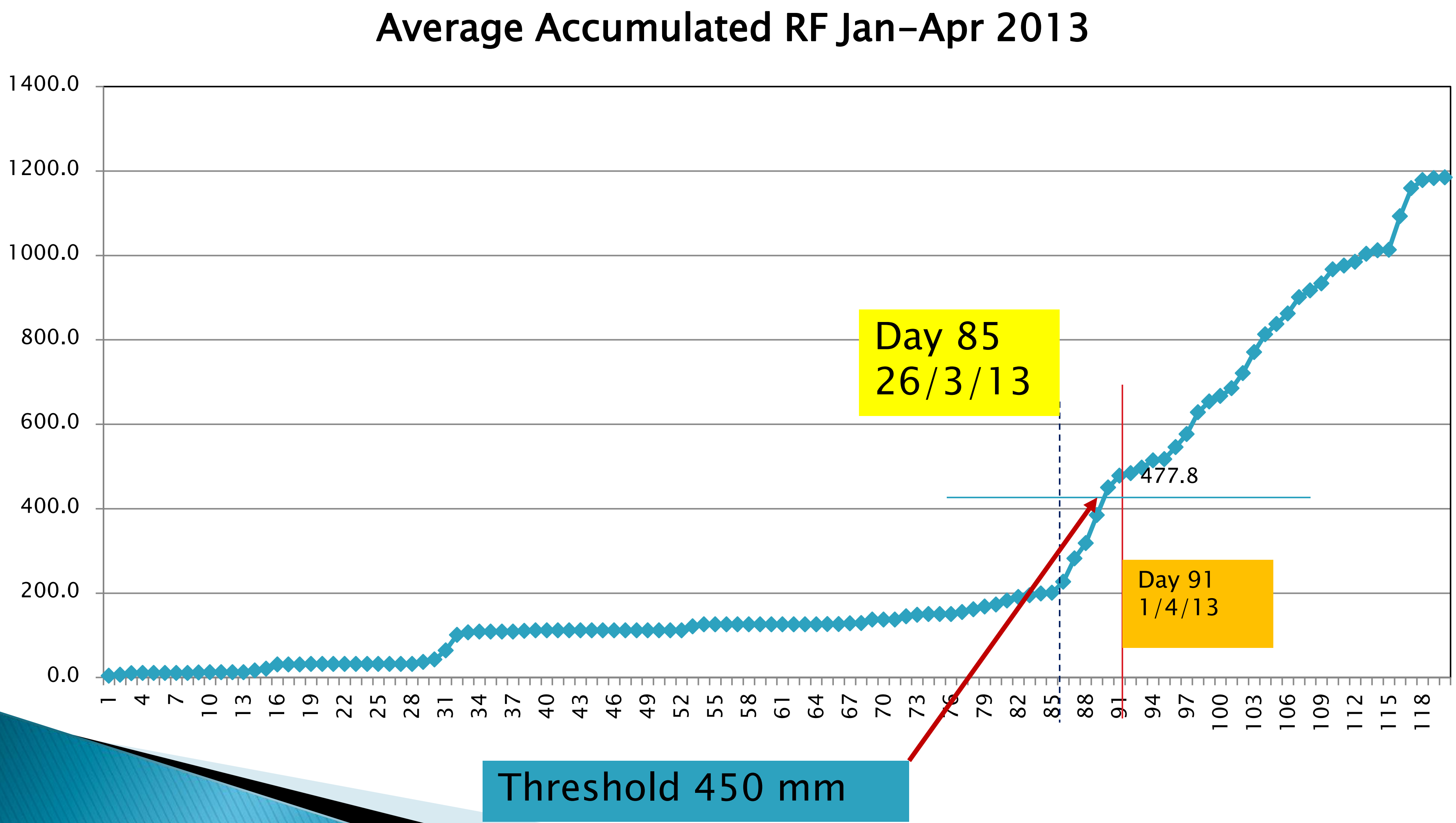
Use of accumulated rainfall toestablish threshold values to forecast landslides



