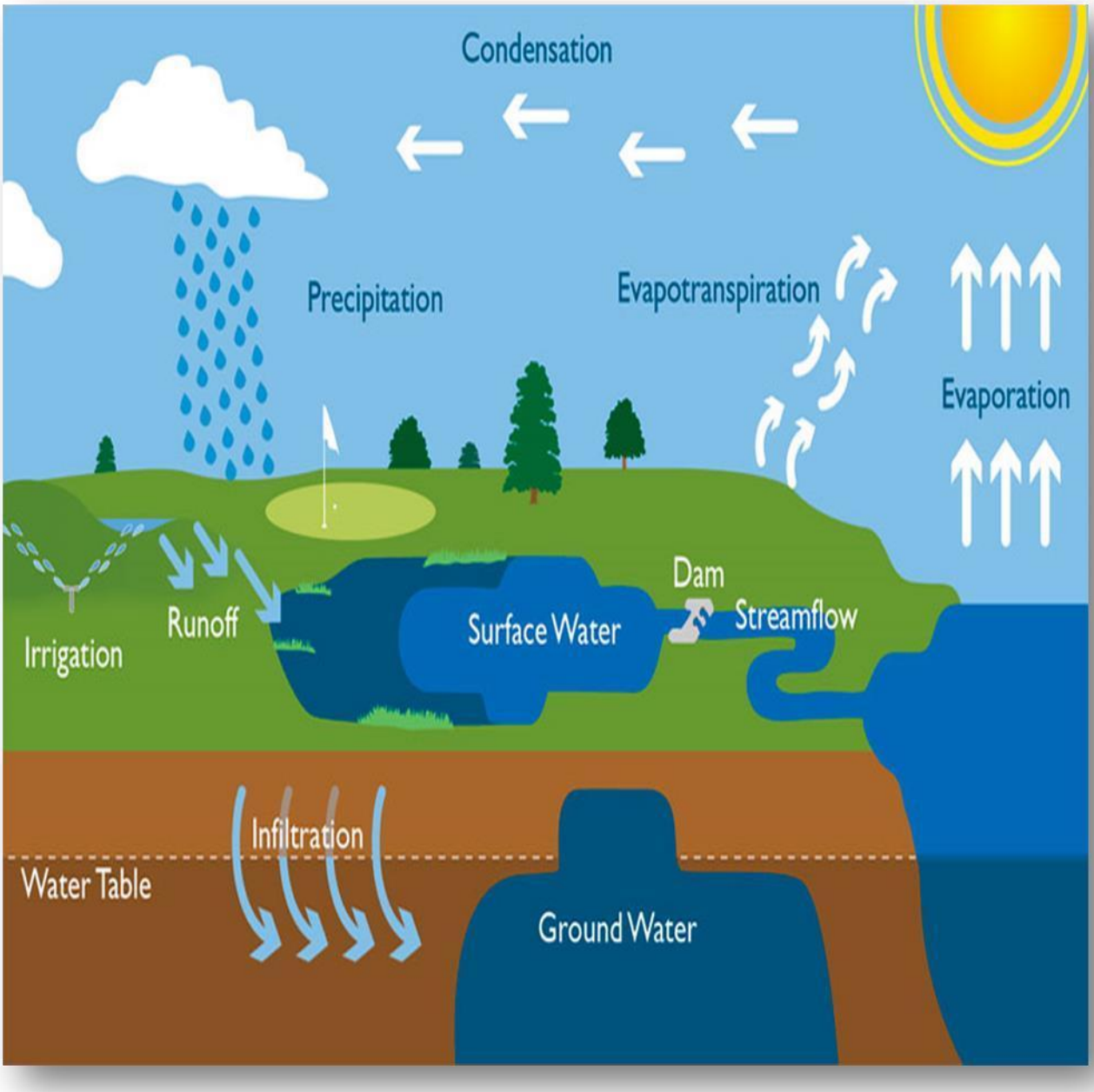
Ethiopia Meteorology Institute



Hydro Meteorological and flood monitoring Bulletin for Bega, 2024/25 impact assessment and Hydro meteorological impact outlook for Belg, 2025

