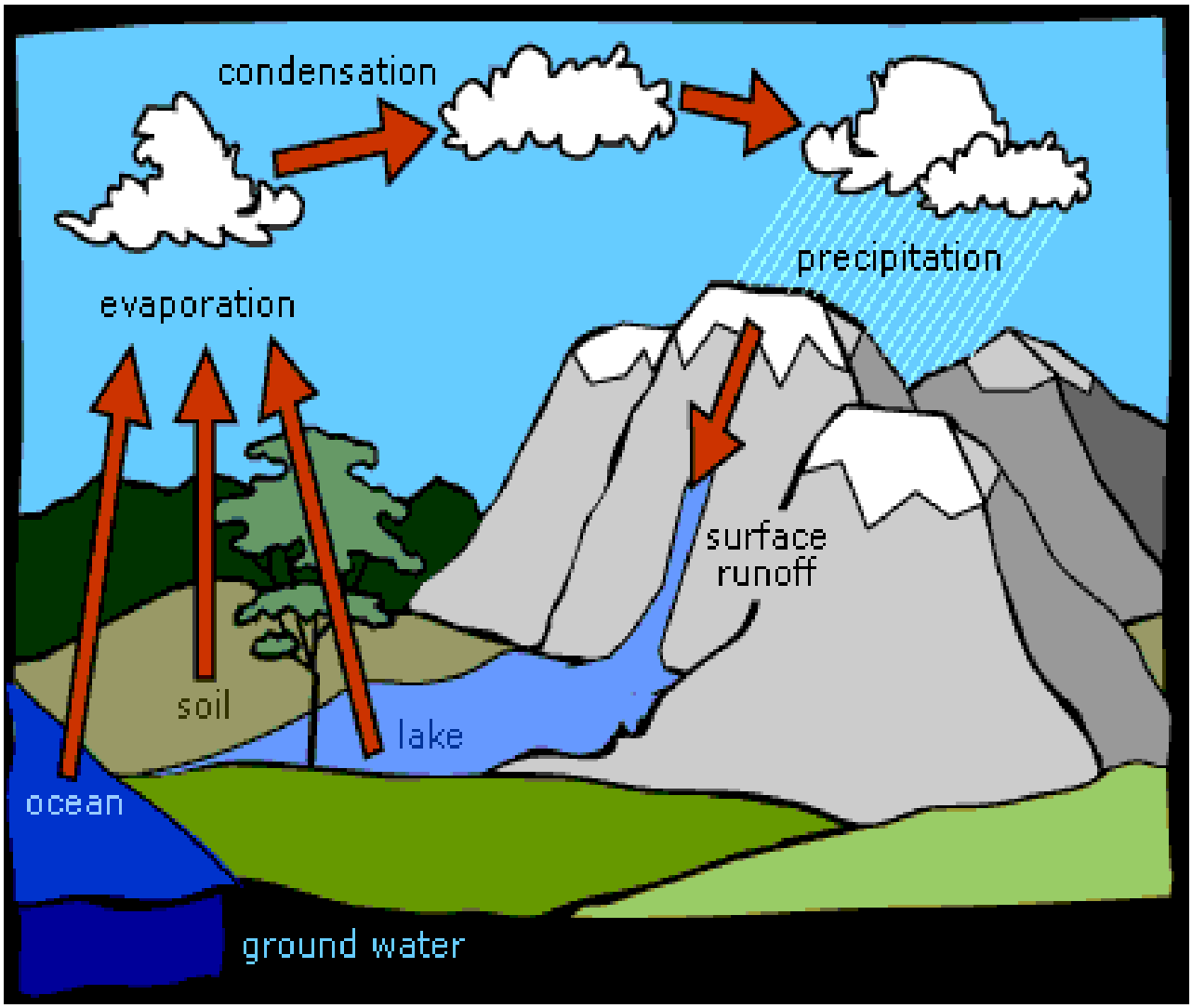
National Meteorological Agency



Hydro Meteorological Bulletin for Belg, 2018

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 14.5°N and longitudes of 33°E to 48°E with an area of about 1.12 million km^2. The varied topography of the country shows extreme changes in altitude with its lowest point at about 120meters below sea level (Kobat Sink Afar depression) and its highest point about 4620 meters above sea level (Ras dashen.).These physographic variations create a large difference in meteorological and hydrological condition 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 compromise 7 catchments with only 11 percent of the water resource and while the west compromise 5 catchments with 89 percent of water resources.

