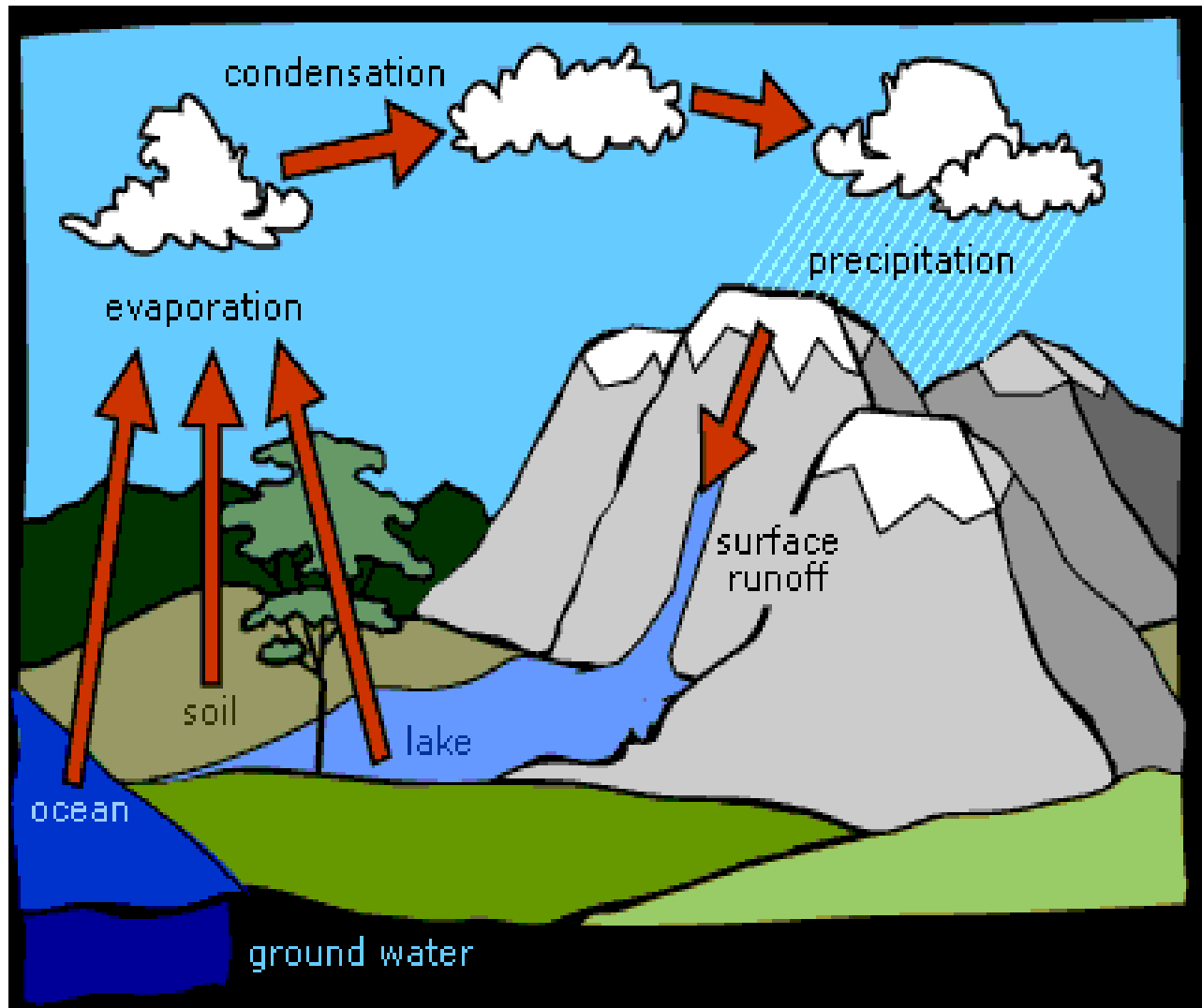


# National Meteorological Agency



Hydro Meteorological Bulletin for Belg, 2014

## Foreword

This seasonal Hydro meteorological Bulletin is prepared and disseminated by the National Meteorological Agency (NMA) of Ethiopia, for the purpose of providing hydro meteorological information to different sectors of the community involved in water related activities.

In general, Hydrometeorology is concerned with the study of the atmosphere and land phases of the hydrologic cycle, particularly, on the interrelationships involved. In this bulletin, more emphasis is given to presenting the results of analyses done on the extreme rainfall events as well as the moisture status prevailed over river catchments.

Accordingly, the data used in producing this bulletin are collected from selected indicative meteorological stations, which are believed to represent each of the main river catchments (hydrological regimes) of the country and the results of the hydro meteorological analyses are presented in maps format. Analysis presented in the forms of maps indicates comparisons of the total and extreme monthly rainfall events, monthly mean temperature and aridity index conditions for each basin.

Thus, the information contained in this bulletin is believed to be helpful in monitoring the performances of many hydraulic structures such as culverts, bridges, reservoir spillways, road embankments, dikes, flood prone areas as well as in planning and designing such new structures over the respective basins. It also gives the user an insight into the value as well as the contributions of the hydro-meteorological information towards the accomplishment of water resources assessment and management with respect to sustainable development of the country. Meanwhile, your comments and constructive suggestions are highly appreciated to make the objectives of this bulletin a success.

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## I. Introduction

Ethiopia is located between latitudes of 3.8°N to 15°N and longitudes of 33°E to 48°E with an area of about 1.12 million km<sup>2</sup>. The varied topography of the country shows extreme changes in altitude with its lowest point at about 120 meters below sea level (Kobab Sink Afar depression) and its highest point about 4620 meters above sea level (Ras Dashen.). These physiographic variations create a large difference in meteorological and hydrological conditions both by time and space.

*From meteorological point of view, there are three seasons in Ethiopia; Belg, Kiremt and Bega.*

***Belg (February-May) is the small rainy season in Ethiopia. Much of the northeastern, central, southern, southwestern, eastern and southeastern parts of the country receive considerable amount of rainfall during this season.***

***Kiremt (June-September) is the main rainfall season for most parts of the country except for the lowlands of southern and southeastern Ethiopia.***

***Bega (October-January) is mostly a dry season for most parts of the country except for southwestern as well as the lowlands of south and southeast Ethiopia.***

In general the mean annual rainfall amount ranges from 2400mm (over south western) to 500 and below over the northeastern and southeastern lowlands. Hydro meteorologically a rainy day is considered as the one with 2.5 mm of rain or more but in this publication a rainy day is one regardless of the amount.

In Ethiopia, water resources availability in terms of space shows a marked discrepancy when one goes from east to west. The eastern part of the region comprises 7 catchments with only 11 percent of the water resource and while the west comprises 5 catchments with 89 percent of water resources.

## II. Catchments profile

### Catchment

### Location

Mereb – Gash Catchment: -

Northwestern tip of Tigray.

Atbara-Tekeze Catchment: -

The Tekeze River basin is situated in the northwest of Ethiopia between  $11^{\circ}40'$  and  $15^{\circ}12'$  N, and  $36^{\circ}30'$  and  $39^{\circ}50'$  E. It is bordered by the Mereb River basin and by Eritrea in the north, the Atbara River plains in Sudan in the west, the Abay River basin in the south and Danakil basin in the east.

Blue Nile/ Abbay Catchment: -

Roughly  $13^{\circ}$  N South of Gondar to  $11^{\circ}30'$  N, and west of  $39^{\circ}45'$  E of Wollo, northwestern parts of Shoa; Gojam except the South Western and Western narrow area, Wellega and extreme Eastern tip of Illubabor together with a narrow northeastern strip of Keffa. It is the largest catchment that covers about 16 percent of the total area of Ethiopia. The Catchment that includes the Lake Tana, Upper Abbay (to Guder confluence), Middle Abbay (to didessa confluence), Didessa, Dabus, Lower Abbay, Dinder and Rahad Sub-basin.

Baro –Akobo Catchment: -

The south western and western narrow strip of wellega, except the eastern tip, the whole of Illubabor and southwestern tip of Keffa. The Catchment has upper and lower sub-basins along Baro River. The Catchment It is the wettest catchment because of the highest rainfall over the area.

Danakil – Afar Catchment: -

East of  $40^{\circ}$  E of Tigray, North of  $11^{\circ}$  N of Wollo, narrow coastal strip south of  $14^{\circ}30'$  N of Eritrea. The basin is the lowest region in the country where the kobar sink, with an elevation of about 120 meters b.s.l is found.

Awash Catchment: -

North of Garamuleta mountains, south of  $11^{\circ}40'$  N of Wollo, south of  $9^{\circ}$  N of Shoa, Northern tip of Bale and North part of Arsi. The catchment has upper, middle and lower sub-catchments. In general the catchment is narrow at the upper part marked by numerous volcanic mountains and wider at the lower part joining major tributaries from

northwestern highlands and a number of seasonal wadies from the southeast highlands.

Gulf of Aden – Aysha Catchment): - Eastern narrow strip of Hararghe. It is a very dry area with no stream flow representative meteorological station. Thus, no assessment is done for this catchment in this publication.