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 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

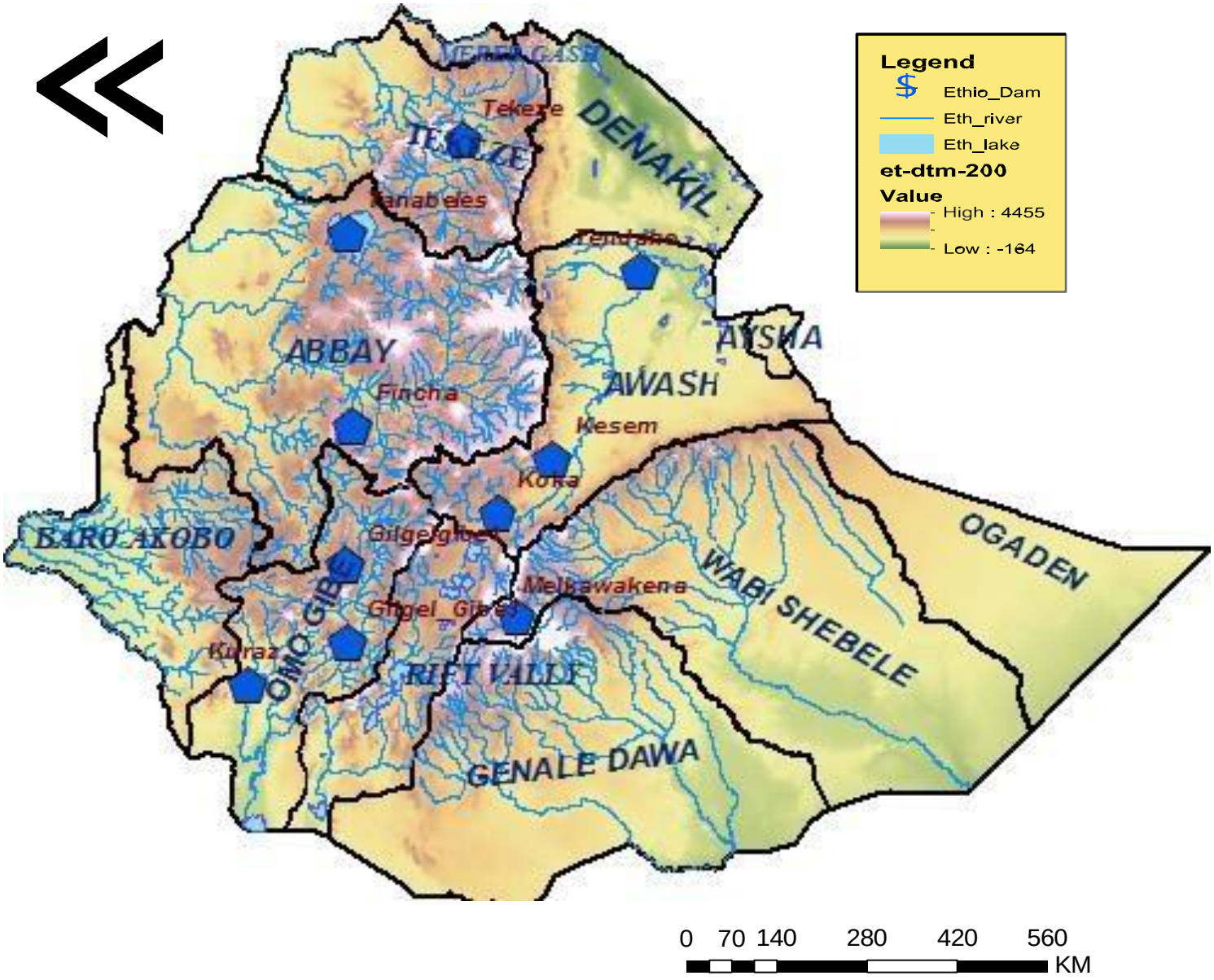
Catchment	**Location**
Mereb – Gash Catchment: -	Northwestern tip of Tigray.
Atbara-Tekeze Catchment: -	The Tekeze River basin is situated in the northwest of Ethiopia between 11 040` and 15 012` N, and 36 0 30` and 390 50` E. It is bordered by the Mereb River basin and by Eritrea in the north, the Atbara 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 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 11^0N 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.