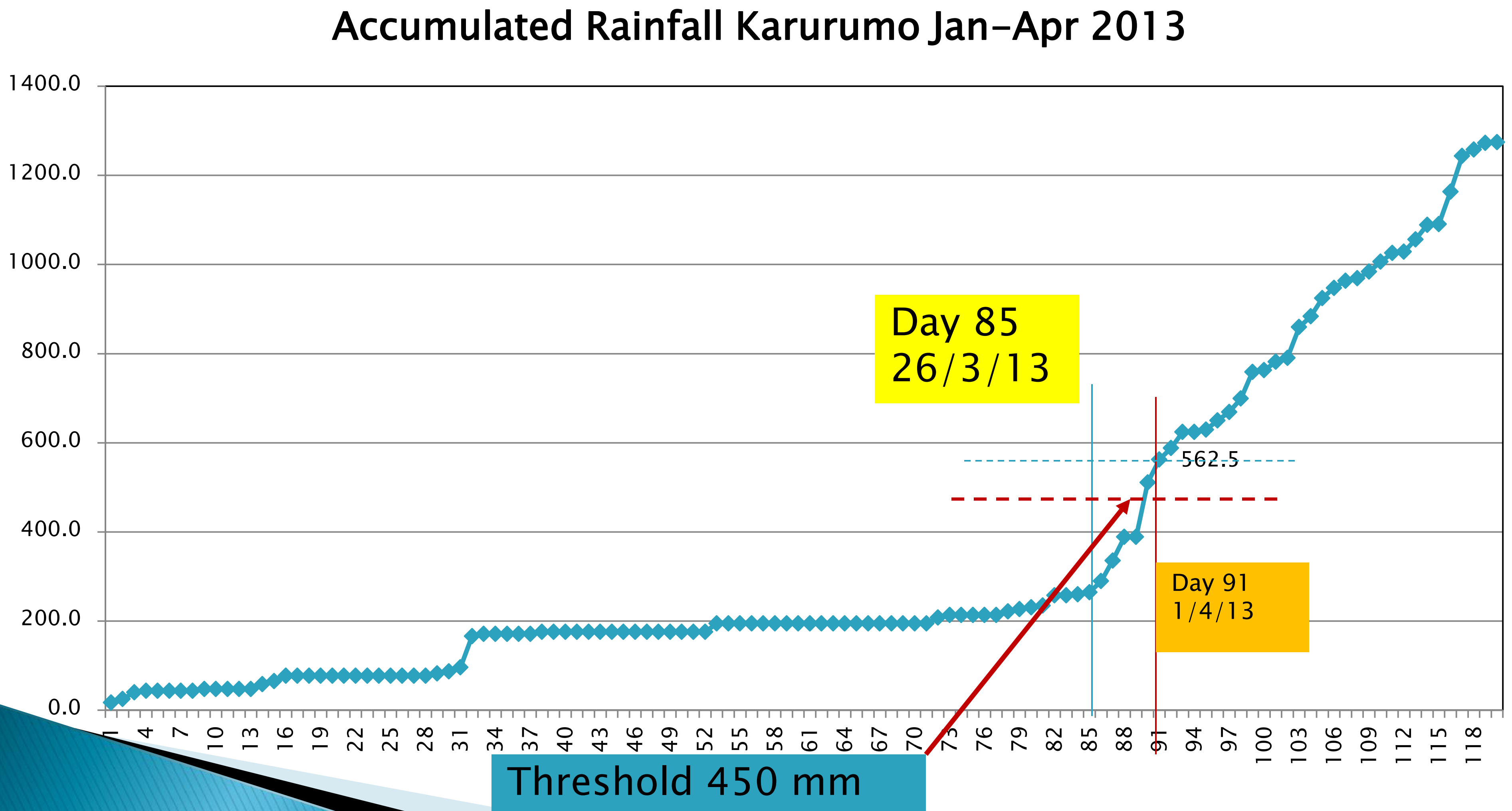
Observed rainfall (raingauge)



