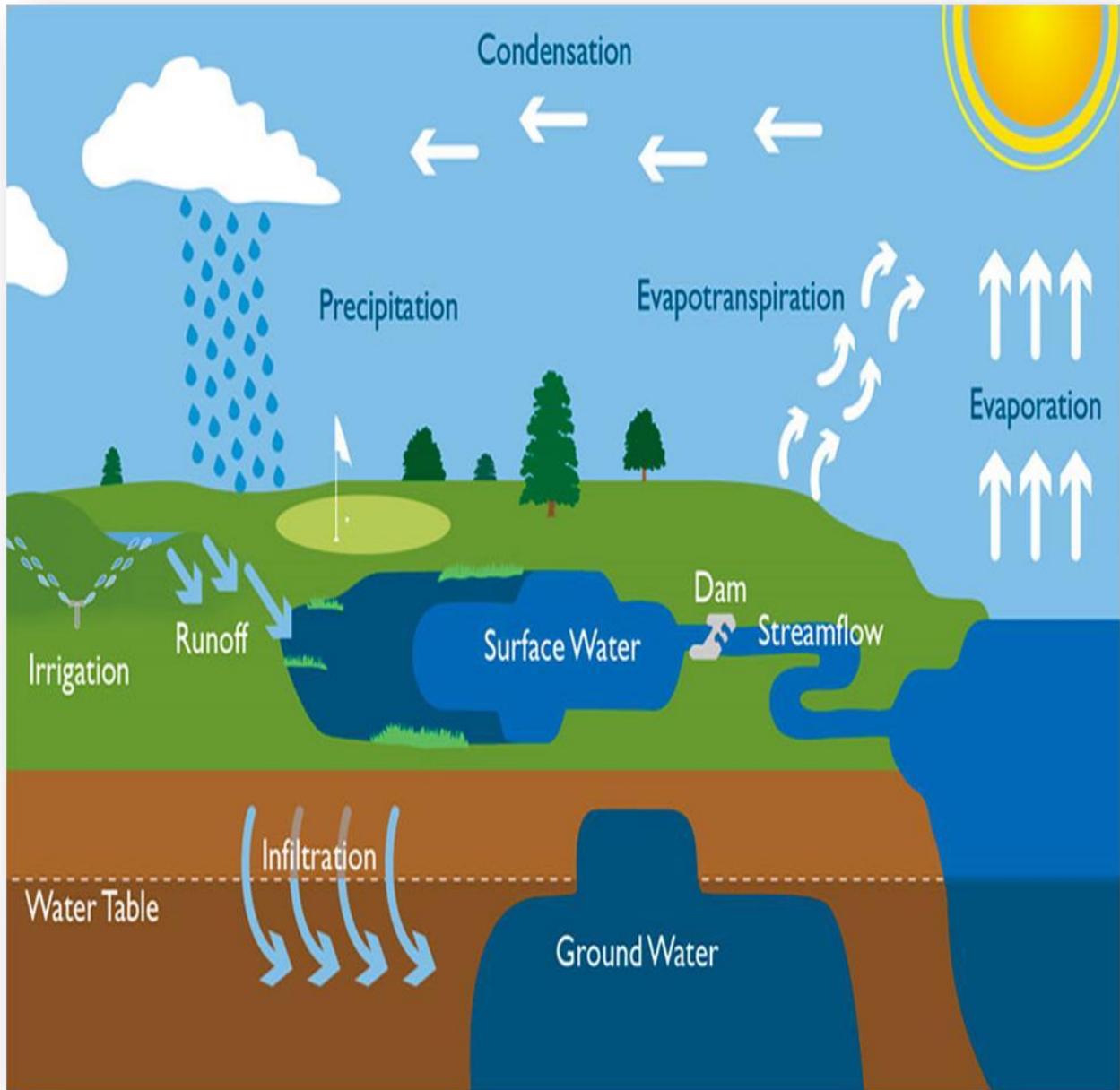


Ethiopia Meteorology Institute



Hydro Meteorological and flood monitoring Bulletin for Bega, 2023/24
impact assessment and Hydro meteorological impact outlook for Belg,
2024

Foreword

This seasonal hydro meteorological bulletin is prepared and disseminated by the Ethiopia Meteorological institution (EMI) 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 km². 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 11 040` and 15 012` N, and 36 0 30` and 390 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 130 N South of Gondar to 110 30`N, and west of 390 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 Tena, 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 40⁰ E of Tigray, North of 11⁰N of Wollo, narrow coastal strip south of 14⁰30`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 11⁰ 40` N of Wollo, south of 9⁰ 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.