II. Catchments profile

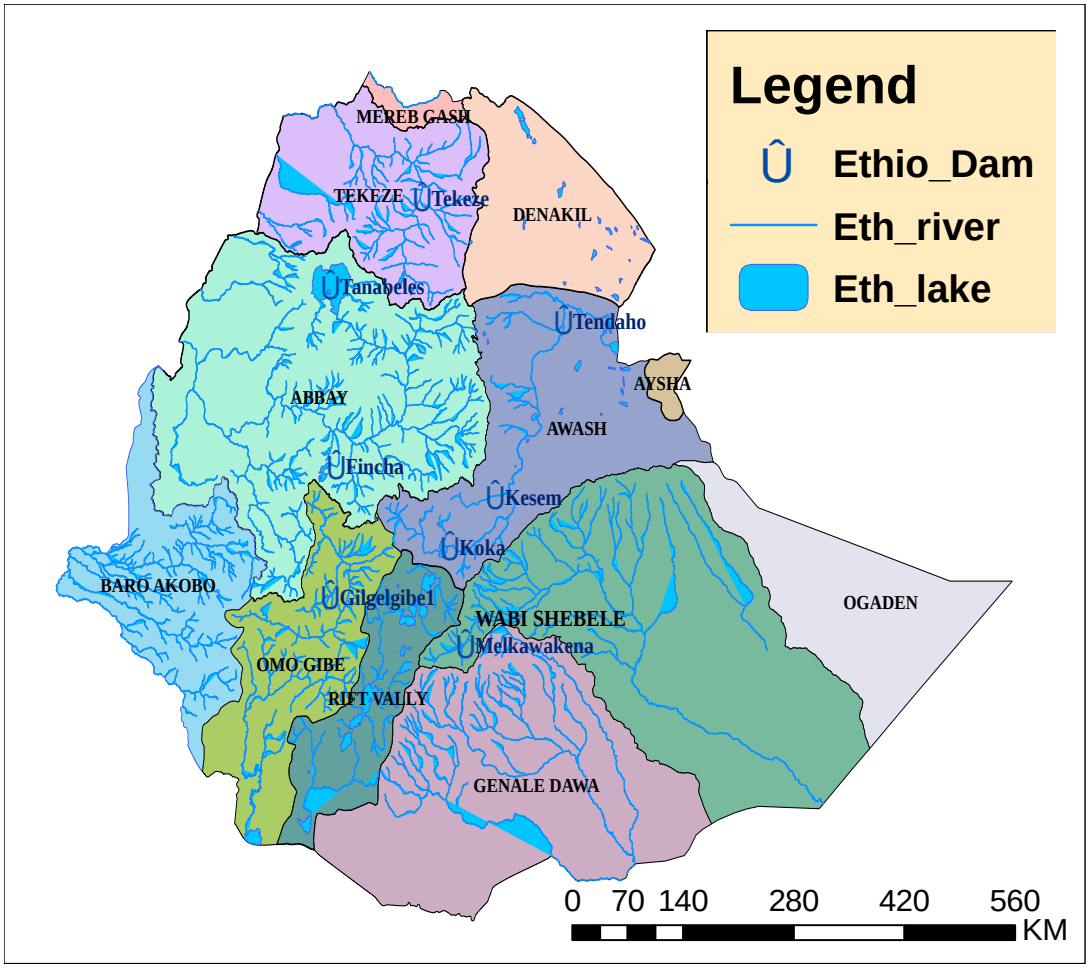
Catchment	Location
Mereb – Gash Catchment: -	Northwestern tip of Tigray.
Atbara-Tekeze Catchment: -	The Tekeze river basin is situated in the northwest of Ethiopia between 11 ^{0}40` and 15 $^0$12` N, and 36 ^{0} 30` and 39$^0$ 50` E. It is bordered by the Mereb river basin and by Eritrea in the north, 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 13^0 N south of Gondar to 11^0 30'N, and west of 39^0 45'E of Wello, 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.
Danikil – Afar Catchment: -	East of 40^0 E of Tigray, North of 11^{0}N of Wollo, narrow coastal strip south of 14^{0}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 11^0 40᾽ N of Wollo, south of 9^0 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.

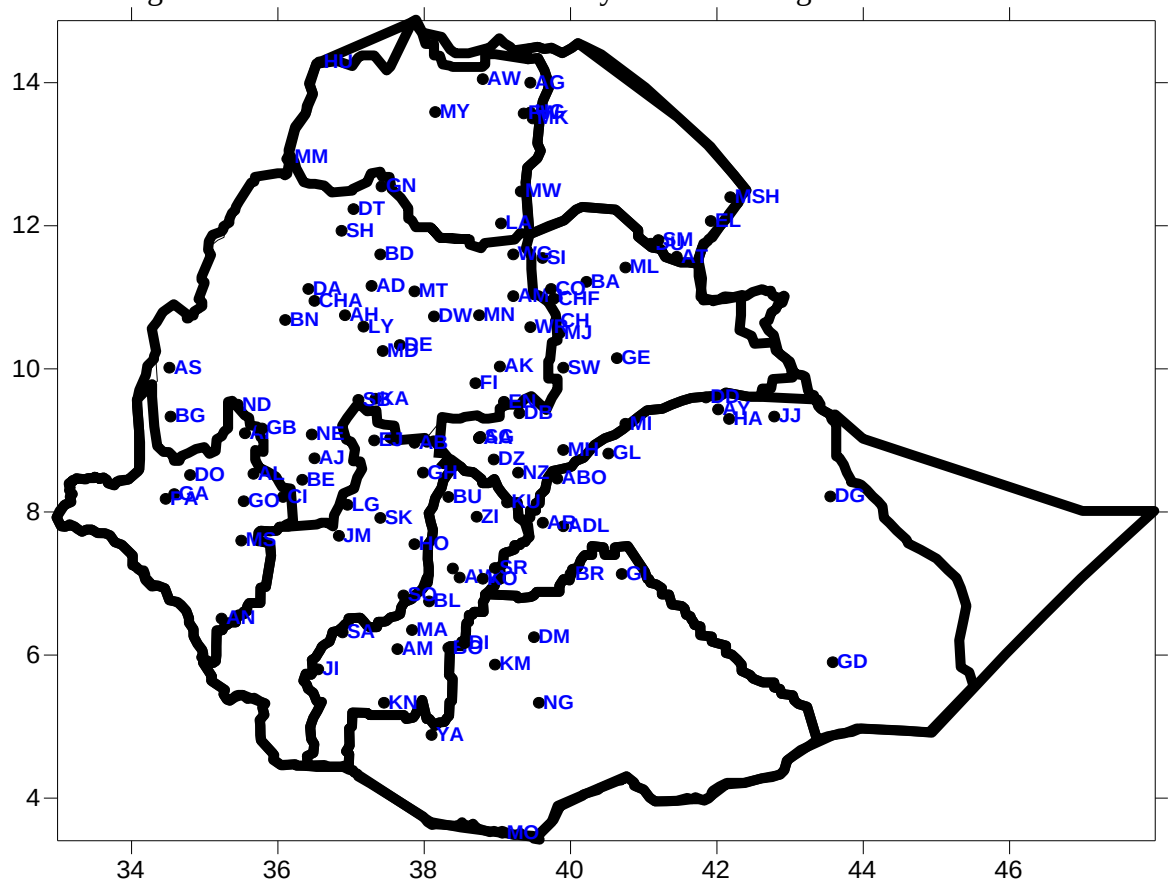
IV. Major River Catchments in Ethiopia, Location and Spatial Status

No.	Catchement Name	Area ($km^{2)}$	Length in Kilo meter			Volume of water bm^3/Annum	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

V. Basin map of Ethiopia



VI. 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**	Debremarkose	**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**	ShewaRobit	**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	**BL**	Ghion	**GH**	Mekele	**MK**	Ziway	**ZY**
Bui	**BU**	Gimbi	**GB**	Metehara	**ME**		
Bullen	**BN**	Ginir	**GI**	Meisso	**MS**		
Chagni	**CG**	Gode	**GD**	Metema	**MM**		

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.