Average for the 4 stations from same zone



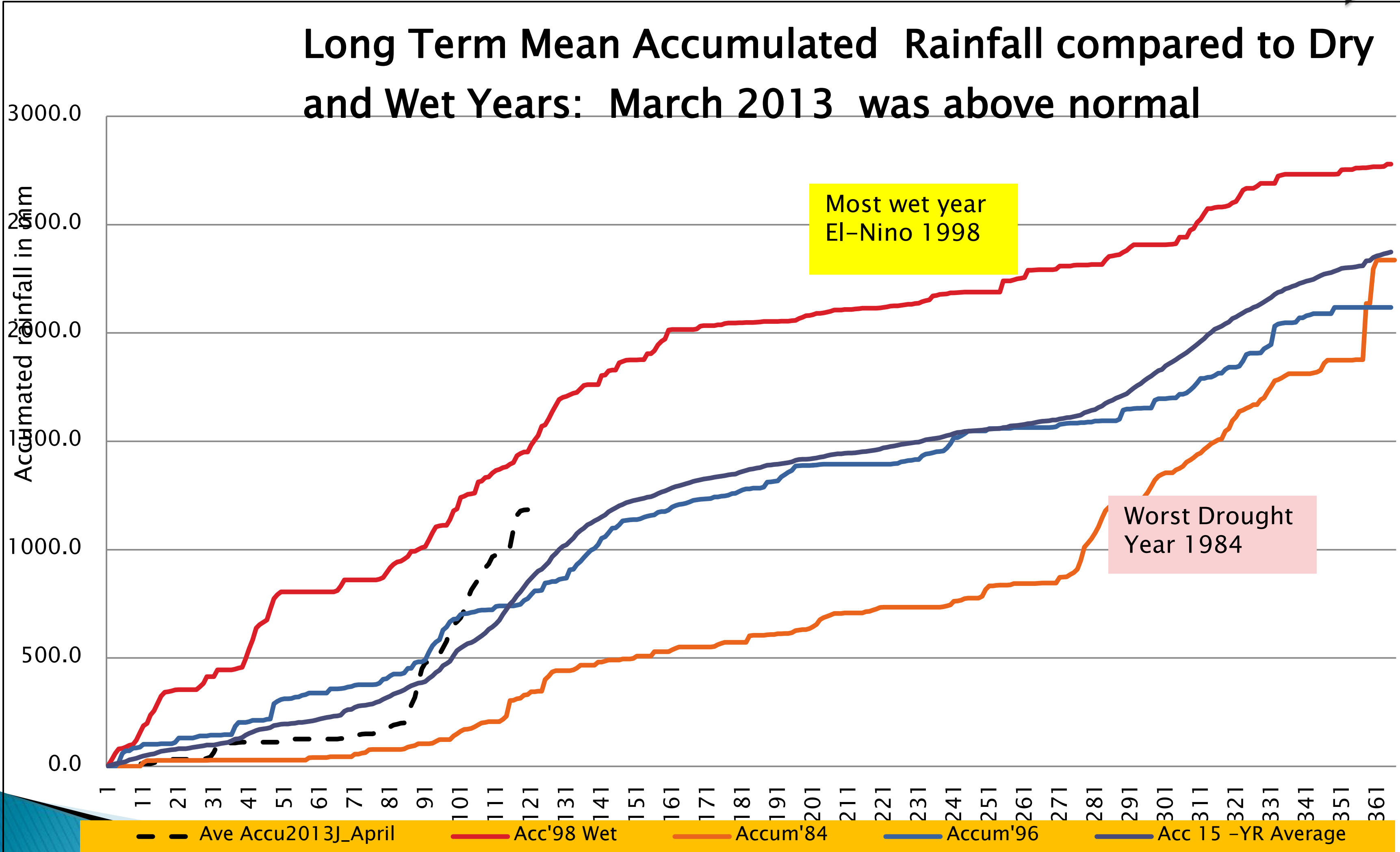
Karurumo STN



Estimated 15-Years mean Accum. Rainfall: Gatare station

- The 15-Years accumulated mean rainfall for Gatare Station from same zone of landslides has given the climatology of rainfall distribution from 1984 to 2008, (*only years with complete data were used)*
- Results:
  - Show that year 1998 was most wet as an El Nino year,
  - 1984 as the driest year (very extreme drought that caused death to many families in the NW and NE regions of Kenya)
  - 2013 began as **a below normal** but the long rains season was **enhanced over Central Kenya**.