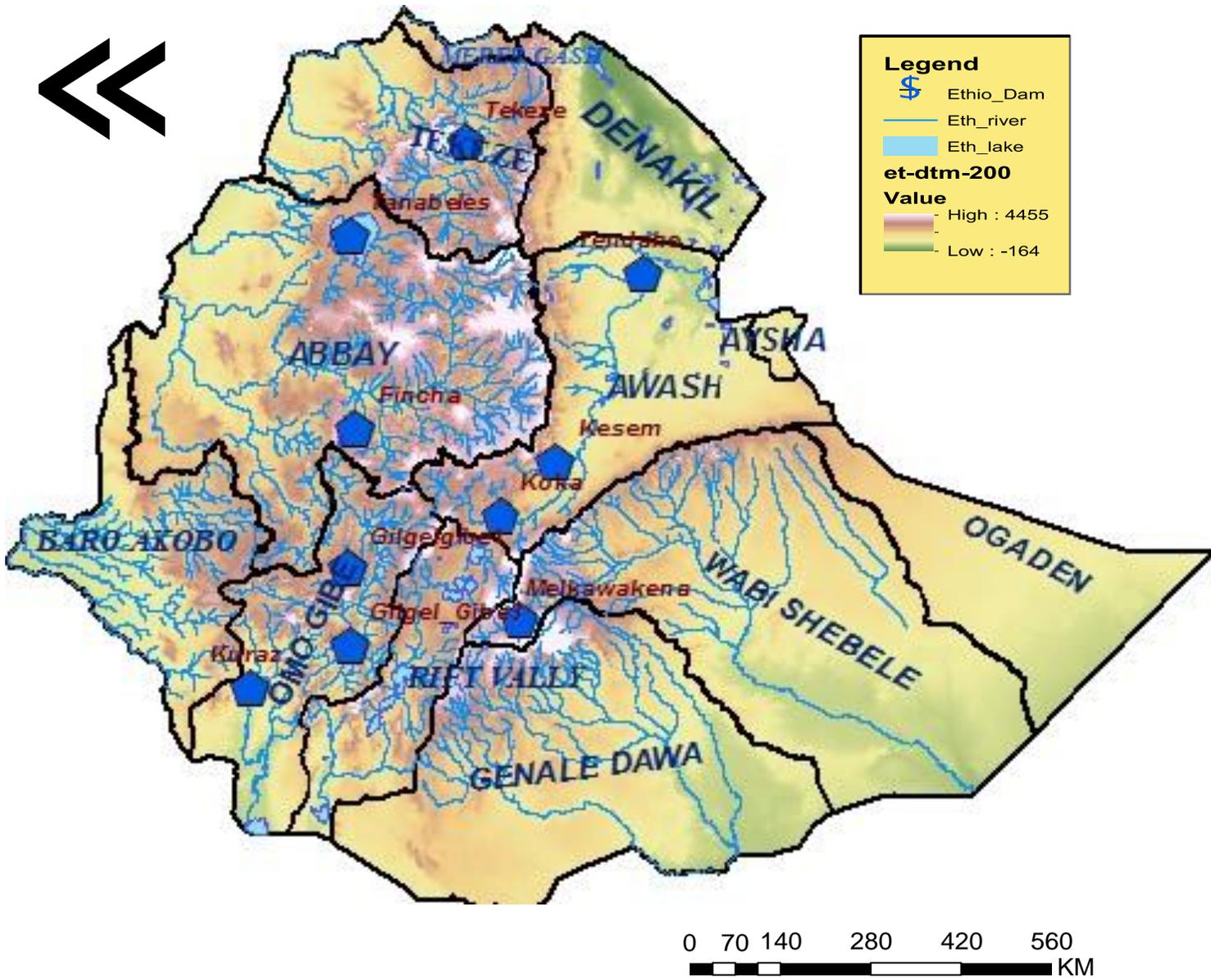
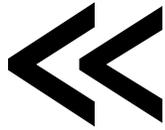
Genale Dawa Catchment: -

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.

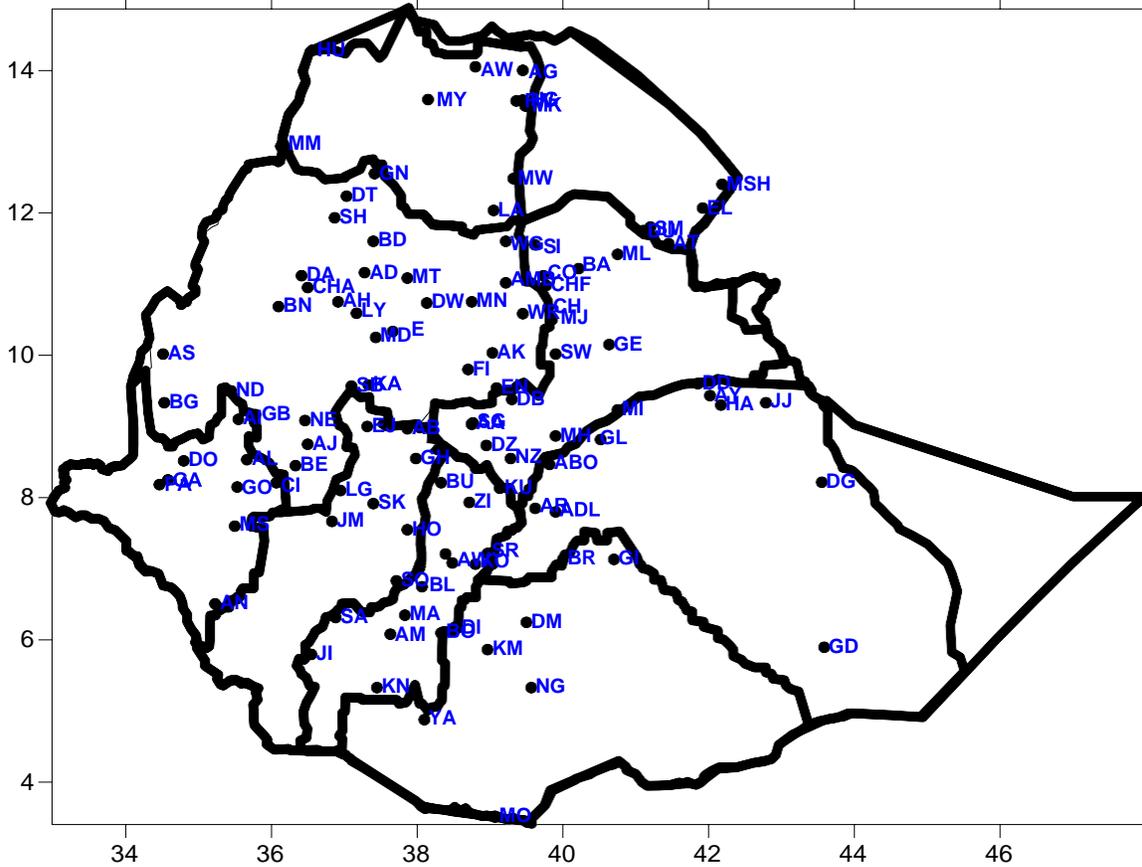
III. Major River Catchments in Ethiopia, Location and Spatial Status

No.	Catchment Name	Area (km ²)	Length in Kilo meter			Volume of water bm ³ /An num	Altitude (meter) <i>Peaks</i> (Highest & Lowest)
			Within Eth.	Outside Eth.	<i>Total</i>		
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

IV. Basin map of Ethiopia



V. 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 Tadore	DT	Jinka	JJ	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 EMI. 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. Bega season description

Bega from October to January is mostly an arid season for most parts of the river basin except Ogaden, lower and middle Wabishebele, Rift valley, lower OmoGibe, middle and lower Genale Dawa as well as lower Rift Valley catchments. The main rainy months with Bega season are October and November provides rainfall mainly for southern, south eastern and south western catchments. Sunny and windy condition dominated across many river basins thus it increase the loss of water by evaporation. Surface runoff not occurs during Bega hence, the flow of river water is low. In the meantime springs and ponds starting to dry up after mid Bega season. Availability of water is also decrease across upstream of main river basins. In some years unseasonal rain slightly fevered for water availability.