Omo-Ghibe Catchment: -

Southwestern narrow strip of Shoa, the whole of Keffa except the southwestern tip, southwestern tip of Wellega, Western half of northern Omo and northwestern tip of Sidamo. The upper part of the catchment starts from the plateaus in north part of Ghibe and extends southward to the lower part of it (known as Omo River).

Central Lakes-Rift Valley Catchment: -

The whole of North and South Omo, west and southwestern narrow strip of Sidamo, southwestern portions of Shoa and western narrow tip of Bale and western part of Arsi. The catchment is found in the Great Rift Valley system and typically known by its lakes and streams. Lakes which adjoin the awash catchment are found in its upper part, while Lake Awassa and Bilate in its central part and end to chamo bahr in its lower part.

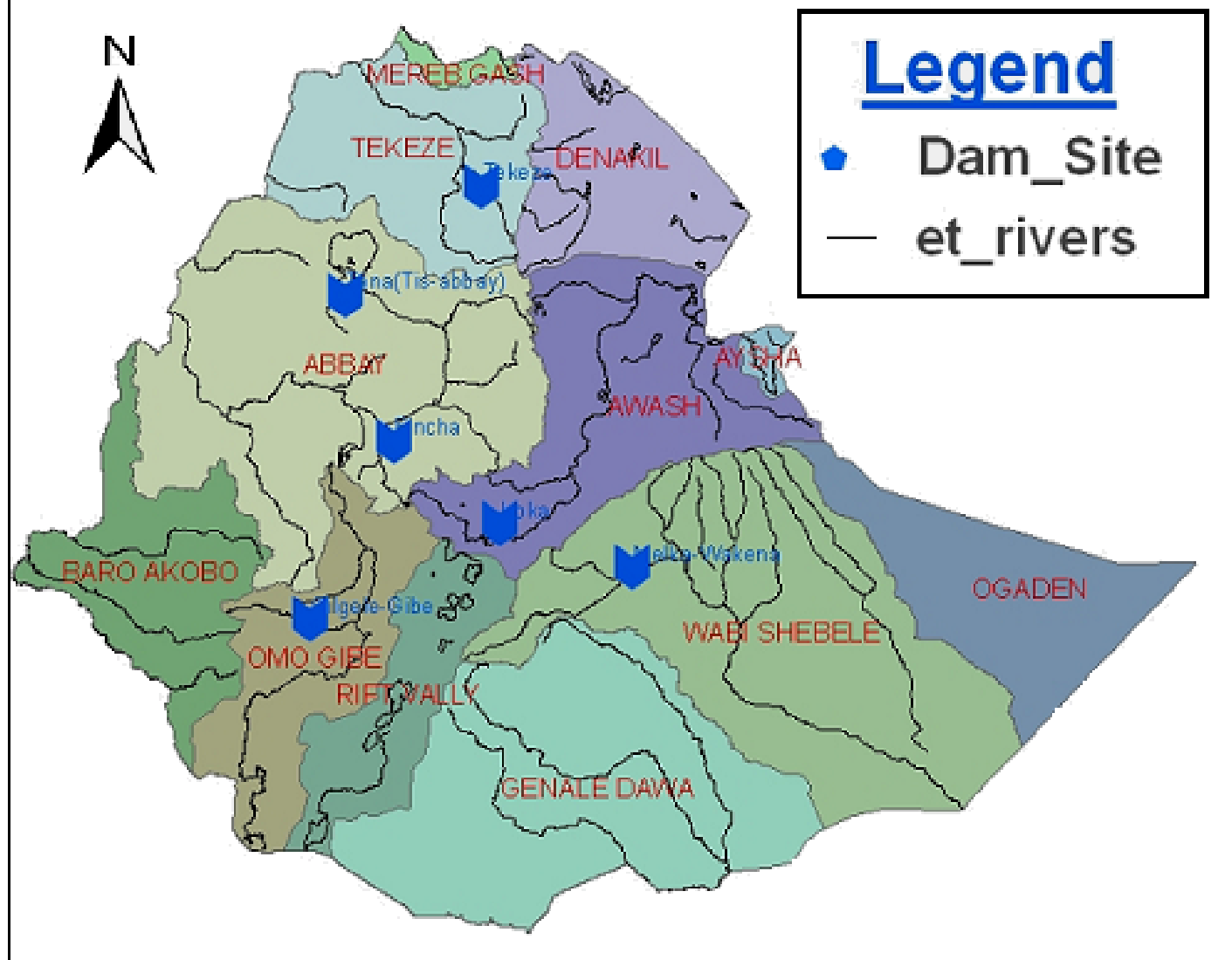
Genale Dawa Catchment: -

The western half of Bale (South of Goba) and southeast, southwestern and northeastern parts of Sidamo. The catchment constitute three river systems namely Dawa ,Genalle and Wabi gestaro that meet each other before they cross the Ethio-Somalia border.

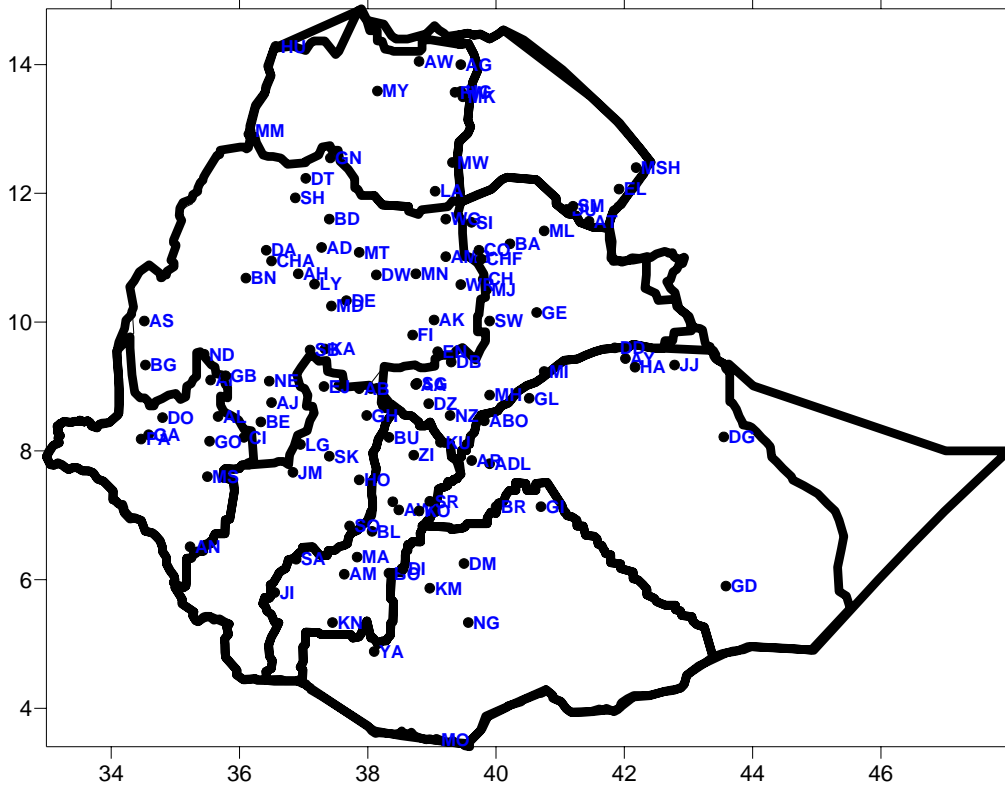
### III. Major River Catchments in Ethiopia, Location and Spatial Status

No.	Catchement Name	Area (km <sup>2</sup> )	Length in Kilo meter			Volume of water bm <sup>3</sup> /An num	Altitude (meter)
			Within Eth.	Outside Eth.	Total		Peaks (Highest & Lowest)
01	Mereb-Gash	5,700	440	160	600	0.15	North tip of Tigray
02	Tekaze – Atbar	90,001	608	560	1168	8.13	4620 Ras Dashen 125 Tikil -Dengay
03	Blue Nile(Abbay)	204,100	800	650	1450	52.62	4231 Guna 200 Horekelife
04	Baro - Akobo	75,912	227	280	557	23.55	3700 Masha 410 Jikawo
05	Afar (Denakil)	62,882	-	-	-	0.86	
06	Awash	112,696	1200	-	1200	4.6	4000 N.Shewa 4001 NW mt. 4002 of A.A 250 L.Abe
07	Aysha	2223				0.86	
08	Omo-Ghibe	78,213	760	-	760	17.96	4203Guge/Gurage Mt. 195 Chiri
09	Rift valley	54,900	-	-	-	5.63	
10	Genale - Dawa	171,042	480	570	1050	5.88	4310 Bale mt./Batu 500 Dolo Odo
11	Wabi - Shebele	205,697	1340	660	2000	3.16	3626 Mt.Gololcha 200 Somalia Desert
12	Ogaden	77,121	-	-	-	-	1500 Turkile 350 Gelad

# Basin Map of Ethiopia



Meteorological Station distribution used for hydro meteorological Bulletin.