1.Belg 2018

Season

Assessment

1.1 Introduction

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. In weak rainfall Belg season exacerbate shortage of water due to occurrence of high temperature. It has more benefited to compensate the loss of water during the previous dry condition effect which is during Bega season and important to minimize evaporation from open water surface due to the presence of cloud coverage and some amount of rainfall. Belg rainfall contributed for surface runoff about 5 to7% during wet season. Due to this in some catchments availability of water is increase over small stream and ponds.

1.2 Methods

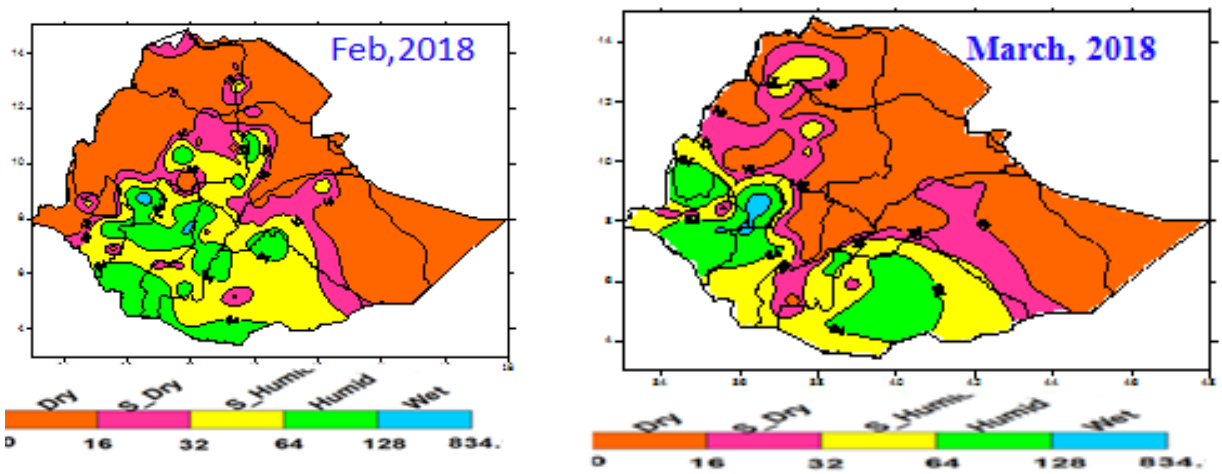
To compute the aridity index we use Thornthwait method, which is computed from the monthly values of rainfall and evaporation. The evaporation is computed empirically from mean monthly air temperature. In assessing the effectiveness of rainfall, in terms of water availability relationships between the 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 Rf= monthly rainfall in mm; T= monthly mean temperature in °C

1.3 Aridity status for Belg, 2018 over different basins

The moisture performance During February and March most Belg rain benefiting catchments were preformed sub humid to humid moisture condition**.** According to this most of, OmoGibe, Rift Valley, Abay, Eastern BaroAkobo, upper Awash, Abay and upper part of GenaleDawa catchments were received rainfall. The river basins which were got rainfall during this month had a chance to harvest rain water. During April 2018, Baro Akobo, Genale Dawa, Omo Gibe, Rift valley observed wet condition, while lower Abay & Omo Gibe, parts of Baro akobo, upper Wabishebele and southern Genale Dawa catchments preformed wet to humid weather condition The better moisture performance was observed during April and May over all main Belg benefiting catchments shown below in figure (1a-d).

1a. 1b.



1c 1d

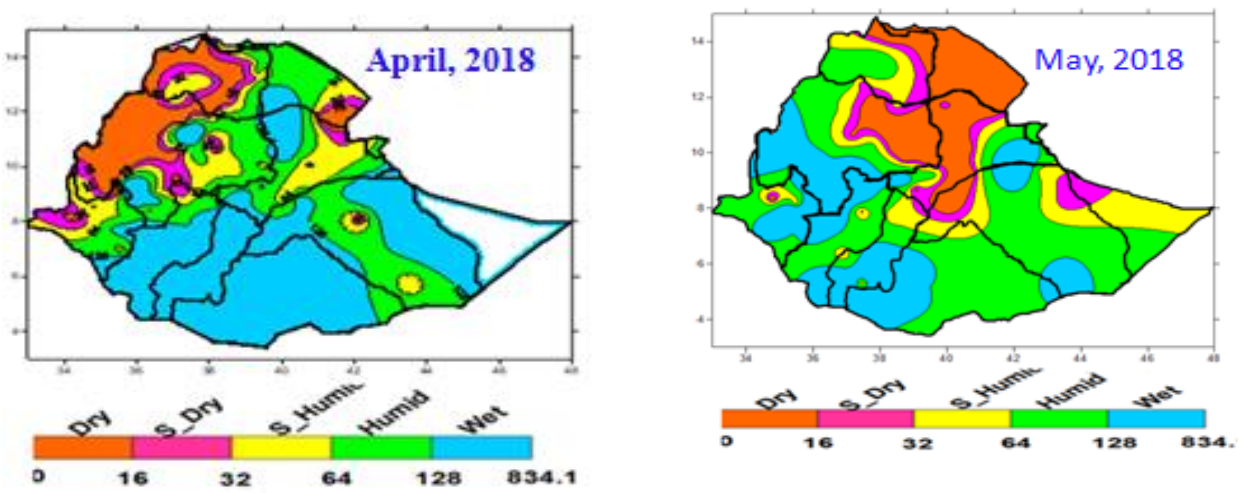


Fig.1 (a-d) Aridity Index for February, 2018 to May, 2018.

1.4 Distribution of heavy fall days exceeding 30mm during February to May, 2018 over different river basins

The occurrence of heavy fall in this season also was observed during February to May. During February some stations were recorded heavy fall for none day over GenaleDawa, middle Awash, Abay and Rift valley catchments. In March the frequency of heavy fall occurrence was increased

above one day over upper Wabishebele, upper Baroakobo, southern and upper Abay, western OmoGibe, most part of Rift valley and lower Awash. During the month of April and May 2018 Upper Catchment of Wabi Shebele, Omo Gibe and the adjoining areas of Genale Dawa Basins experienced frequent heavy falls that might have caused flood and flash floods over the areas.