Methods

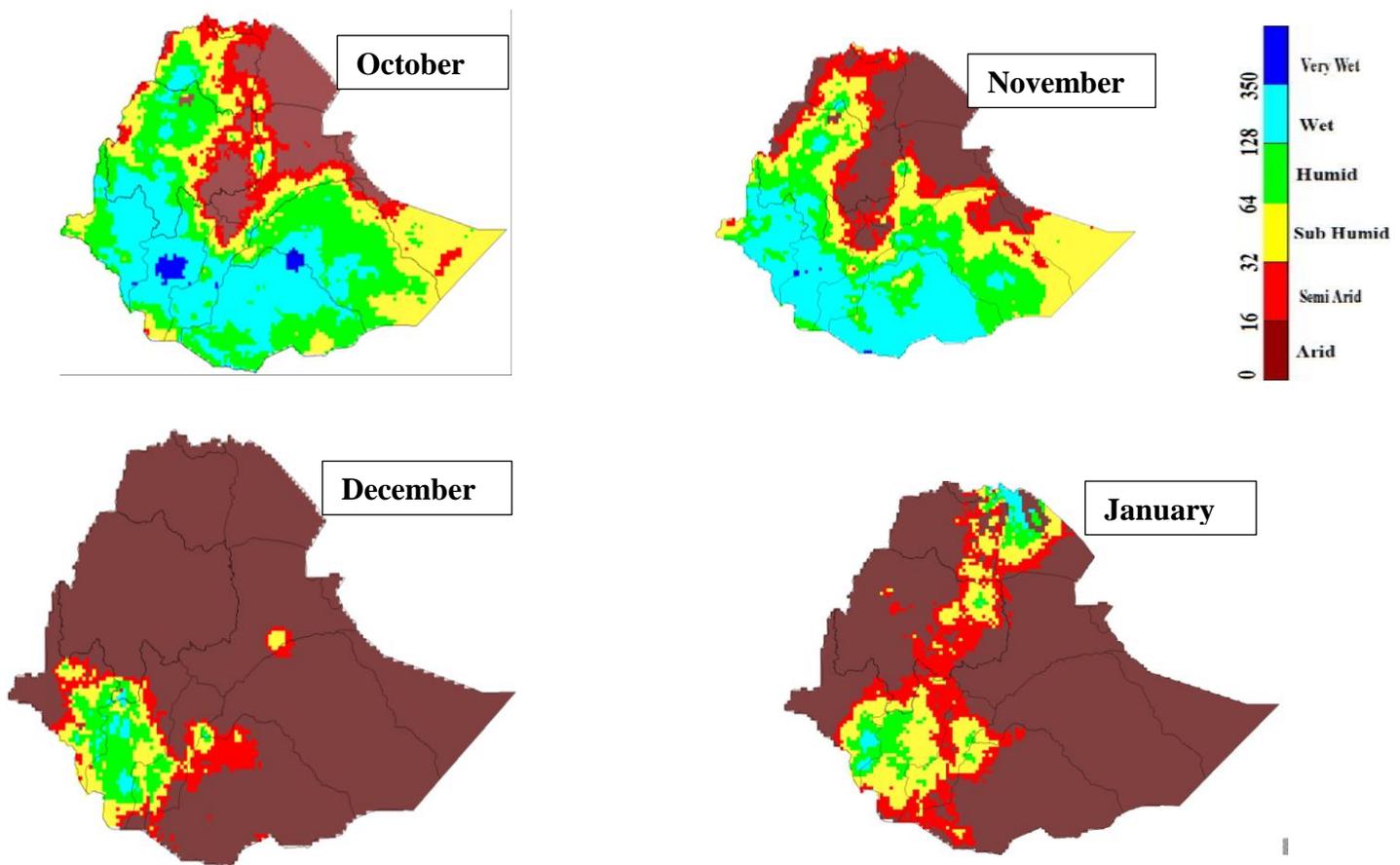
To compute the aridity index we use Thornthwait method, which is computed from the monthly values of rainfall and evaporation. The evaporation is computed empirically from mean monthly air temperature. In assessing the effectiveness of rainfall, in terms of water availability relationships between the rainfall and air temperature has been worked out in terms of moisture indices. The aridity index values above 350 which shaded in Blue green very wet and 128 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

2. Aridity status for Bega 2023/24 at different river basins

October and November: most part of in OmoGibe, Genale Dawa, Wabishebele, lower Abay Baro Akobo, Lower and middle Omogibe, Rift Valley, lower of Tekeze, River basins have experienced humid to wet moisture condition. This condition has positive impact for water availability over Bega Benefiting catchments. Other River basins are not explained above was dominantly prevailed under arid and semi-Arid condition.

December and January the wet moisture condition has decrease from the northern and North West shift to few area of south western and south eastern catchments, especially to Bega benefiting catchments during those month upper part of Baro Akobo, middle and lower Omo Gibe, Rift valley upper Genale Easter part middle Abay had Humid to wet moisture condition, and the rest most part of Awash, Wabeshebele, Ogaden, Tekeze, and Abay were performed Arid to Semi-Arid moisture conditions.