STATION	CODE	STATION	CODE	STATION	CODE	STATION	CODE
A.A (Bole)	AA	Cheffa	CHF	Gonder	GN	Mille	ML
Abomsa	ABO	Chercher	CH	Gore	GO	Mira Abaya	MR
Adet	AD	Chira	CI	Hageremariam	HG	Motta	MT
Adigrat	AG	Combolcha	CO	Harer	HA	Moyalle	MO
Adwa	AW	Dangla	DA	Hossana	HO	Mytsebery	MY
Aira	AI	Debrebrhan	DB	Humera	HU	Nazaret	NZ
Alem ketema	AK	Degehabur	DG	Jijiga	JJ	Nedjo	ND
Alemaya	AY	Debre markose	DE	Jimma	JM	Negele	NG
Alge	AL	Debre Tabore	DT	Jinka	JI	Nekemt	NE
Ambamariam	AMB	Debre Zeit	DZ	Kachise	KA	Pawe	PA
Ambo	AB	DembiDolo	DO	Kibremengist	KM	Sawla	SA
Arbaminch	AM	Dilla	DI	Konso	KN	Sekoru	SK
Arjo	AJ	DireDawa	DD	Kulumsa	KU	Semera	SM
ArsiRobe	AR	Dolomena	DM	Koffele	KO	Freweyni	FW
Assaita	AT	Dubti	DU	Konso	KN	Shahura	SH
Assossa	AS	Ejaji	EJ	Kulumsa	KU	Shambu	SB
Awassa	AW	Elidar	EL	Lalibela	LA	ShewaRobot	SW
Ayehu	AH	Enewary	EN	Layber	LY	Shire	SR
Aman	AN	Elidar	EL	Limugenet	LG	SholaGebeya	SG
Bale Robe	BR	Enewary	EN	Maichew	MW	Sirinka	SI
BahiDar	BD	Fitche	FI	Mankush	MA	Sodo	SO
Bati	BA	Gambella	GA	Masha	MSH	WegelTena	WT
Beddele	BE	Gelemso	GL	Mehalmeda	MD	Wereillu	WR
Begi	BG	Gewane	GE	Mekaneselam	MN	Yabello	YB



Blate	<b>BL</b>	Ghion	<b>GH</b>	Mekele	<b>MK</b>	Ziway	<b>ZY</b>
Bui	<b>BU</b>	Gimbi	<b>GB</b>	Metehara	<b>ME</b>		
Bullen	<b>BN</b>	Ginir	<b>GI</b>	Meisso	<b>MS</b>		
Chagni	<b>CG</b>	Gode	<b>GD</b>	Metema	<b>MM</b>		

The above stations have five basic meteorological elements they send daily records for Addis Ababa main office of NMA. We use the meteorological elements which are the main factors for hydro meteorological impacts. These are rainfall, temperature, wind speed, evaporation and sunshine duration. This information is important to guide for different water resource activities.

Belg rain benefiting catchments are found across eastern half, central and southern portion of the country. Among this season April is the pick rainy months over those catchments. It has more benefited to compensate the loss of water during the previous dry condition effect (Bega season) and important to minimize evaporation from open water surface due to the presence of cloud coverage. Belg rainfall contributed for surface runoff about 5 to 7% during wet season. Due to this in some catchments availability of water is increase over small stream and ponds.

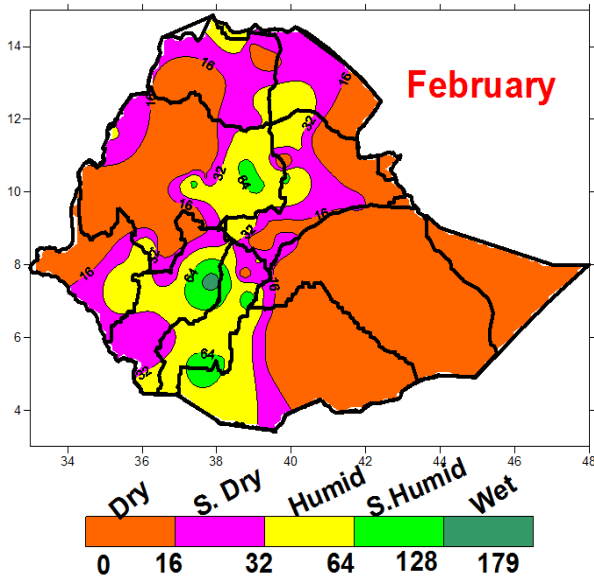
## Methods

To compute the aridity index we use Thornthwait method, which is computed from the monthly values of rainfall and evaporation. The evaporation is computed empirically from mean monthly air temperature. In assessing the effectiveness of rainfall, in terms of water availability relationships between the rainfall and air temperature has been worked out in terms of moisture indices. The aridity index values above 128 which shaded in deep green were show wet condition. Light green to yellow value indicates humid to semi humid and pink to red values show semi dry to dry condition.

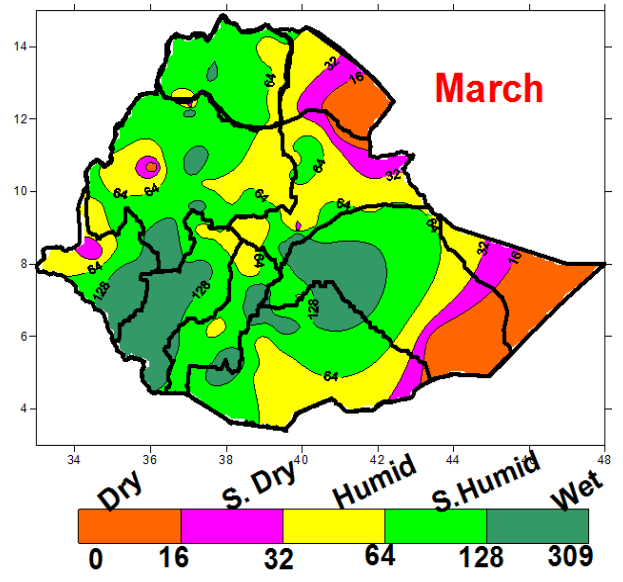
Where  $R_f$  = monthly rainfall in mm;  $T$  = monthly mean temperature in °C

The moisture performance of February was insignificant over all river basins. However, across the central high ground pocket catchments of the margin of Omo Gibe and Rift valley and also the margin of Abay, Tekeze and Awash and lower Genale Dawa catchments were performed humid to wet condition. During March the wet weather condition was experienced across Belg benefiting river basins. As the result of this across the margin of Omo Gibe and Baro Akobo, upper Wabisheble and Genale Dawa, pocket areas of Abay, eastern Rift valley and some places of Tekeze catchment were remained in wet condition. The moisture performance of April was experienced in wet weather condition across Belg benefiting river basins. According to this across the margin of Omo Gibe, Abay and Baro Akobo, upper Wabisheble and Genale Dawa, central Rift valley and Denakel catchment were performed in wet condition. Most of Rift valley, Tekeze, eastern and northern Abay, upper OmoGibe, middle Wabishebele, some places of Awash, lower Genale Dawa and Afar Denakel catchments were performed humid to semi humid condition. In the last Belg season during May many river basins were remained wet condition shown below in figure (1a-d).

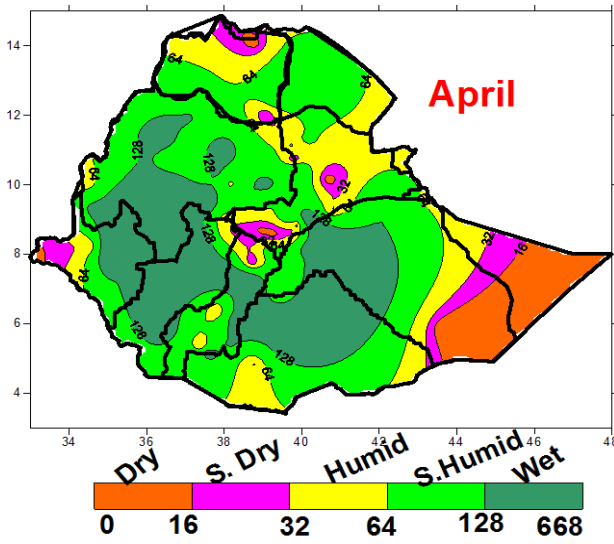
1a.



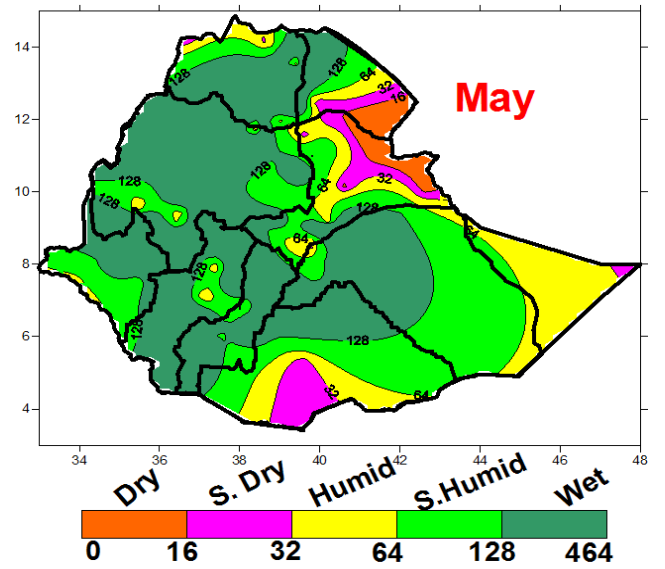
1b.