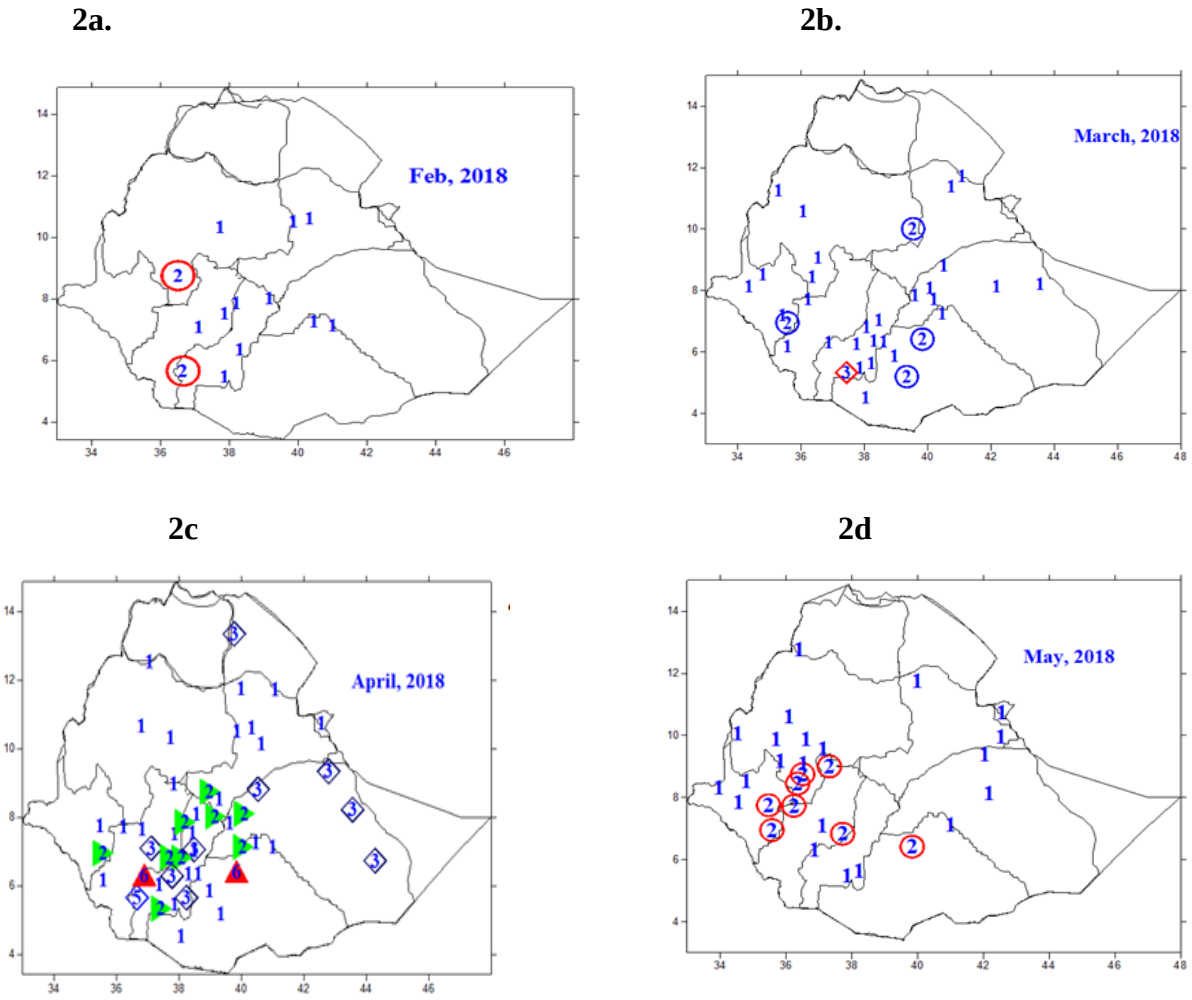


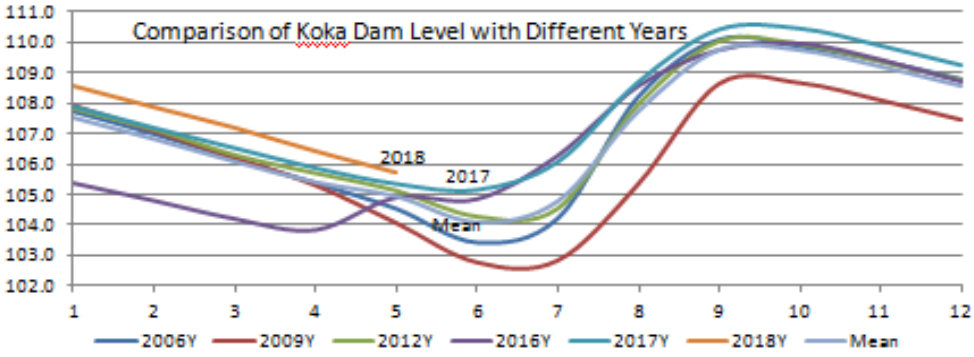
Fig.2 (a-d) Distribution of heavy fall February to May, 2018

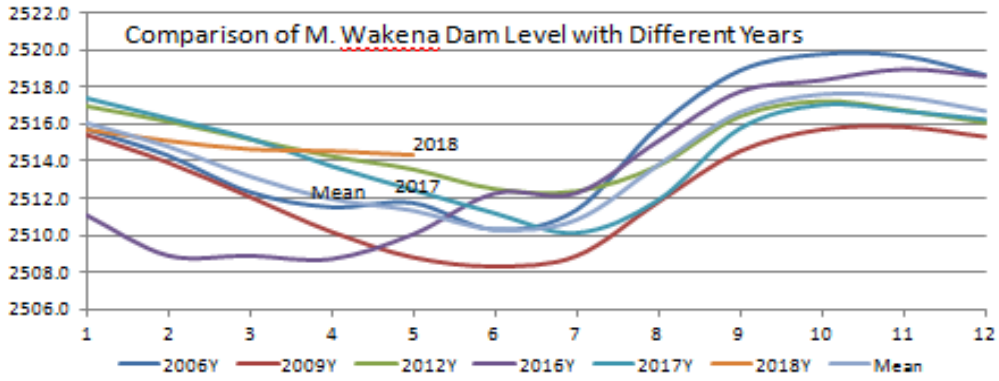
1.5 Performance of Dams and Reservoirs water level in Belg, 2018 season

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, reservoirs and dams reaches at low level. In the case of 2018 Belg season rain fall had better contribution for water resource. In line

with this the performance of 2018 Belg season water level of Koka, Melkawakena and Gilgelgibe1 shown increment of water level. The current performances of Dams and reservoirs are comparatively found in better level conditions than their mean and the previous year 2017.