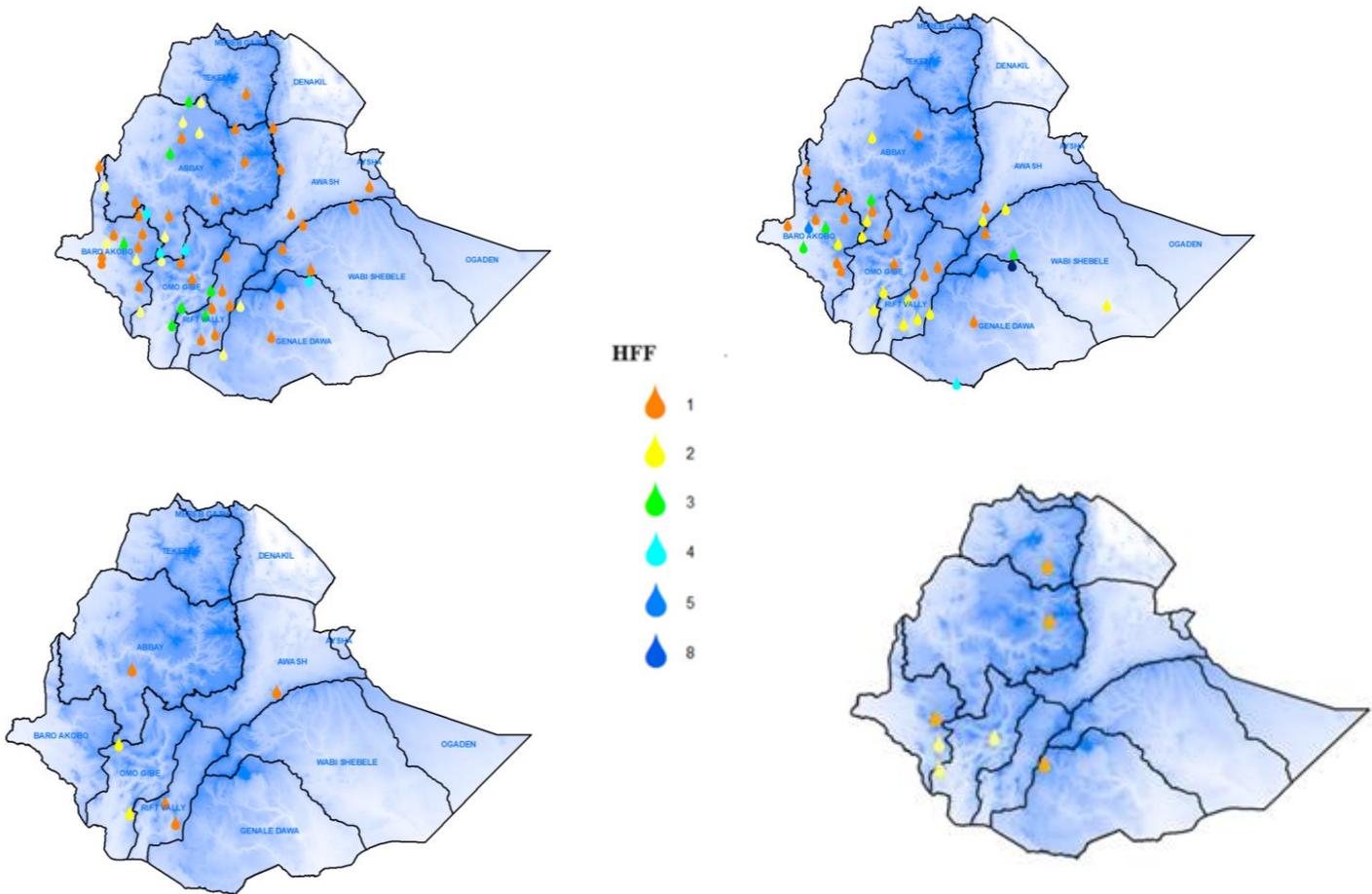
(Fig.1) Aridity Index for October, 2023 to January, 2024.

Distribution of heavy fall days exceeding 30mm during October to January, 2023 / 24 over different river basins .

In October, 1-4 days heavy fall was recorded over Abay, Baro-Akobo, Omo-Gibe Rift- Valley,

and Genale-Dawa Catchments. Maximum frequency of heavy fall days was observed over, Omo gibe, Abay catchment and GenaleDawa for 4 days.

In November and December, heavy fall was observed over Baro Akobo, Abay and Omo gibe Catchments. Heavy fall was observed for two day over different stations. The seasons of maximum frequency observed in Upper Genale Dawa Ginir station, and January was few basins observed one to two days. Such as upper GenaleDawa, middle OmoGibe and upper BaroAkobo and middle Awash.



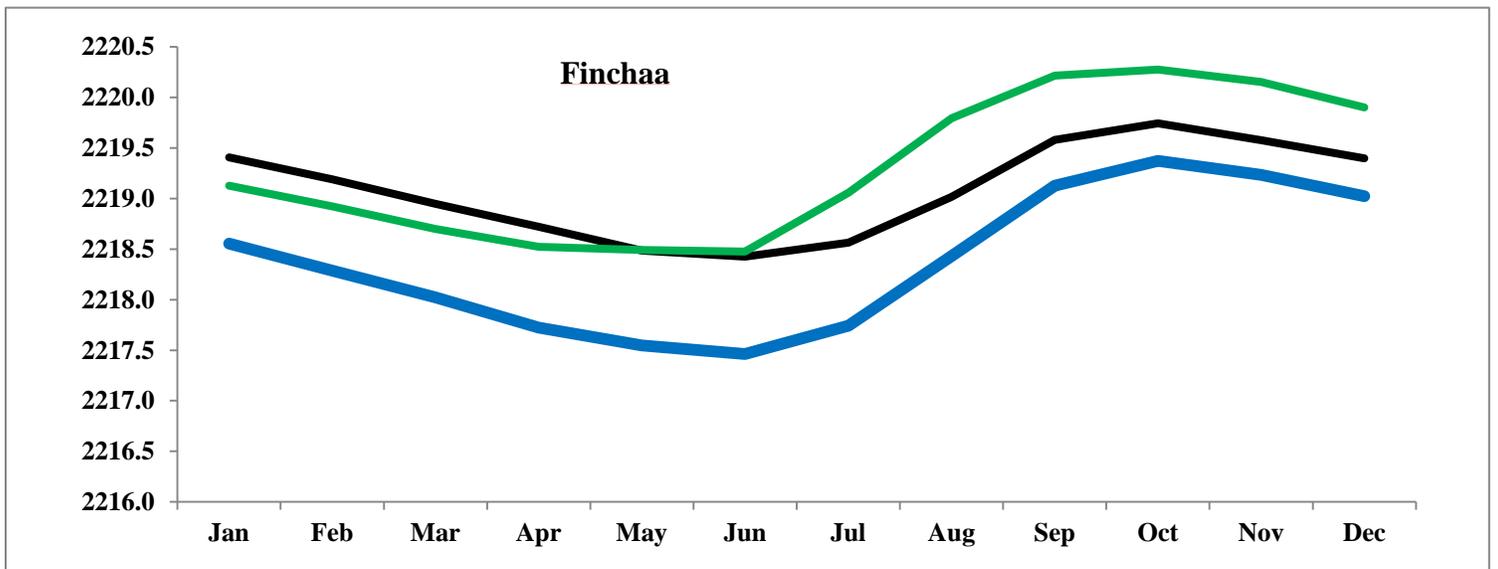
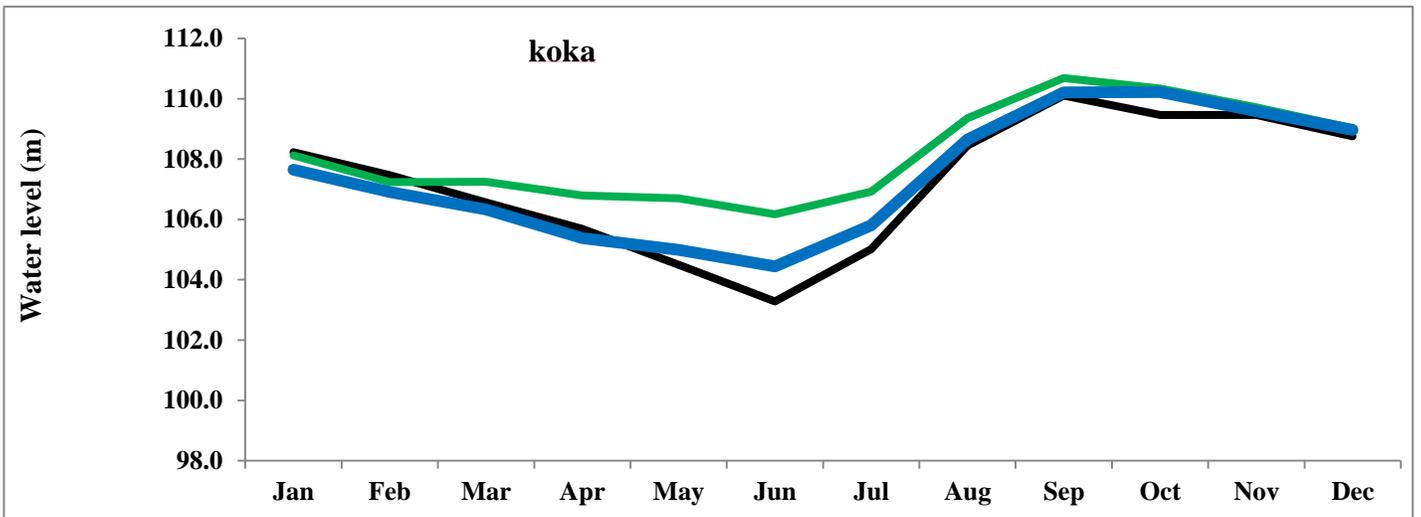
Distribution of heavy fall exceeding 30 mm per day over different river basins 2023/24