1c.

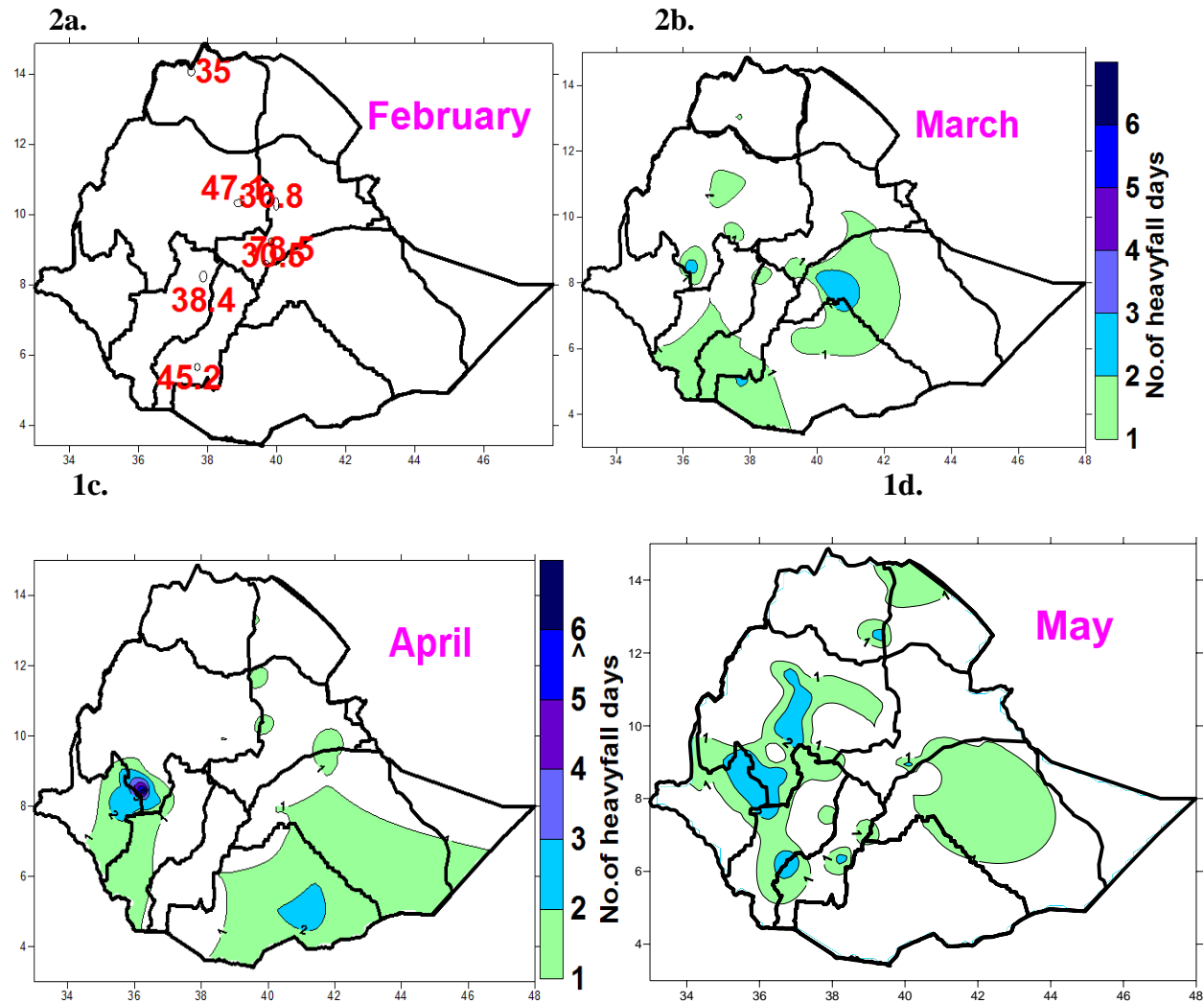


1d.



**Occurrence of heavy fall days exceeding 30mm during Belg 2014 season over different river basins.**

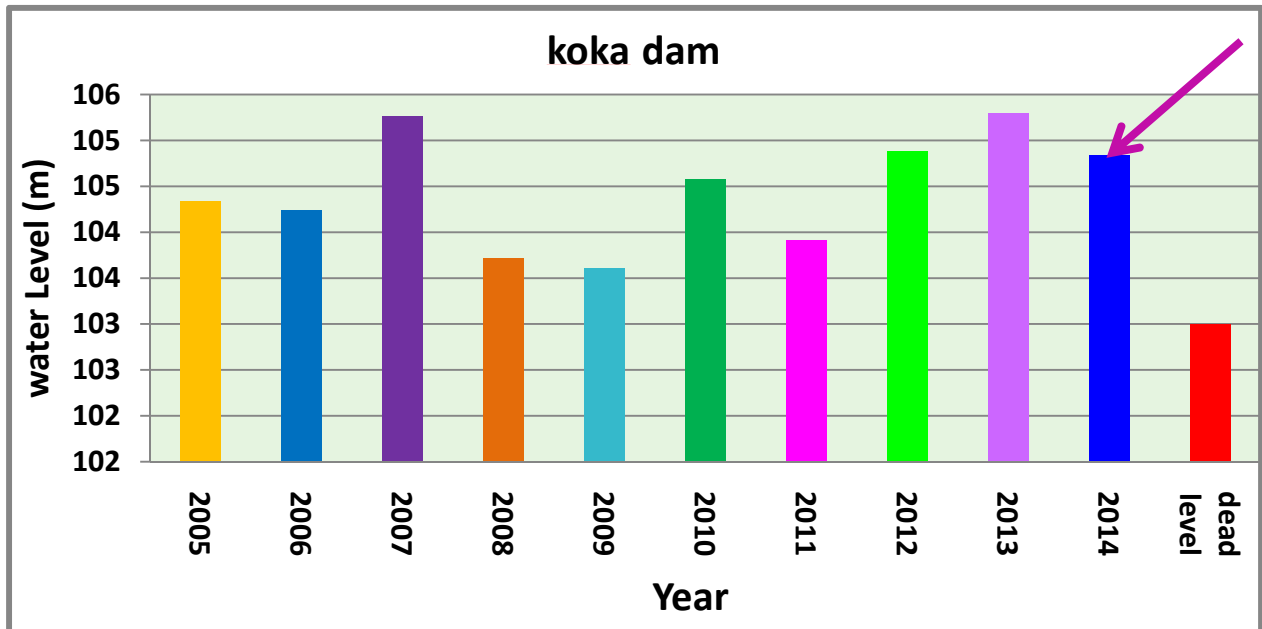
The occurrence of heavy fall in February indicates that Omo Gibe and Rift valley were received for 2 heavy fall days and over eastern Abay, Awash and Tekeze were recorded for one day respectively. During March from one to four heavy fall days was recorded over Omo Gibe, Abay, Wabishebele, GenaleDawa, Awash, Tekeze and Rift valley catchments. The highest heavy fall days were observed over Abay basins at Arjo station. In April from one to eight heavy fall days was observed over Omo Gibe, Abay, Wabishebele, GenaleDawa, Awash, Tekeze and BaroAkobo catchments. The highest heavy fall days were observed over Abay basins at Arjo station for eight days during a month. In addition in May the occurrence of heavy fall was observed over many river basins shown below in figure (2a-d).



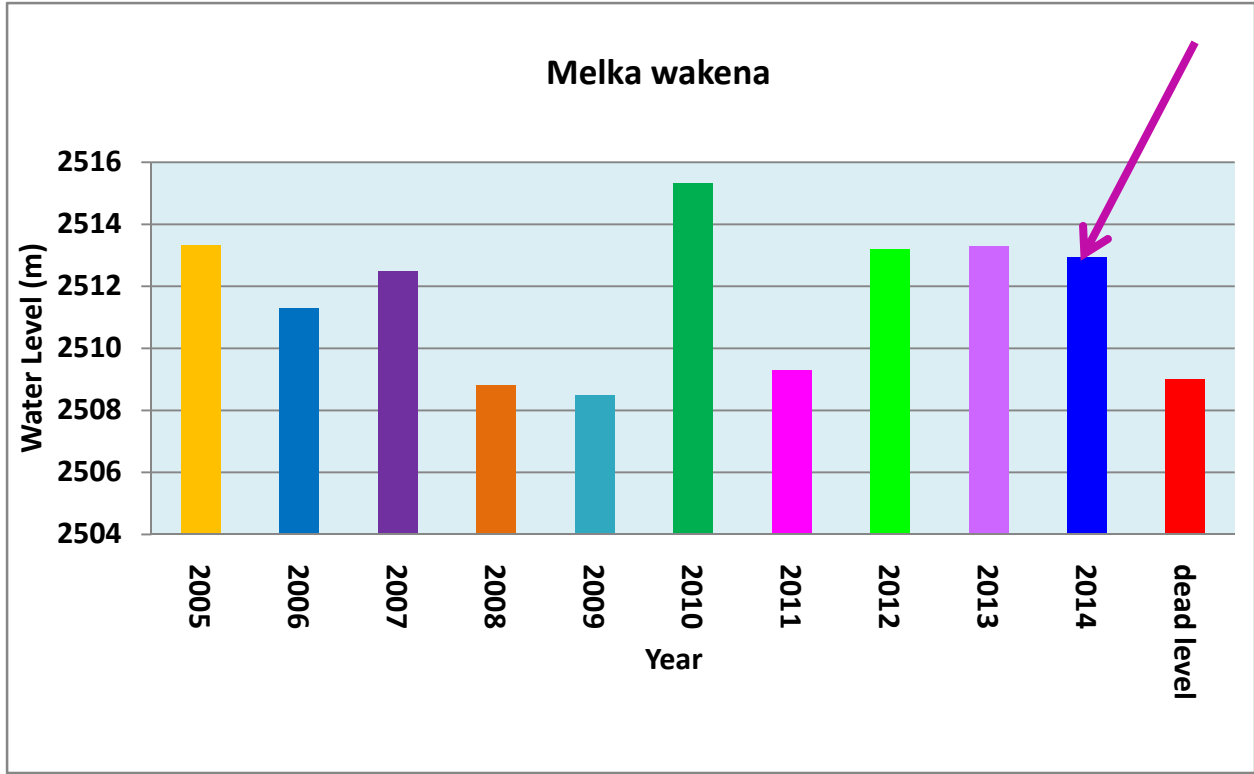
### Hydrological Situation for Reservoirs and Dams level during end of Belg season at different years