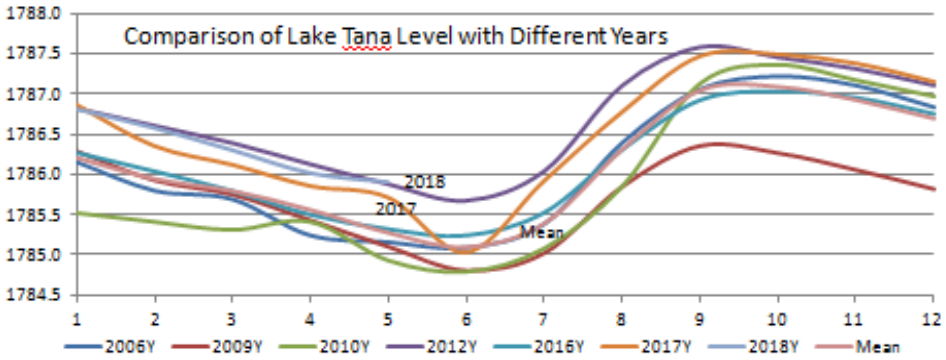
3 a and b.

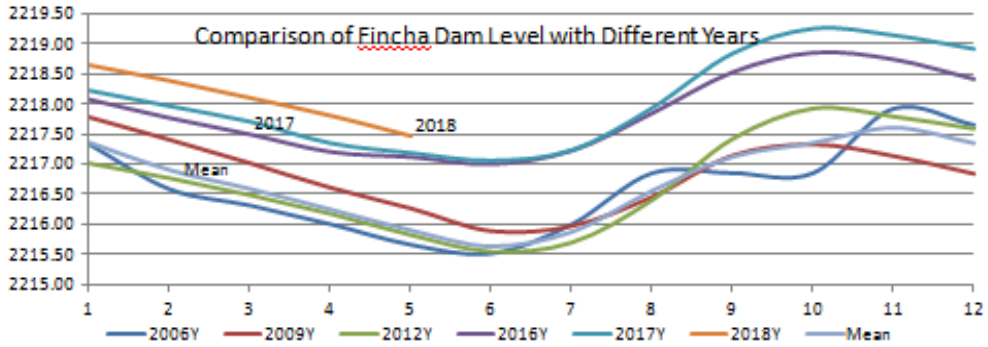




Data source: EEPU

3 c and d.


Comparison of Lake Tana Level with Different Years
1788.0
1787.5
1787.0
1786.5
1786.0
1785.5
1785.0
1784.5
1 2 3 4 5 6 7 8 9 10 11 12
2018
2017
Mean
2006Y 2009Y 2010Y 2012Y 2016Y 2017Y 2018Y Mean


Comparison of Fincha Dam Level with Different Years
2219.50
2219.00
2218.50
2218.00
2217.50
2217.00
2216.50
2216.00
2215.50
2215.00
1 2 3 4 5 6 7 8 9 10 11 12
2017
2018
Mean
2006Y 2009Y 2012Y 2016Y 2017Y 2018Y Mean