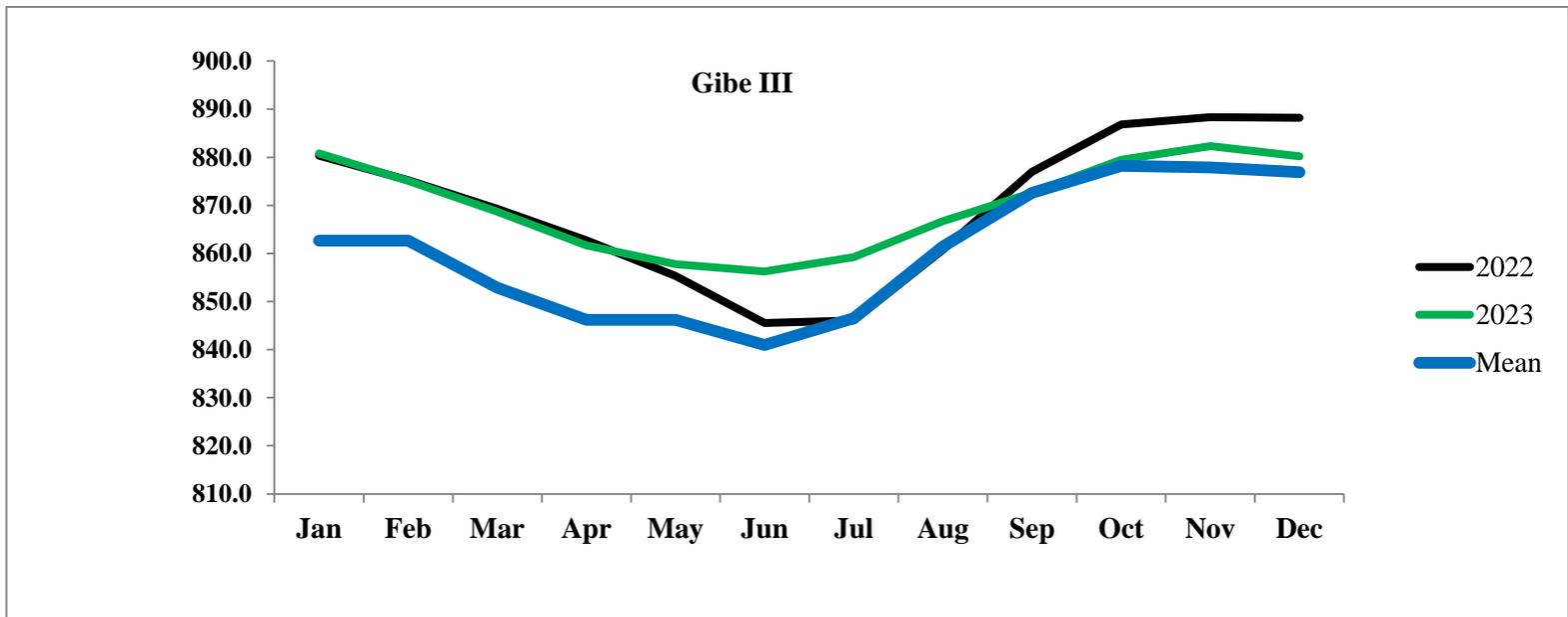
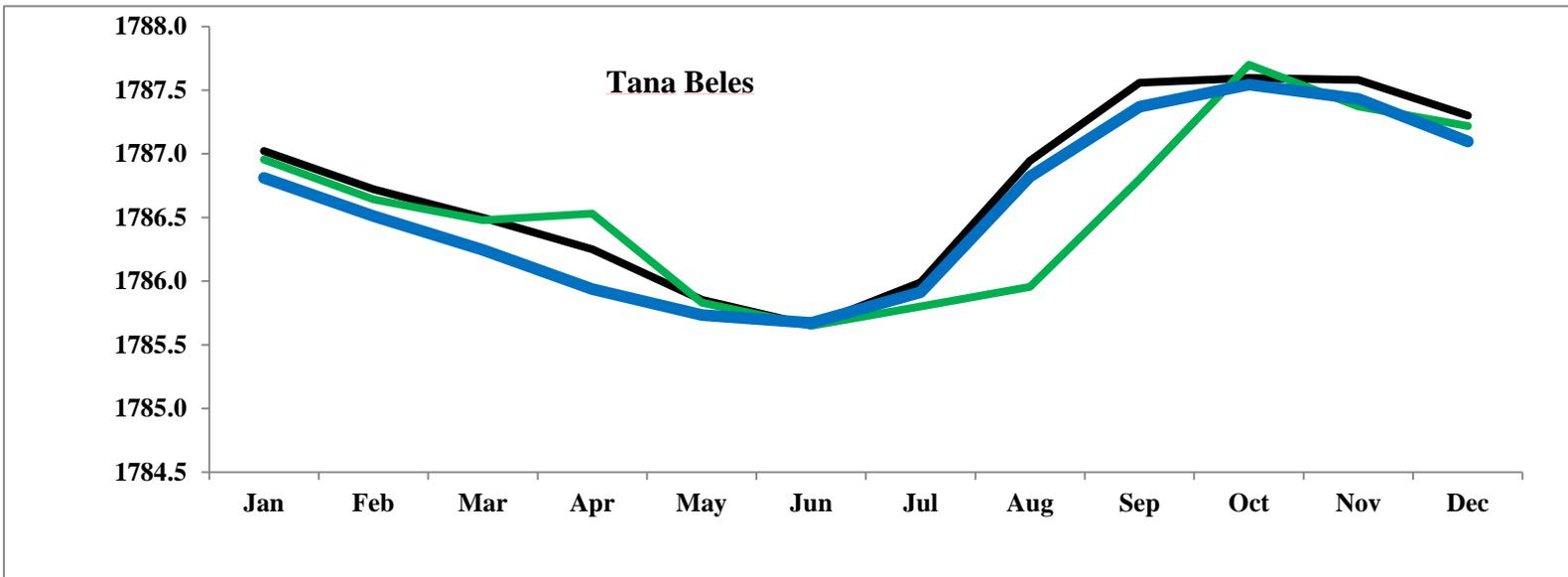
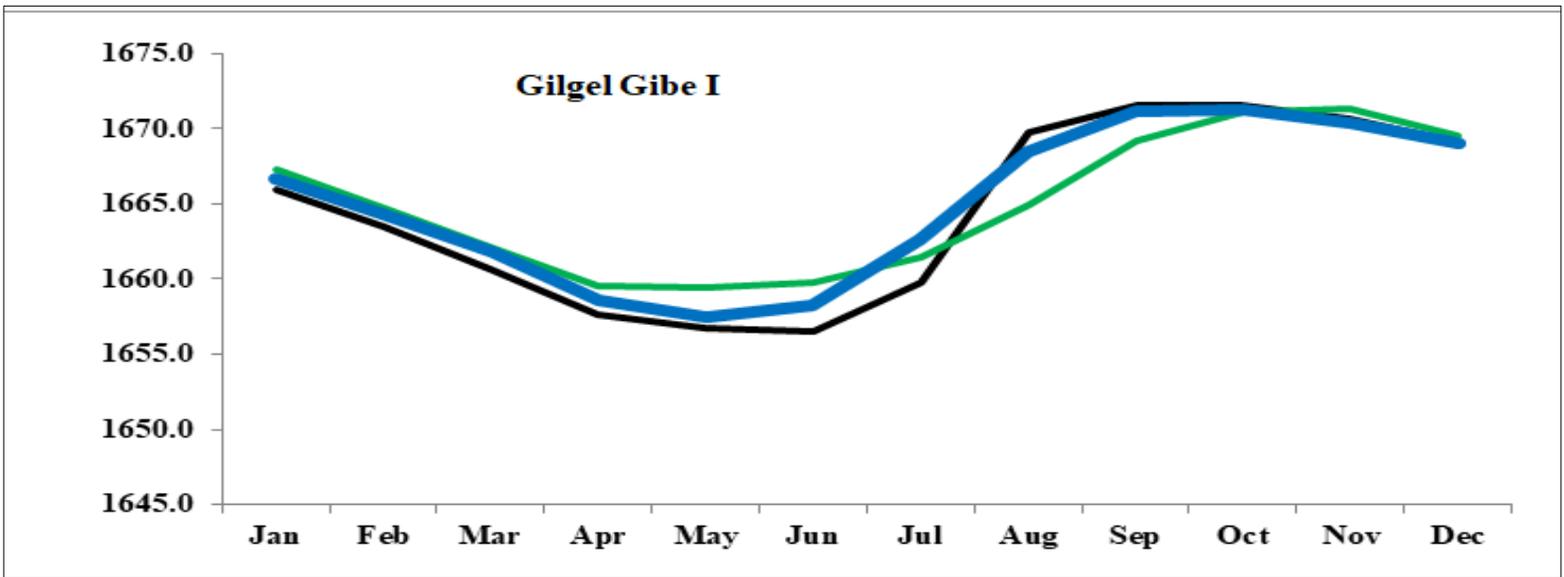
(Fig 2) Distribution of heavy fall October to January, 2023/24