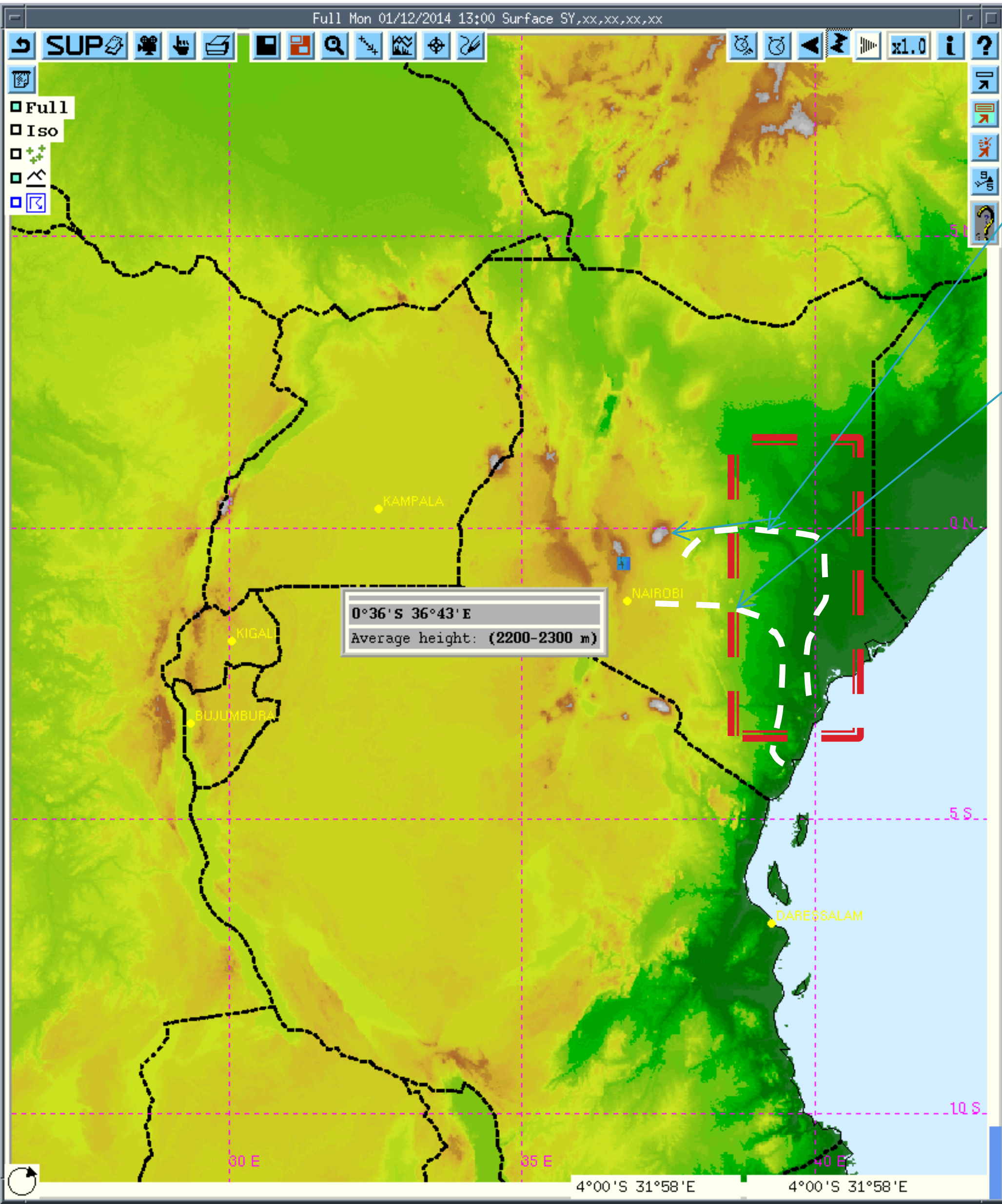
Climatological rainfall (15 years Accumulated mean Gatare Station)



Introduction (Floods)

- Floods occurs on lower plains of the (Rivers Tana, Athi River Plains) causing great disaster to pastoralist lands who live in theses Arid and semi arid zones
- Heavy rains on the Central Kenya highlands cause flooding downstream destroying home shelters, bridges and roads on the Athi River and Tana River Plains.
- The risks associated with floods is great as many families live and cultivate along in the river valleys