The main source of runoff is rainfall which is the input for Dams, reservoirs and ponds but from Bega season to end of Belg season runoff is very little and flow of river is low. According to this at the end of Belg season the level of water in river, ponds, reservoir and dams reaches at low level. In the case of 2014 Belg season rain fall had better contribution for water resource. In line with this the performance of 2014 Belg season water level of different dams and reservoirs was in good condition compare to the previous year's and the dead level shown below in figure (3a-f).

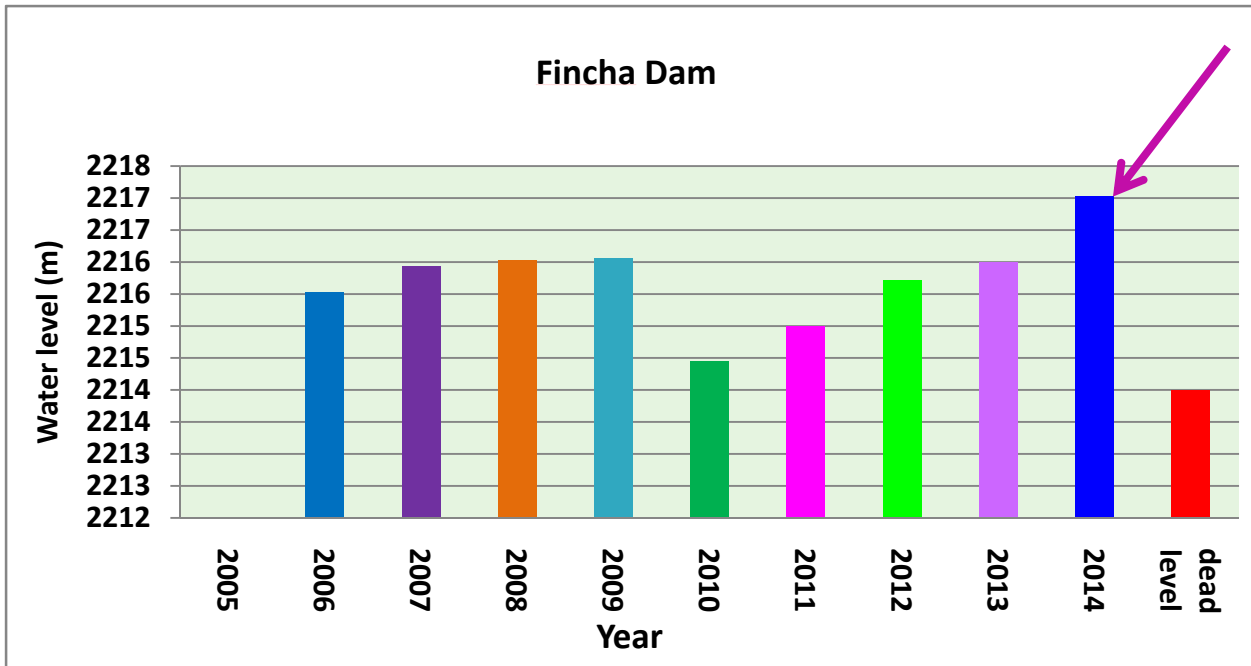
3a.



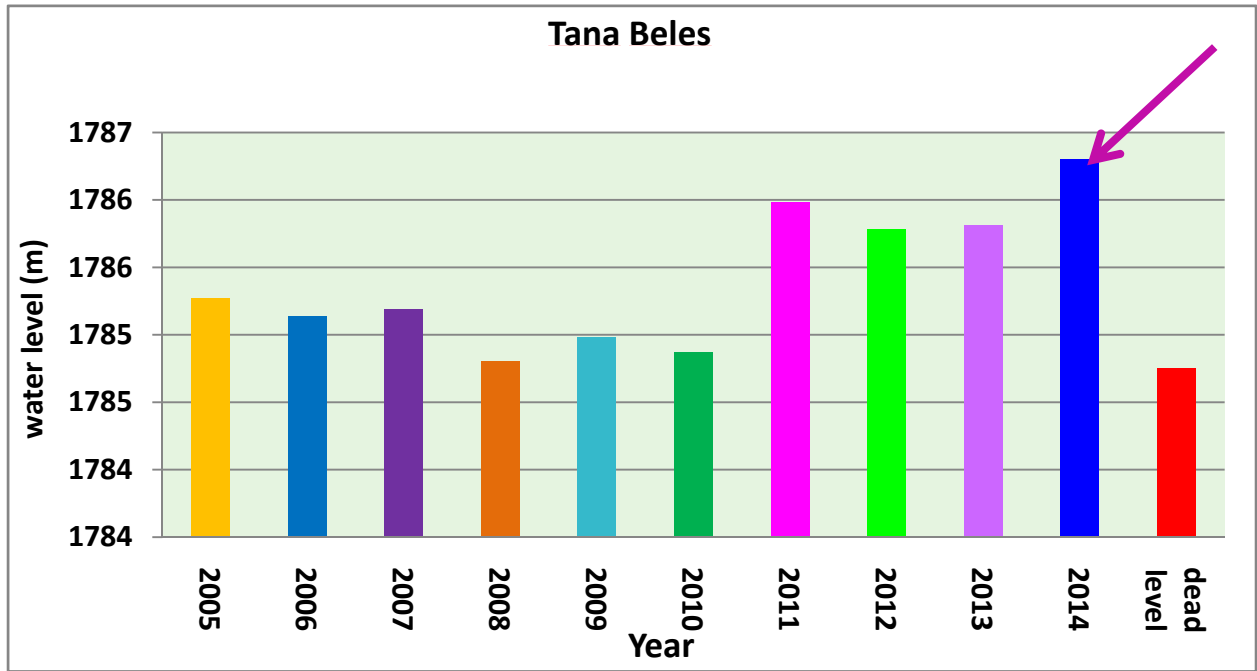
3b.



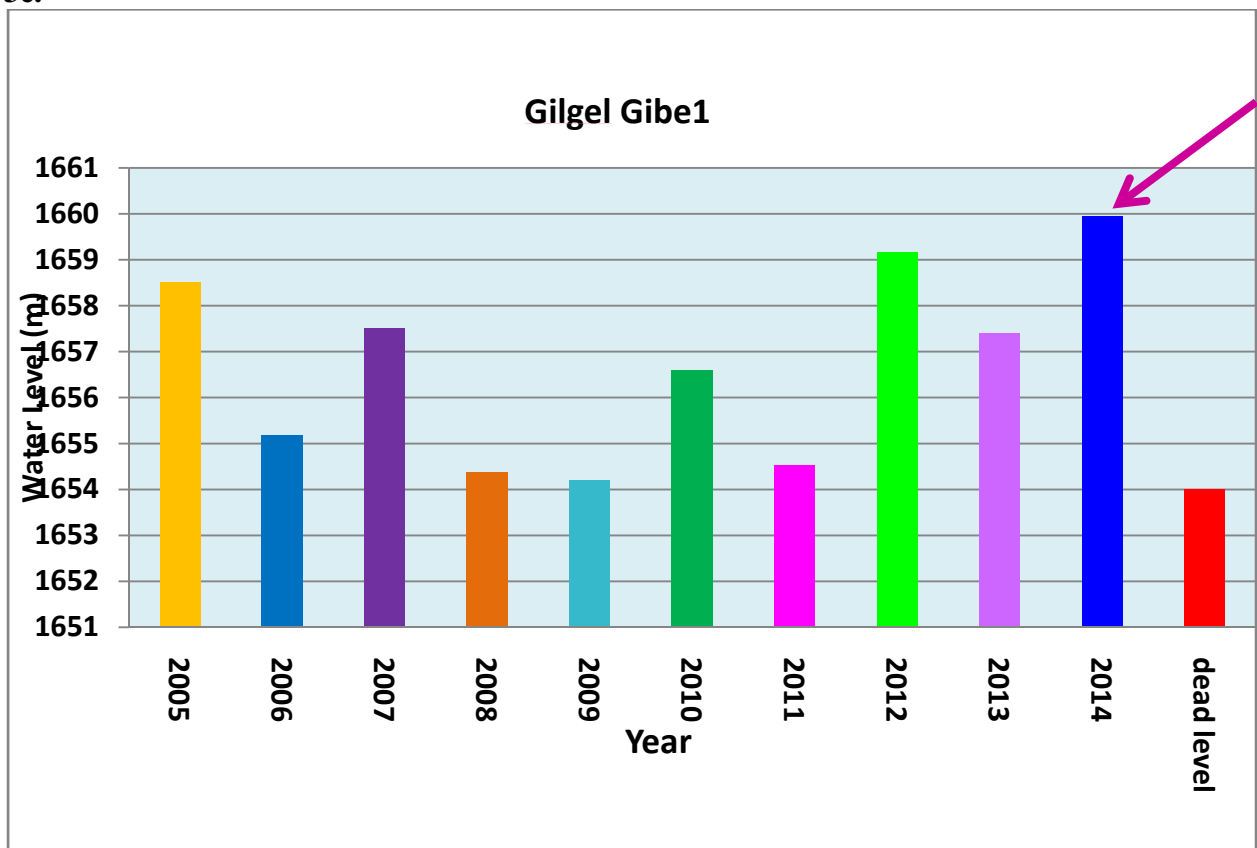
3c.