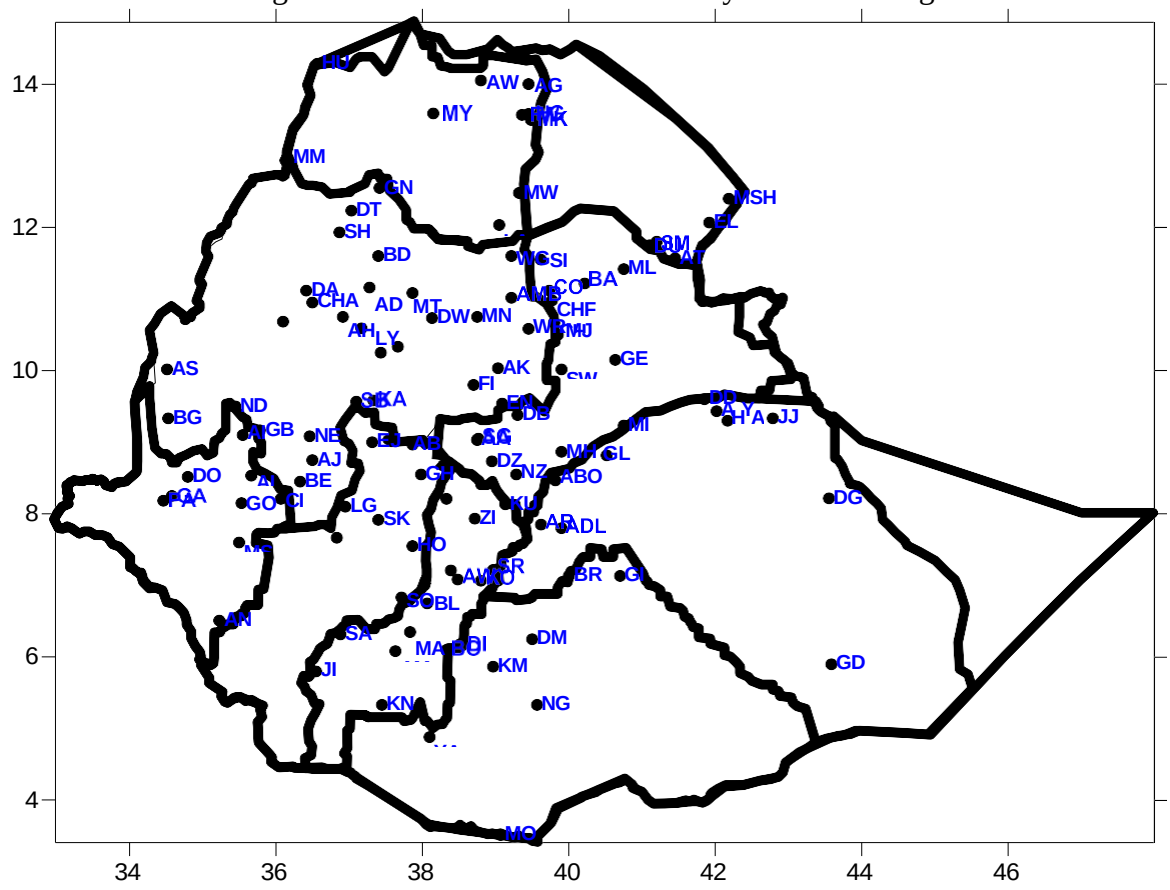
III. Major River Catchments in Ethiopia, Location and Spatial Status

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

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**	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 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.

During the **Bega season** (October–January), Ethiopian river basins experience significant hydrological changes due to reduced rainfall and increased evaporation. In the **Abay (Blue Nile), Baro Akobo, and Tekeze Basins**, river discharge declines as there is minimal precipitation to replenish water sources. Reservoirs, such as those supporting the **Grand Ethiopian Renaissance Dam (GERD)** and other hydroelectric projects, rely on stored water from the **Kiremt (main rainy season)**. Similarly, the **Omo-Gibe and Rift Valley Basins** witness a drop in water levels, affecting major lakes such as **Lake Turkana, Lake Abaya, and Lake Chamo**. While the Gibe hydroelectric dams help regulate flow, natural tributaries shrink, impacting both hydropower production and local livelihoods dependent on fishing and irrigation.