Flood Plains in Kenya



- Tana and Athi River plains suffer from floods in rainy seasons as they are low lands.
- Monitoring on heavy storms over the Central highlands provides information on possibility of flooding over the lowlands

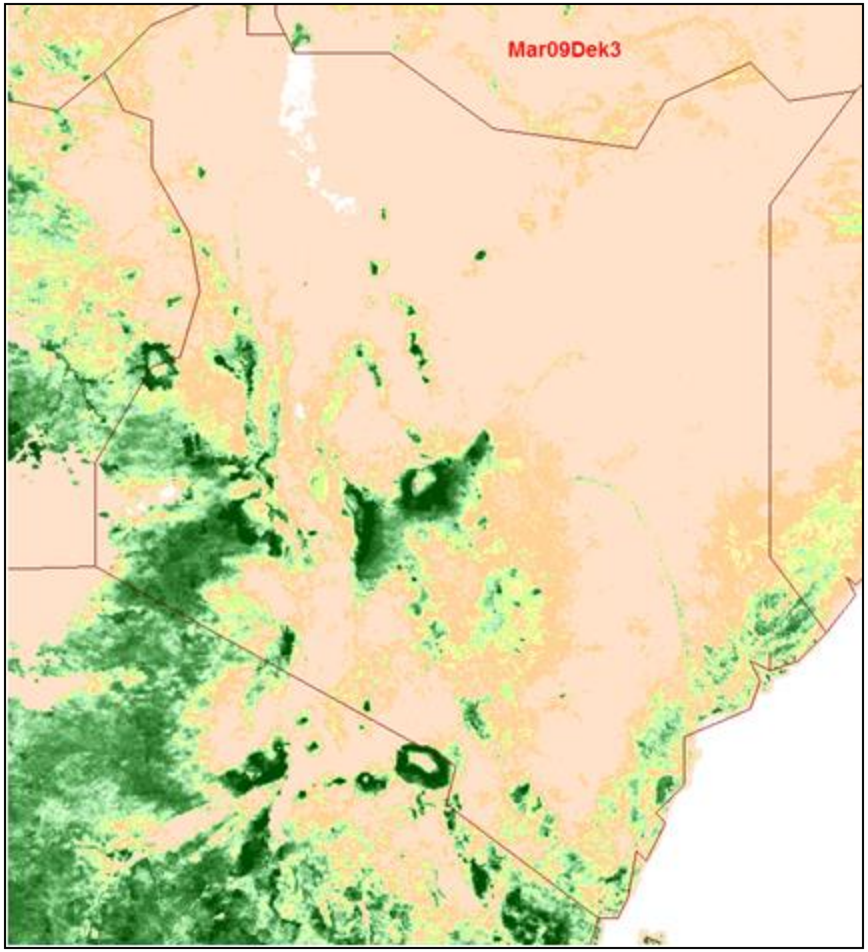
Introduction: Droughts

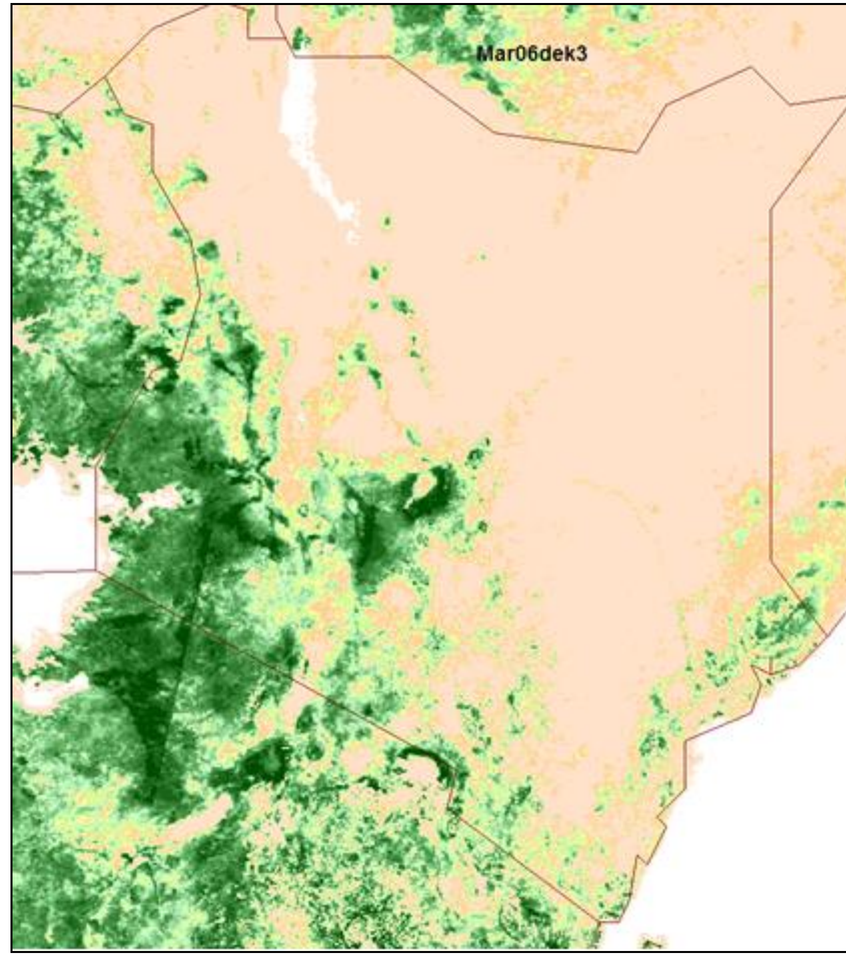
- The three types of droughts (meteorological, agricultural and Hydrological) are climatological in nature that occur at different areas.
- Early detection of Meteorological drought is monitored through vegetation indices that indicate deficiency on rainfall
- Arid and semi arid regions within East Africa are most affected (SAHEL Region in Africa)