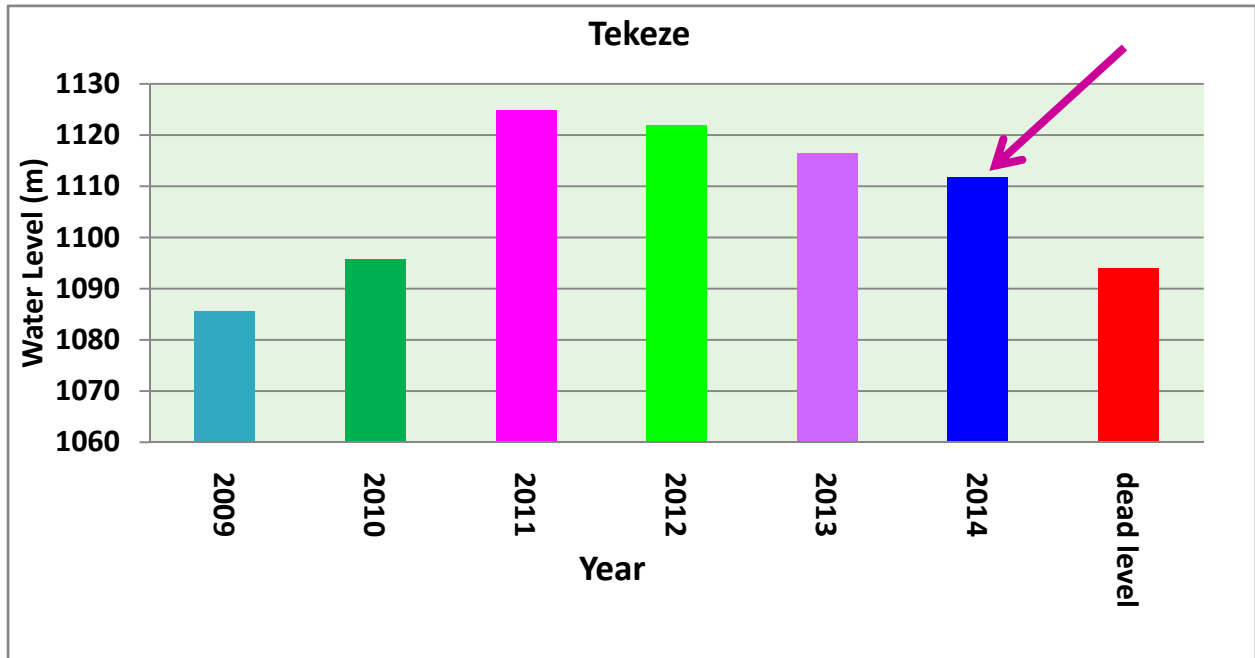
3d.



3e.



3f.



(Fig.3a-f) water level of different dams.

### Summary

In the month of February most catchments were remained under dry condition except some places of Omo Gibe, Rift Valley and eastern Abay. During March most parts of Belg benefiting catchments were received rainfall. In line with this over upper Wabishebele and Genale Dawa, OmoGibe, eastern Baro Akobo and Rift Valley were observed wet condition. In April among Belg benefiting catchments across upper and middle Awash and Tekeze were experienced dry to humid condition, but the rest were performed wet condition. During May better moisture performance was observed most parts of main river basin. Across western half catchments and Belg rain benefiting eastern and southern catchments had a better moisture performances. The maximum moisture index value was observed over Abay and OmoGibe basins. The occurrence of heavy fall in this season was observed over many catchments during February to May. The maximum frequency of heavy fall days was observed over Abay and Genaledawa catchments. In general Belg 2014 season rainfall performance had good contribution for the supply of water for different economic sector.

## *Hydro meteorological outlook for Kiremt 2014 over different river basins.*

### **Introduction**

Kiremt season is the main rainy season across most basins. It has significant importance for water resource of the country. Dams, reservoirs and ponds can capture the highest volume of water during this season. The occurrence of flood and land slide is widely known phenomenon in flood prone areas and rugged surface of the country during Kiremt season respectively.

### **Selected analogue Year**

For the coming season the selected analogue year **1997, 2006, 2009 and 2002** were compared based on probabilistic seasonal forecast for **Kiremt 2014** and viewed out on catchments based map using geostatistical kriging method. Among those are **2006, 2009 and 1997** are the best analogue year that can enlighten the Aridity status in the coming Kiremt season.

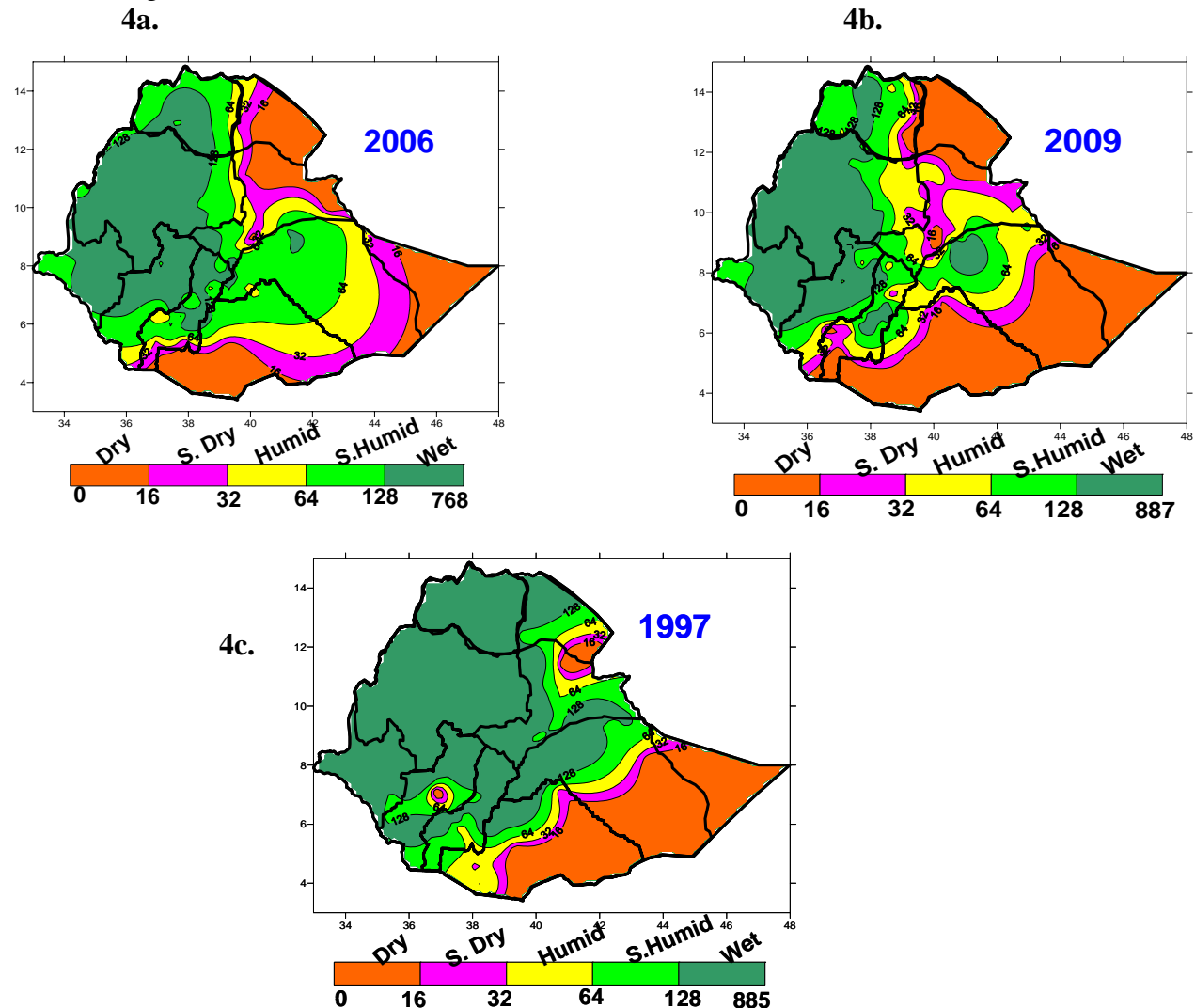
### **Methods**

Thornthwaite introduced the concept of the precipitation effectiveness index, which is computed from the monthly values of rainfall and evaporation. The evaporation is computed empirically from mean monthly air temperature. In assessing the effectiveness of rainfall, in terms of water availability relationships between the rainfall and air temperature has been worked out in terms of moisture indices.