3 e and f

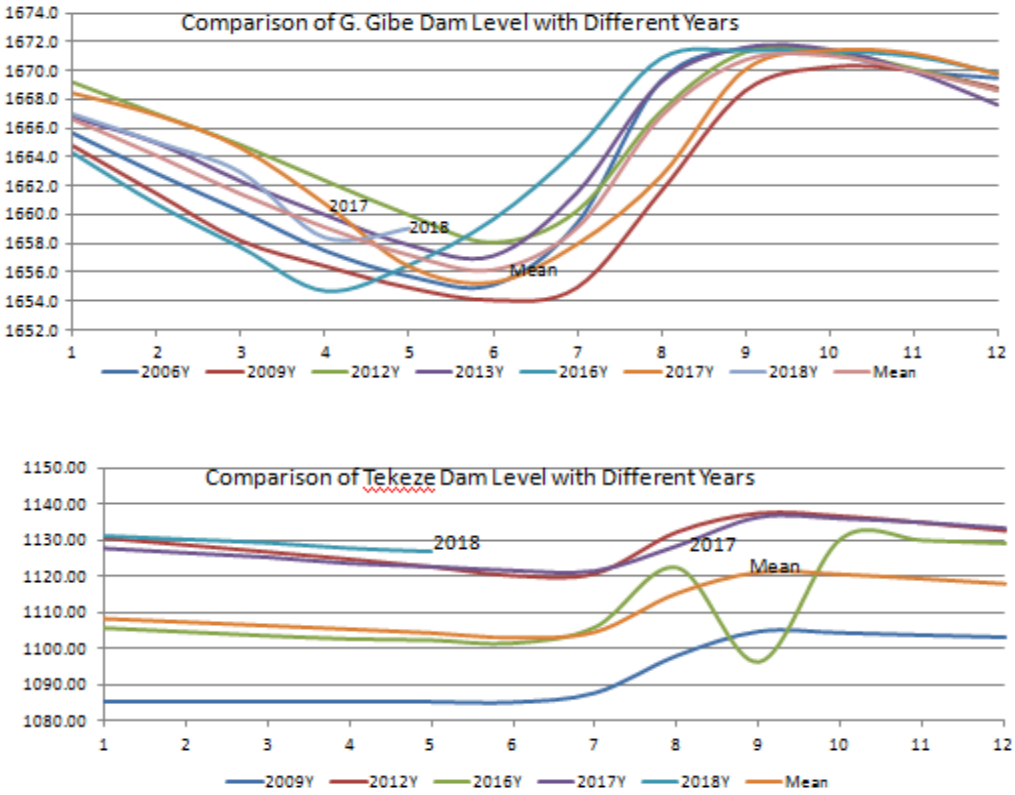


Fig.3a-f water level of different dams

1.6 Seasonal Mean Aridity index of Belg, 2018

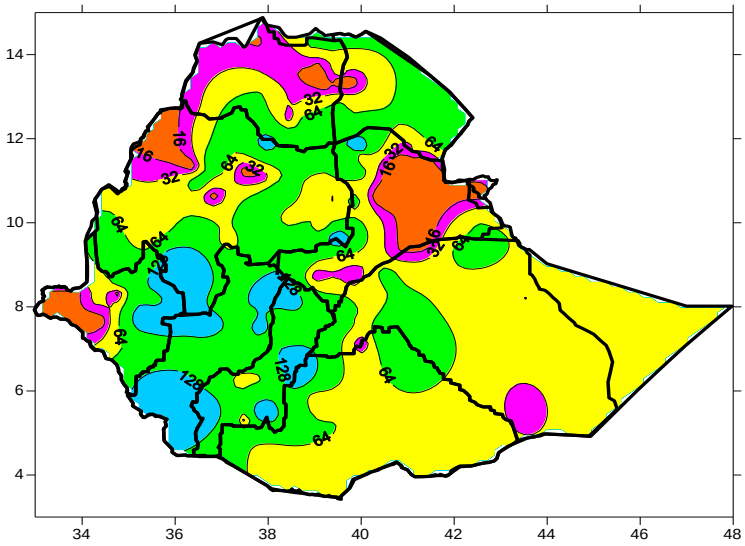


Fig. 4a. Seasonal aridity depth of Belg, 2018

1.7 Summary of Belg, 2018 season

During February and March most Belg rain benefiting catchments were preformed sub humid to humid moisture condition**.** According to this most of, OmoGibe, Rift Valley, Abay, Eastern BaroAkobo, upper Awash, Abay and upper part of GenaleDawa catchments were received rainfall. The river basins which were got rainfall during this month had a chance to harvest rain water. During April all Belg benefiting catchments were experienced wet to humid condition and the better moisture performance was observed. This condition had better contribution for water option to minimize the shortage of water. In addition to this some dams along Belg benefiting catchments were shown increment of water level. In May many catchments including western and north western catchments were received rainfall. The occurrence of heavy fall was observed during March to May all main river basins. The impact of this event had both negative and positive consequence along those catchments which received heavy fall. The positive impact of intensive rainfall was contributed for the availability of water resource, while the frequent occurrence of heavy fall was caused flash flood and landslide which causes the loss of life and property. In the case of these phenomena along Awash, Wabishebele, Genaledawa, RiftValley and OmoGibe catchments were experienced flash flood and land slide.

2.Kiremt 2018 hydro-meteorological outlook

2.1Climate condition of kiremt season

Kiremt is the main rainy season for Ethiopia except South and South Eastern part. Therefore, the Northern, North Western Central and North Eastern part of the country are mostly Kiremt rain benefiting areas. It covers from June to September. Among the major catchments which are benefited from Kiremt season are Tekeze, Abay, Baro Akobo, Rift vally, Omogibe, Upper parts of Afar Denakil, Upper and Middle Awash and Upper part of Wabishebele and Genale Dawa. Climatologically, onset of Kiremt starts with the South Western part and ends with the North Eastern part of the country and Cessation star begins from the Western to Eastern parts of the country.

2.2 Selected analogue Year

For the comiing 2018 Kiremt season, 1996, 2001, 2006 and 2012 are the four selevcted analogues years. Among these, 1996 and 2006 are selected as the best analogue years. The Aridity index for these two best analogues years are calculated and viewed out on catchments based map using geostatistical kriging method.

2.3 Aridity Index for selected best analogue years

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.

Figure 2.1 (a,b,c and d) indicates the aridity index of best analogue years (1996 and 2006) for Jun, July, August and September Months.

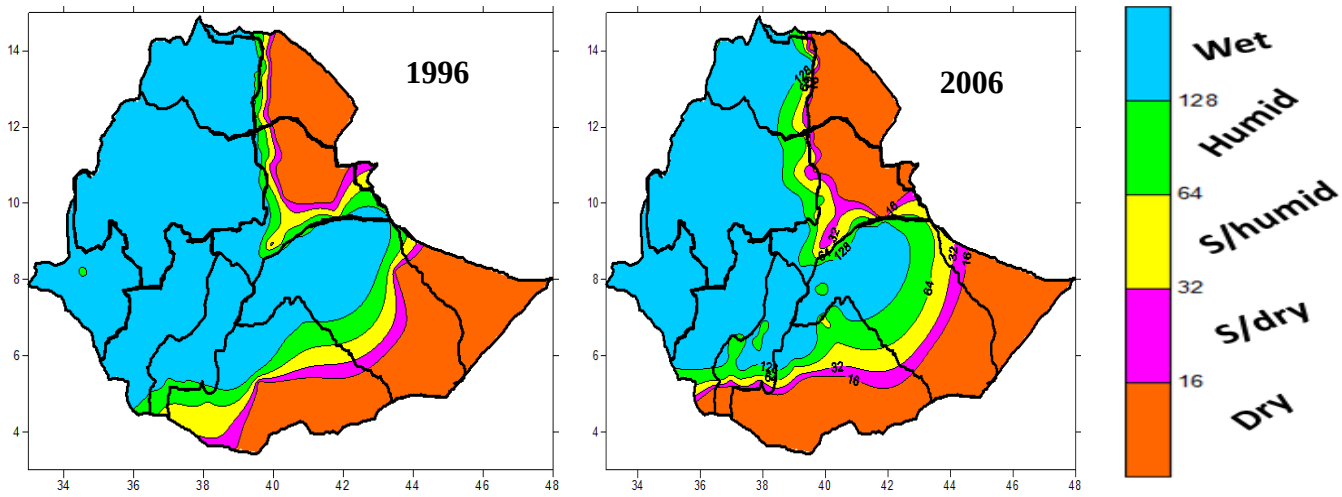


Figure 2.1 (a) Aridity index of 1996 and 2006 for June

June:- The wet weather condition were observed over western parts of the country. According to this, most of Abay, OmoGibe and BaroAkobo and lower, Upper Genale dawa and middle parts of Tekeze, Rift Valley, upper Wabishebele, Upper Awash, Wabishebele and GenaleDawa catchments were under wet condition. Upper and middile Genale dawa, Wabishebele some eastern part of Awash River basin got semi dry to humid condition.