- The risks associated with drought are common in NW and NE Kenya, death to animals and human conflict due scarce fodder for animals.

Use of NDVI in early drought monitoring

- Comparison between dekads provides information that on interpretation you are able to distinguish the wet and dry regions and you are able to get the anomalies between long term mean and the current dekad.
- This information is obtained on every ten days from VITO on EUMETcast data stream or from The online VEGETATION Website by Vito.

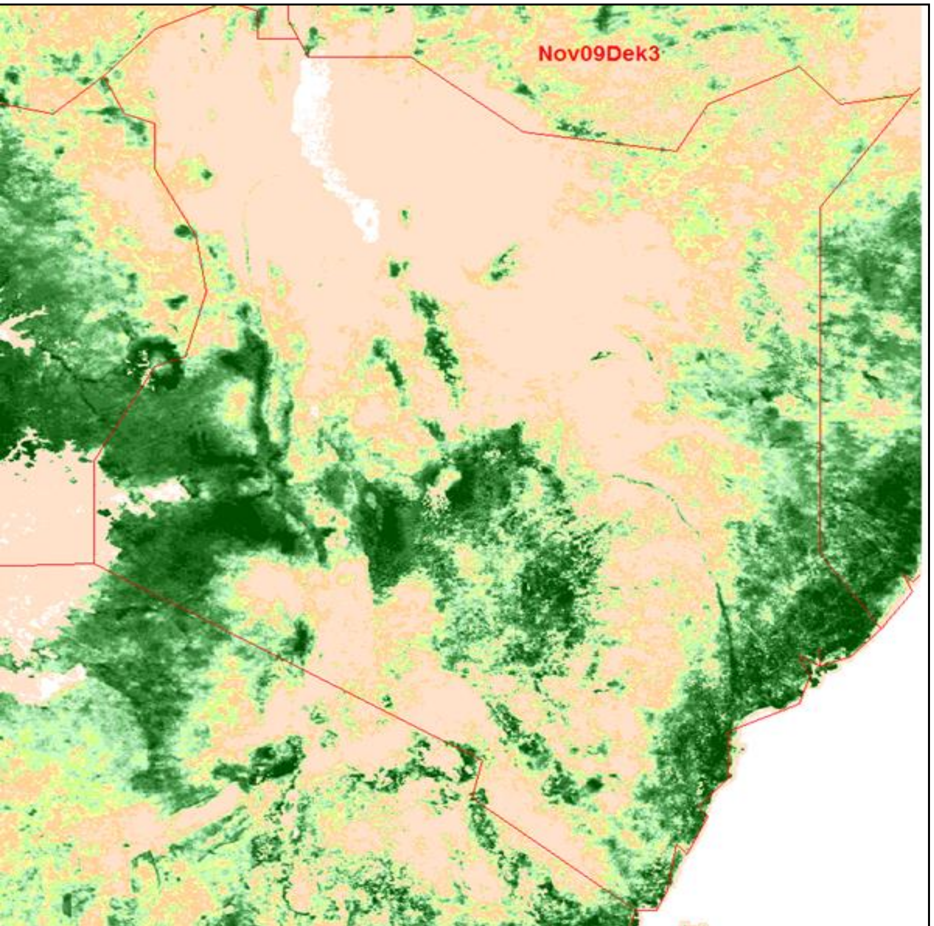
March 2009 Dekad3 & Dekad3 2006: As early as March year was bad