Where, Rf= monthly rainfall in mm;

T = mean monthly temperature in C°

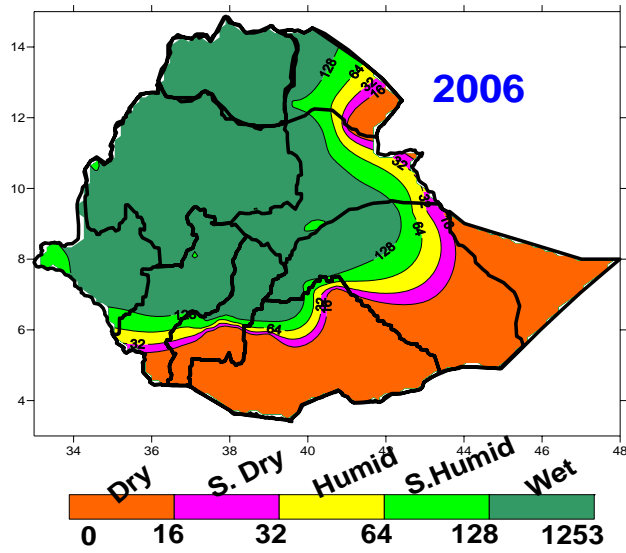
**June:-** During this month the upper catchments of Tekeze, Awash and Genaledawa river basins were experienced humid to semi humid condition based on 2006 and 2009 analogue years shown below in Figure(4a-c).



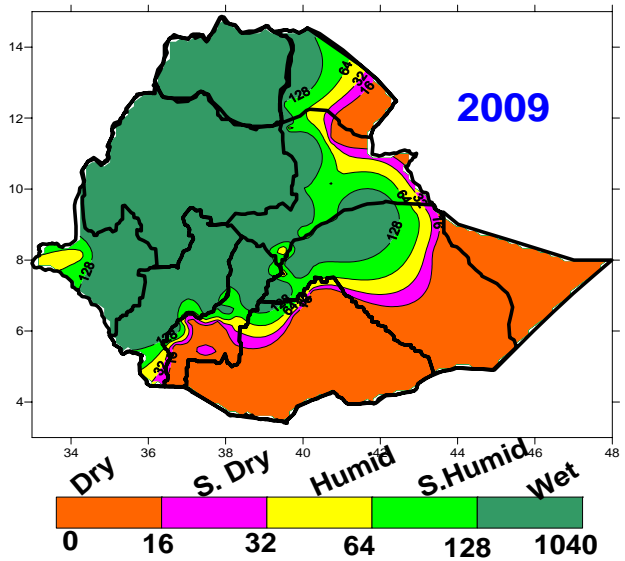


**July:-** The wet and humid condition were covered across the middle and upper parts of all main river basin over the country shown below in figure(5a-c). .

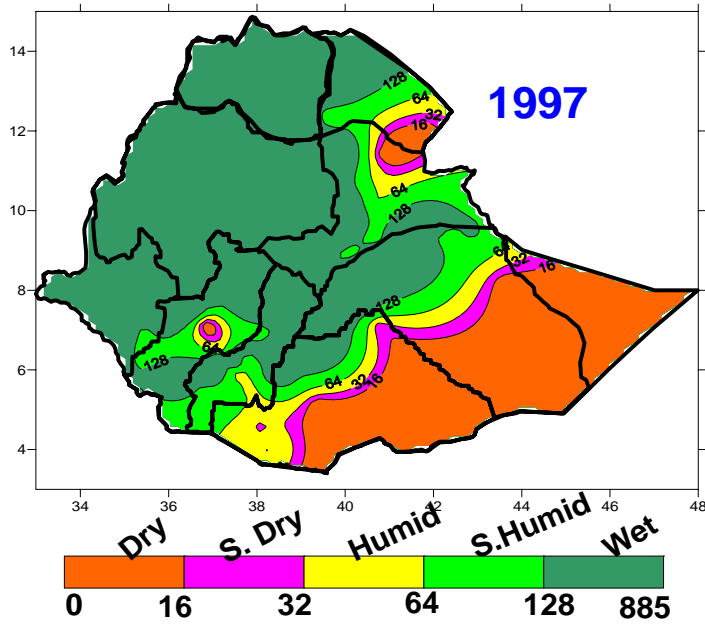
5a.



5b.

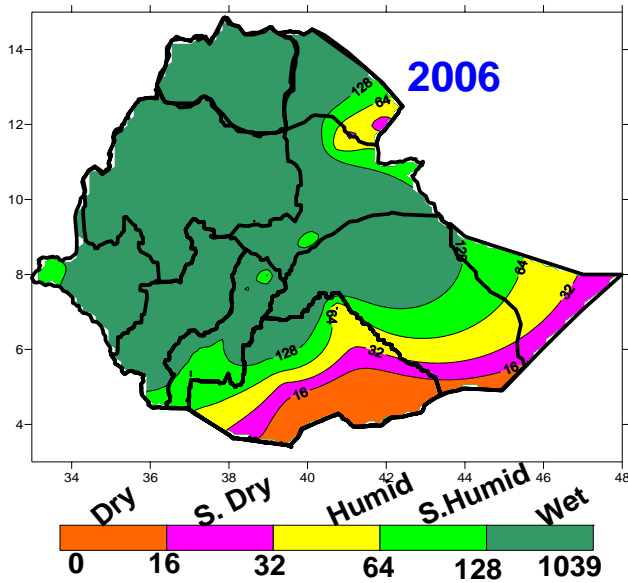


5c.

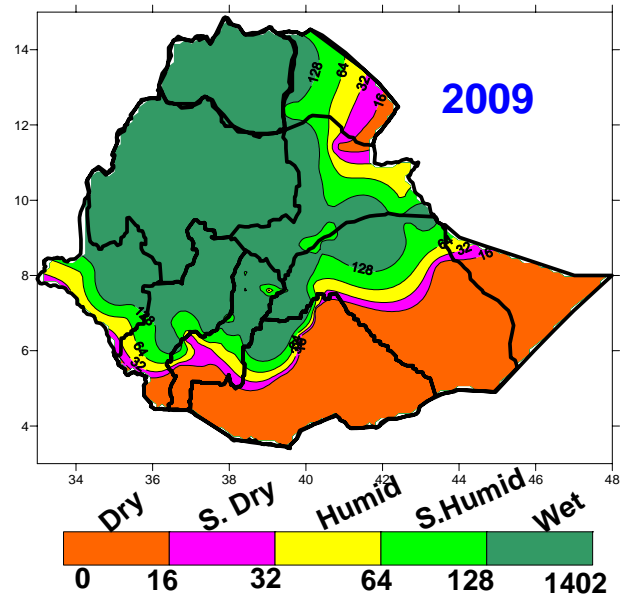


**August :-** Based on the analogue years comparable to July the middle and upper catchments of main basins were experienced under wet condition shown below in figure(6a-c). .