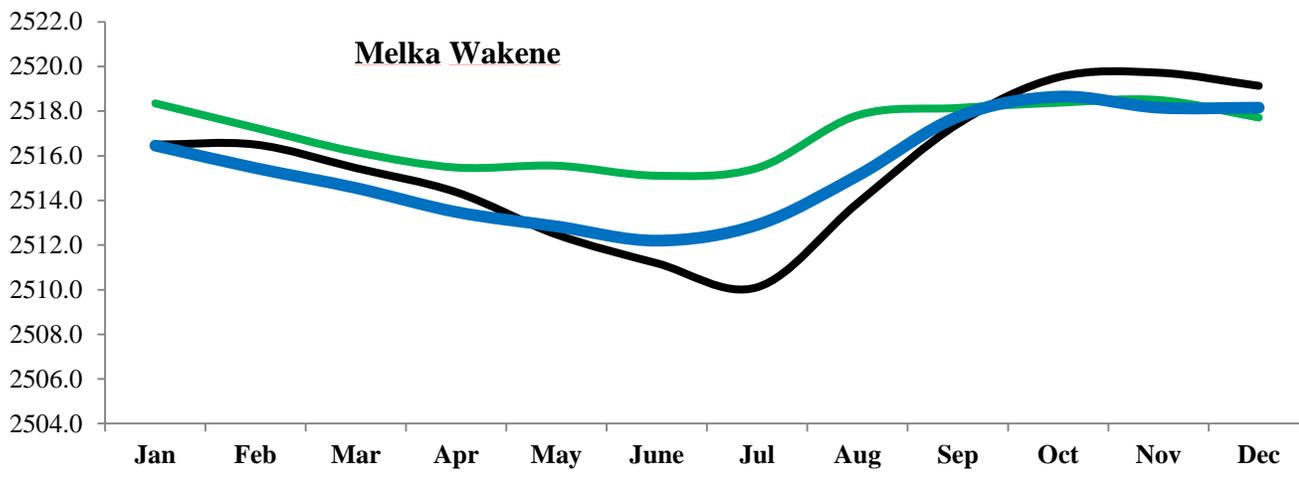
3. Performance of Dams and Reservoirs water level in Bega 2023/24 season compared to long mean

4.