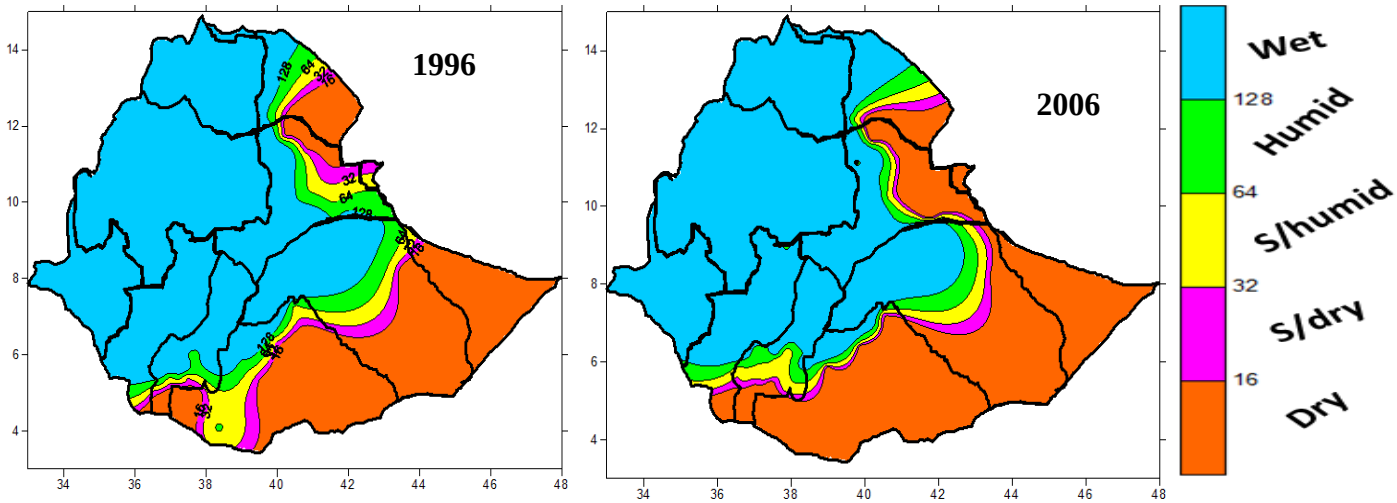


Figure 2.1 (b) Aridity index of 1996 and 2006 for July

July:-The wet weather condition was observed over Central, North and North western catchments of the country. With this, the Wet aridity Index expendaded to the eatern catchments compared to June month. During this Month, Abay, Tekeze, Baro Akobo, Rift vally have got wet moisture and Upper and middile Omogibe and Awash, Upper, Genaledawa, Wabishebele and Afar Denakil have had wet aridity index. The remaining catchments especially their upper part had had Semi-dry to Humid condition.

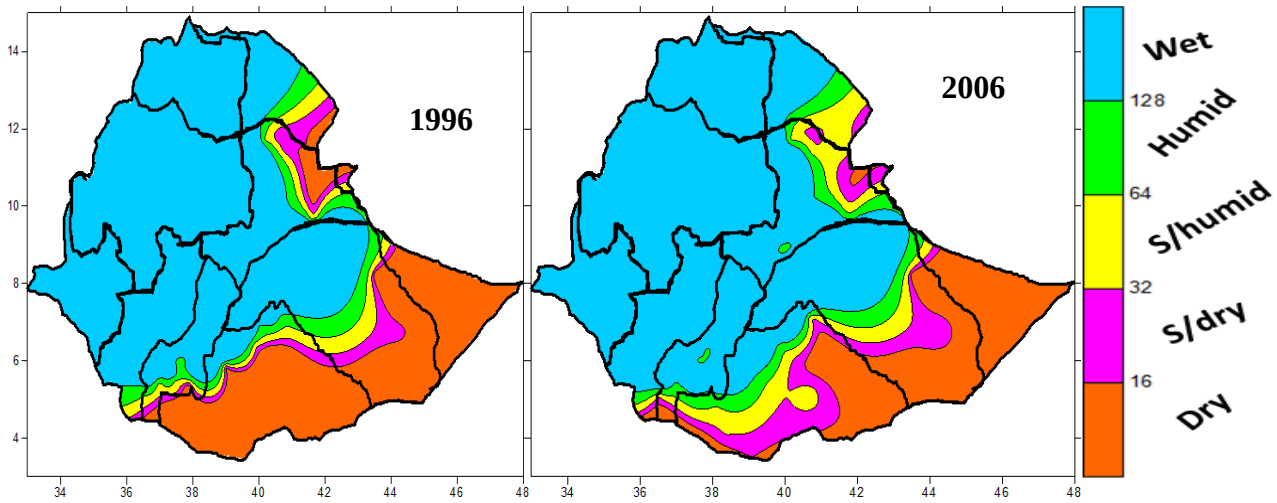


Figure 2.1 (c) Aridity index of 1996 and 2006 for August

August:- Abay, most part of Awash, Baro Akobo, Tekeze, OmoGibe, Rift vally, most part of Afar Denakil, uper GenaleDawa and Wabishebele catchments were under wet condition. Middil to lower Afar Denakil, Omogibe and middil Wabishebele have got semi arid to Humid condition.