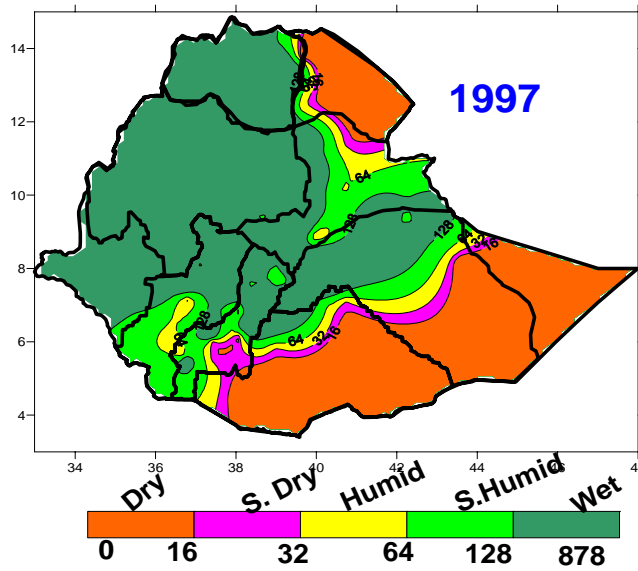
**6a.**



**6b.**

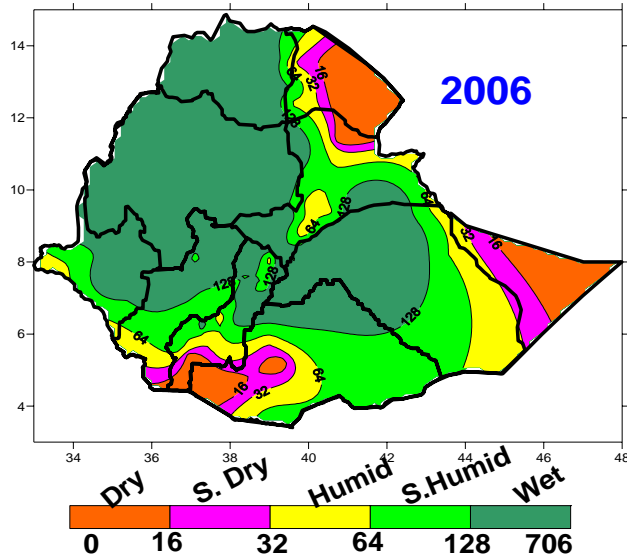


**6c.**

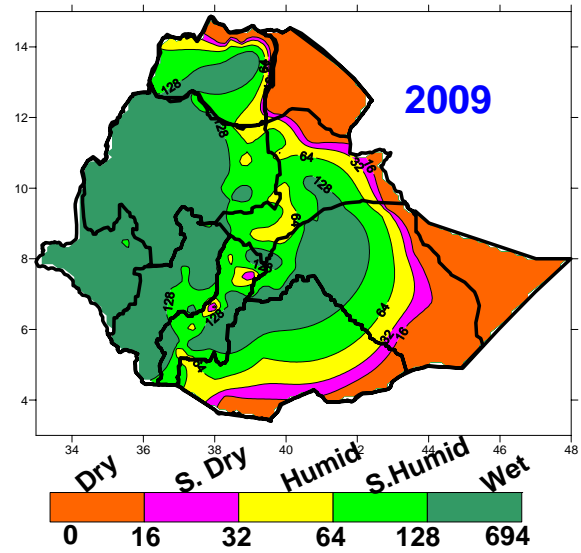


**September:-** During this most of western and south western basins and upper parts of Wabishebele , Genale dawa Awash and Rift valley were performed wet weather condition shown below in figure(7a-c).

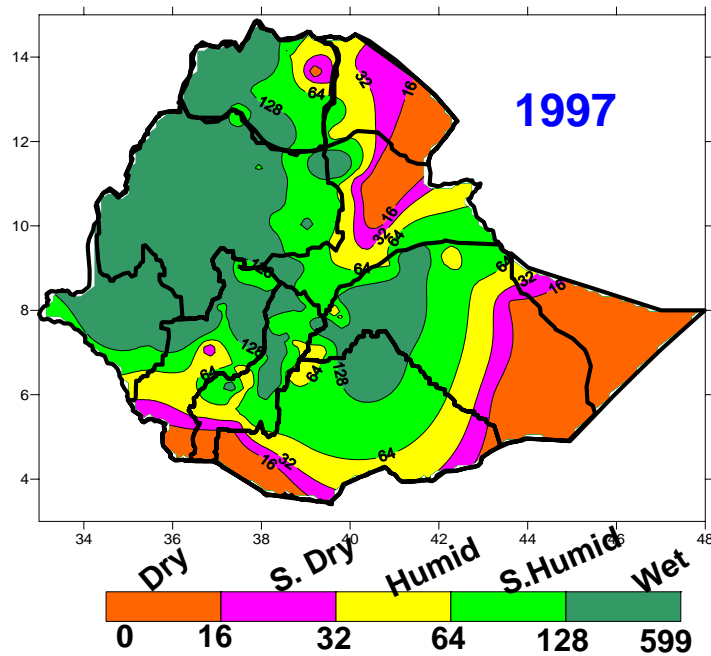
7a.



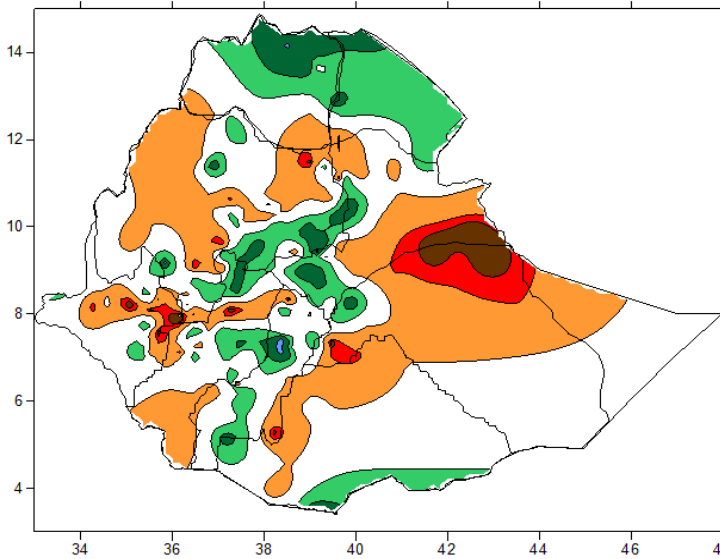
7b.



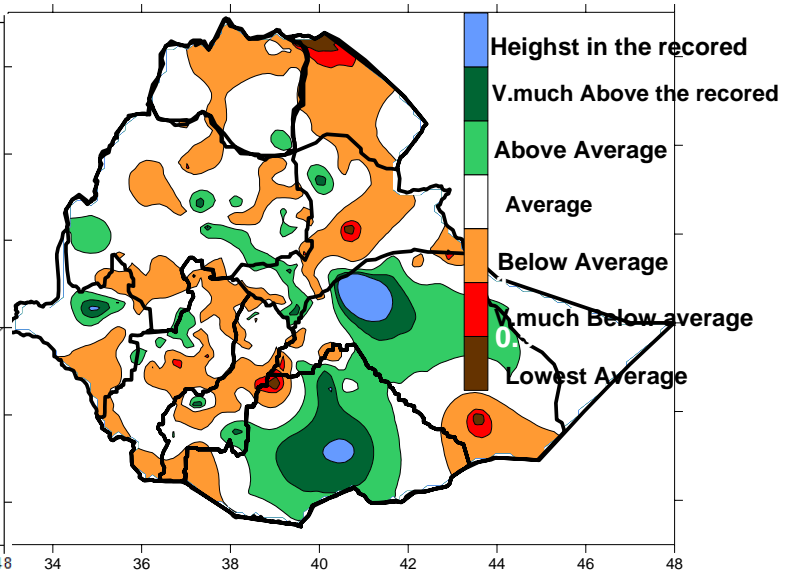
7c.



**Fig. (8a-b) Rainfall Deciles Ranking**  
**8a.2006**

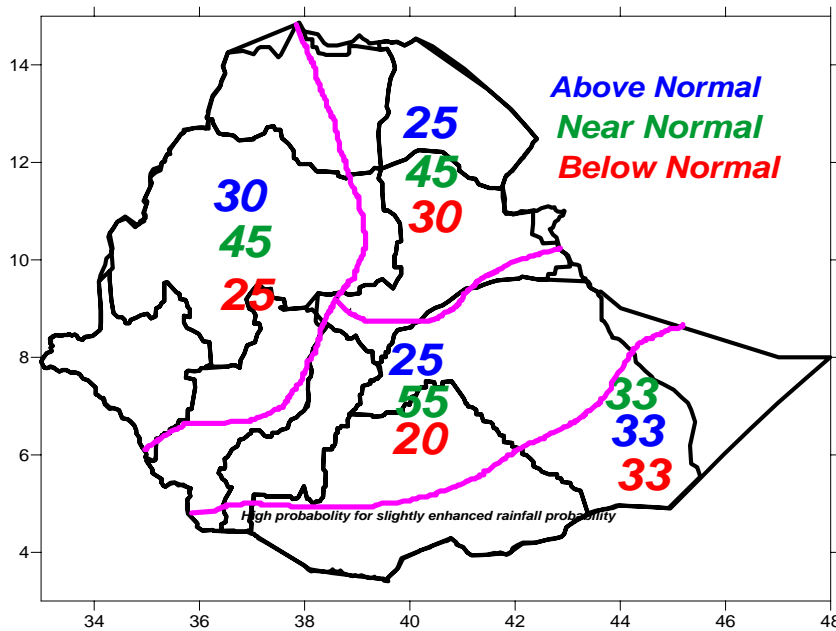


**8b.1997**



In 2006 kiremt rainfall decile shown highest and very much above the recorded indicated that across upper Awash, Mereb, Tekeze eastern Abay and Rift valley catchments. Based on Analogue year (1997) rainfall Deciles ranking of kiremt the highest record of rainfall was observed across upper Wabishebele, middle Genale Dawa and pocket places of upper BaroAkobo.

**Fig. (9) Rainfall Tercile probability for Kiremt, 2014**



The rainfall Tercile probability map also indicated that except north eastern catchments the rest most of Kiremt benefiting catchments will be remain under normal tends to above normal condition shown above in figure(9)

### **Conclusion**

During June, upper catchments of Tekeze, Awash, Wabishebele and Genale Dawa will experienced humid to semi dry condition. From July to September all kiremt benefiting catchments will remained under wet condition. The occurrence of Heavy fall is significant across many portions of Kiremt rain benefiting basins. As a result, probability of flood and land slide is expected at places of flood prone area of the country. All Reservoirs and dams have a better chance to capture water in this Kiremt 2014 season.