The main source of runoff is rainfall which is the input for Dams, reservoirs and ponds but in Bega season runoff is not occur and flow of river is less. While during in some years Bega may give rain for some catchments which contribute for availability of water. The Performance of 2023/24 was sub humid to wet October; therefore the current dams and reservoirs water level in comparison to long mean had shown better condition. Shown below in figure 4a-f).







(Fig.4a-f) Water level of different dams.

5. Summary

In **October** most part of Abay, BaroAkobo, Omogibe, Rift Valley, Genale Dawa, upper Wabishebele and lower Tekeze had experience humid to wet moisture condition. This condition has positive impact for water availability over Bega Benefiting catchments. Moisture status of November was weaker than October. In October, 1-4 days heavy fall was recorded over Abay, Baro-Akobo, Omo-Gibe Rift-Valley, Awash and GenaleDawa Catchments. Maximum frequency of heavy fall days was observed in November GenaleDawa at Ginir station for 8 days

In **December and January** heavy fall was observed over upper part of BaroAkobo for Two days and few basins have one day over different stationsin.

Conclusion

- The moisture performance of Bega 2023/24 was experienced under sub humid to wet most Bega moisture benefiting basins.
- Better moisture performance was observed in October over most catchments of southern, south west, south eastern, Central and western catchments of the country.
- During November heavy fall event in this season maximum frequency on GenaleDawa at Ginir station for 8 days.
- Reservoirs and dams water level performance have shown better status in comparison to the mean.

Hydro-meteorological outlook for Belg 2024 over different riverbasins

1. Introduction

Belg rainfall contributed for surface runoff about 5 to 7% during wet Belg season. Seasonal rainfall benefiting catchments are found across eastern half, central and southern portion of the country. It has more benefited to compensate the shortage of water when there is a good performance of rainfall. Belg rain contributes to minimize extended dry condition (Bega season) and evaporation effect from open water surface across Belg rain benefiting catchments. Another main feature of this season is occurrence of high temperature over most river basins.

2. Selected analogue Year

For the coming Belg season the selected analogue year **1998, 2010, and 2016** were compared based on probabilistic seasonal forecast for **Belg 2024** and viewed out on catchments based map using geostatistical kriging method. Among those **2010** is the best analogue year that can enlighten the Aridity status in the coming Belg season.

3. Methodology

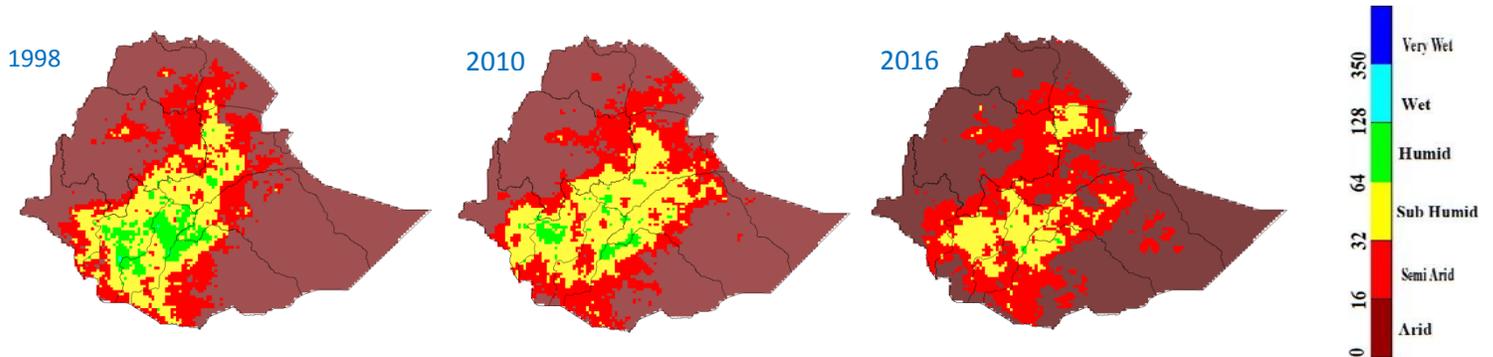
Thornthwaite introduced the concept of the precipitation effectiveness index, which is computed

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.

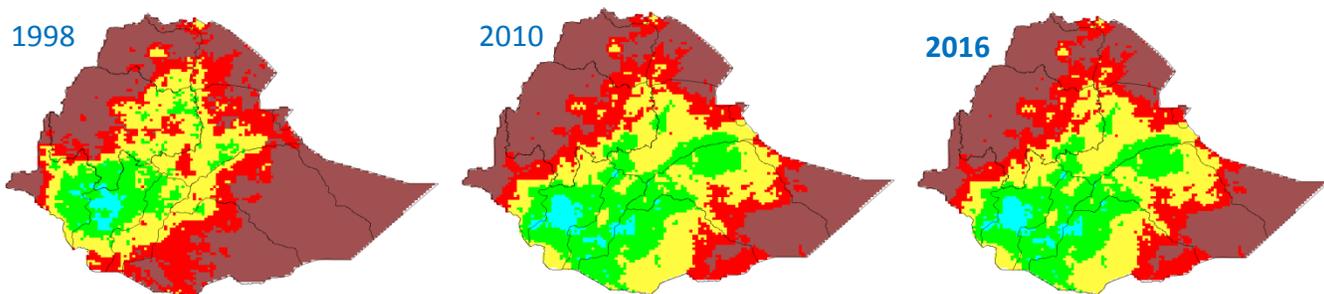
Where, RF= monthly rainfall in mm;