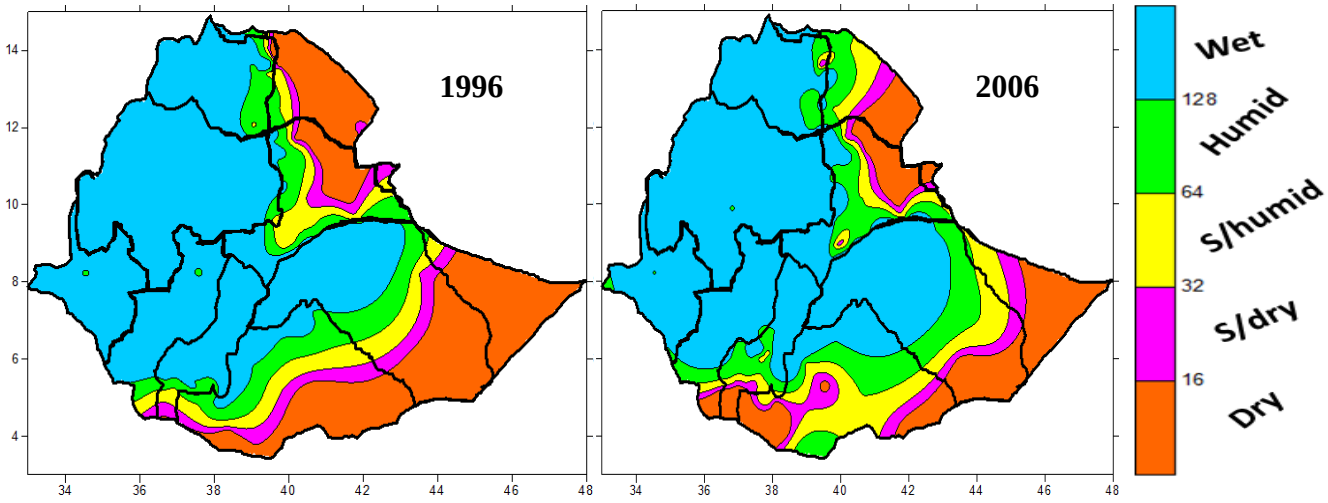


Figure 2.1 (d) Aridity indexes of 1996 and 2006 for September

September:- Since the season cesation starts from the western part of the country, the Aridity index indicated reduction from the western catchments especilly Afar Denakil, Awash and also it reduced from the southern part of the country. However, Abay, Tekeze, Baro Akobo, Rift Vally, OmoGibe Catchments have got persistant Wet Aridity index.

2.4 Tercile rainfall probability for Kkiremt, 2018 season

The rainfall Tercile probability of kiremt 2018 season indicates that the Lower part of tekeze, Some upper part of Abay is expected to get dominantly Normal rainfall and Upper and middile Wabishebele, Upper Genale dawa, Most part of Omogibe, Riftvally and Baroakobo are anticipated to get Dominantly Normal to above normall Rainfall wheras Most part of Abay, Middil and lower Tekeze, Afar Denakil, and Awash catchments are expected to get Normal to above Normal Rainfall (Figure 3.2).

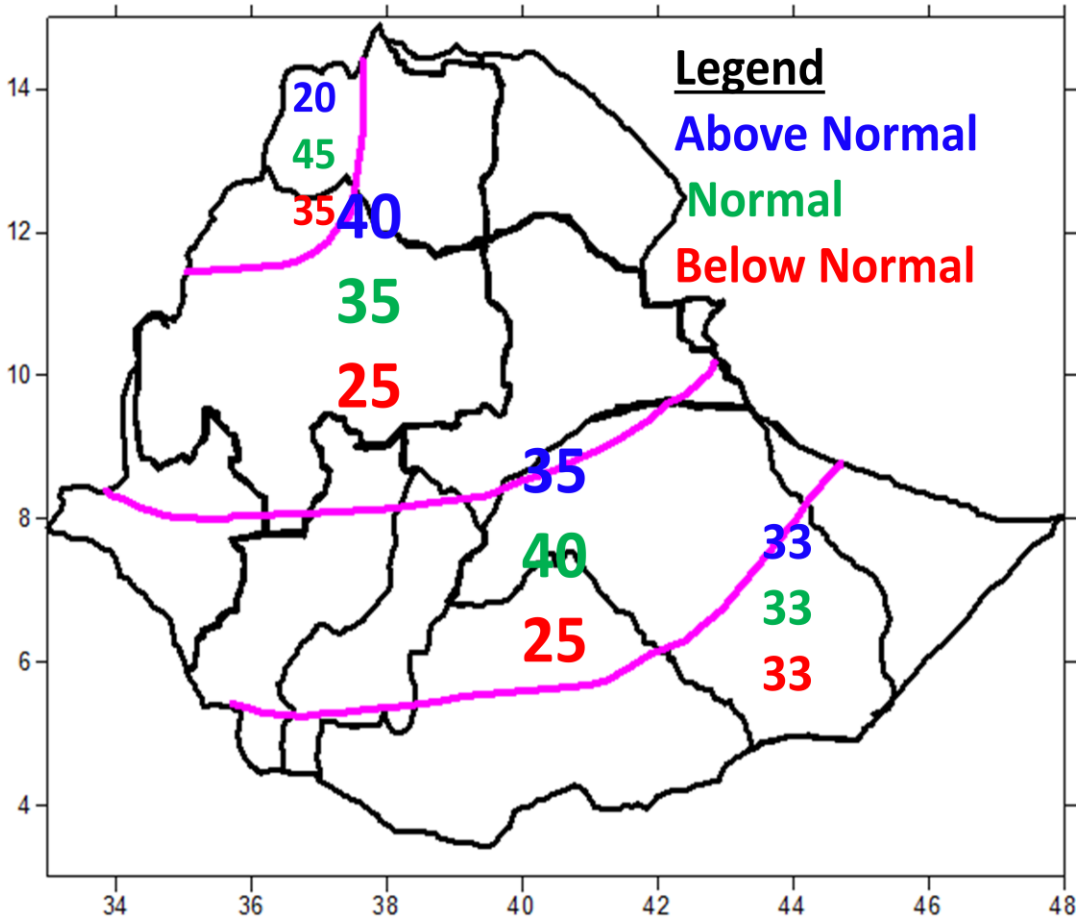


Figure 2.2 Rainfalll tercile probability of Kiremt 2018 season.

2.5 Conclusion and Recommendation

In the coming kiremt 2018 season, most part of kiremt benefiting areas are anticipated to be under wet condtion. Besides to this, heavy fall is also expected over kiremt benefiting areas especially over highland areas. Tana beles, OmoGibe1, Koka, Tekeze and Wabishebele and Fincha reservoir and dams have already reaching to their maximum level from the Belg season, therefore, close monitoring of the dams and reservoir is needed to be done during Kiremt 2018 season.

Due to wetness of the bseason and expected heavy falls, probability of flood, flash flood and land slide are highly anticipated over most flood prone areas and rugged places of the country. Therefore, we advise the responsible bodies to be prepared to control before these hazards affect the socio-economic activities of the country. The towns should also be prepared by clearing the river channels and diches. Sectors involving water development and early warning activities should be aware and prepared to manage and utilize this seasonal water resource properly.

The National Meteorological Agency produce the 10 daily, monthly and mid seasonal outlook for the season.Therefore, we advice all stakeholders to follow up the forecast and advisories inorder to utilize the seasson rainfall and manage the impacts properly.