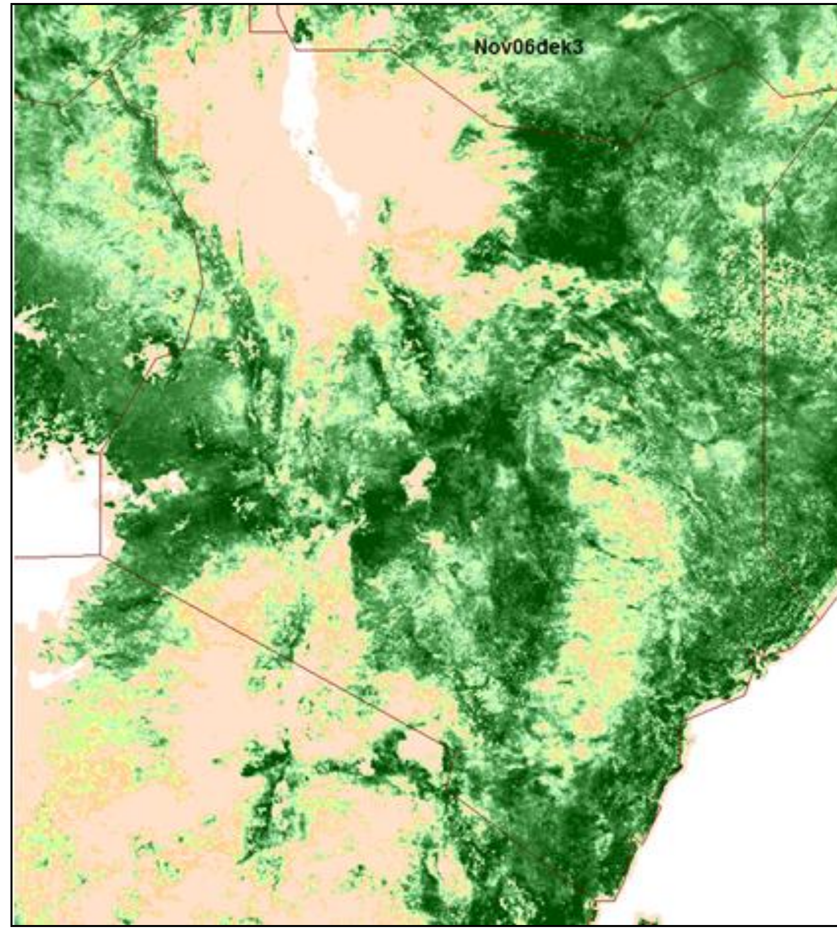




Dekad 3 in 2009 0ver central Kenya was drier than same dekad in 2006. However year 2009 was generally dry than 2006 that was a normal year.

Dekad 33 :Nov 2009 (drought)) Nov 2006 (wet)





conclusion

- Satellite data has the solution on floods, landslides and droughts
- Within 5 to 6 days before a landslide, by Monitoring of both satellite data for deep convection and Accumulated rainfall threshold values it is possible to provide an accurate forecast for the event
- Early drought detection should be a continous process and warnings should be given at least 3 months before it strikes.