T = mean monthly temperature in C°

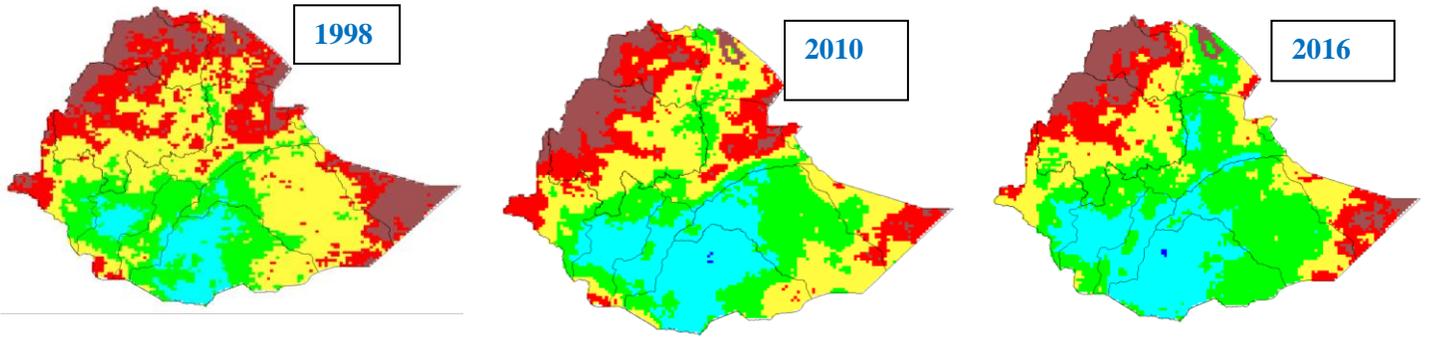
February:- Based on the three analogue years, Belg moisture benefiting catchments start getting some amount of moisture over few basins, and the current belg status the moisture early onset most belg benefit areas, therefore most basin will performed arid to and semi-Arid, but few place of the basin are sub humid to humid moisture condition, such as most of OmoGibe, Rift valley, Upper Awash, Few area middle Eastern Abay.



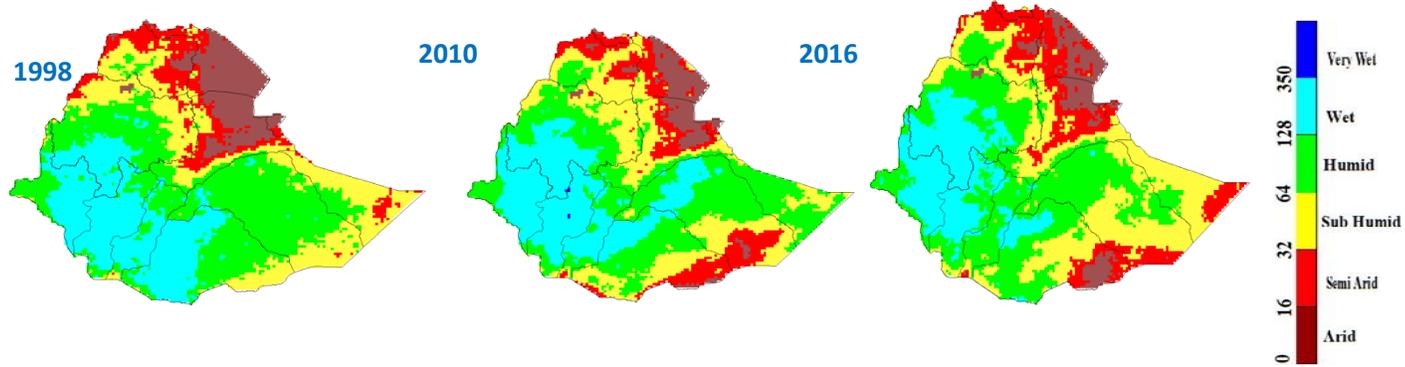
March:- In this month, there would be starting spatial distribution of Belg moisture benefiting catchments, according to this, except analogue year 1998 year, showed domination of humid to wet moisture condition over most part of Abay, Omo-Gibe and Rift valley, Genaledawa, upper Wabishebele, upper and middle Awash and upper BaroAkobo catchments, The rest most parts of the river basin were Arid and semi-arid performed.



April:- In this month Better moisture distribution performed across Belg benefiting catchments of all selected analogue years. Whereas most parts of Omo Gibe, Rift valley, GenaleDawa, upper and middle BaroAkobo, Wabishebele and middle Abay catchments were performed under wet to very wet moisture condition



May: - During this month, the wet moisture condition of spatial distribution was increased 2010. However, during 1998 and, 2010 decreased the spatial coverage compared to 2016 over belg moisture benefiting riverbasins. Generally Except lower Awash, and AfarDenakile and tekeze basins were Belg moisture benefiting catchments were under wet moisture condition.

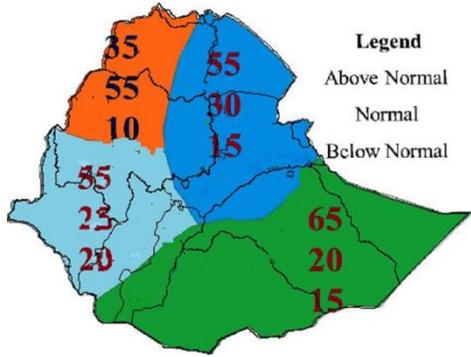


Hydro-Meteorological Summary and advisory for coming Belg (FMAM), 2024

The coming belg 2024 that they will get moisture close to normal to Above normal in the connection with the expected that the rain pattern Early onset, in the first month of belg benefit basin will be mostly dominantly Sub humid to humid, from march most belg benefiting catchment will expect high amount moisture condition over most belg benefiting river basins.

Tercile probability on basin map for coming belg

Southern half and south eastern basin will humid to wet condition.
 Western, south western and central basin will expect humid to wet condition.



Positive impact

- Good opportunity recharging surface and ground water
- Maximized hydropower generation.
- Better opportunity to harvest rainwater.
- Normalize water potential over dams and reservoirs due to good inflow

Negative impact

- Risk of riverine and Flash flood over flood prone areas.
- Likelihood of damaging of irrigation structure and wash facilities,
- Risk in life, properties and infrastructure.

Advisory

- Manage/repair drainage structures.
- Close monitoring of rivers for riverine flood.
- Balanced hydropower generation.
- Equitable water management to reducing water conflict.
- Utilize forecast & early warnings to areas prone.
- Create communities awareness for risk Areas.