In the **Genale Dawa, Wabi Shebelle, and Ogaden Basins**, some areas benefit from **light rainfall (Deyr season)**, which provides temporary relief to pastoralist communities. However, surface water sources still diminish, increasing dependence on **groundwater extraction**. The overall reduction in river discharge across Ethiopia leads to **water scarcity**, affecting irrigation-based agriculture and domestic water supply. **Hydropower generation** may decline in reservoirs without adequate storage, and **drying wetlands** in floodplain areas, such as those in the **Baro Akobo Basin**, threaten biodiversity. In pastoral regions, particularly within the **Wabi Shebelle and Genale Dawa Basins**, livestock face water shortages, increasing vulnerability to drought conditions.

To mitigate the challenges of **Bega**, sustainable **water resource management strategies** are essential. This includes optimizing **reservoir storage**, enhancing **groundwater recharge**, and implementing **efficient irrigation practices**. Without proper planning, the prolonged dry conditions can lead to **water stress, reduced agricultural productivity, and ecological imbalances** across Ethiopia's river basins.

Methods

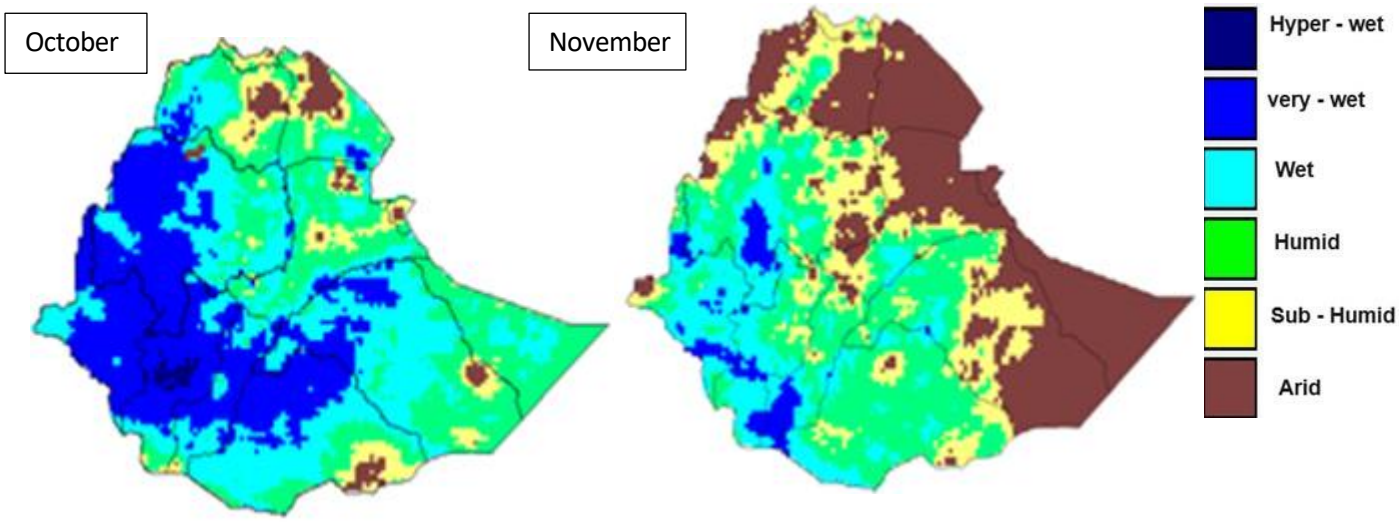
To compute the aridity index, we use Thornthwait method, which is computed from the monthly values of rainfall and evaporation. The evaporation is computed empirically from mean monthly air temperature. In assessing the effectiveness of rainfall, in terms of water availability relationships between the 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 humid, yellow sub- humid and red values show dry condition.

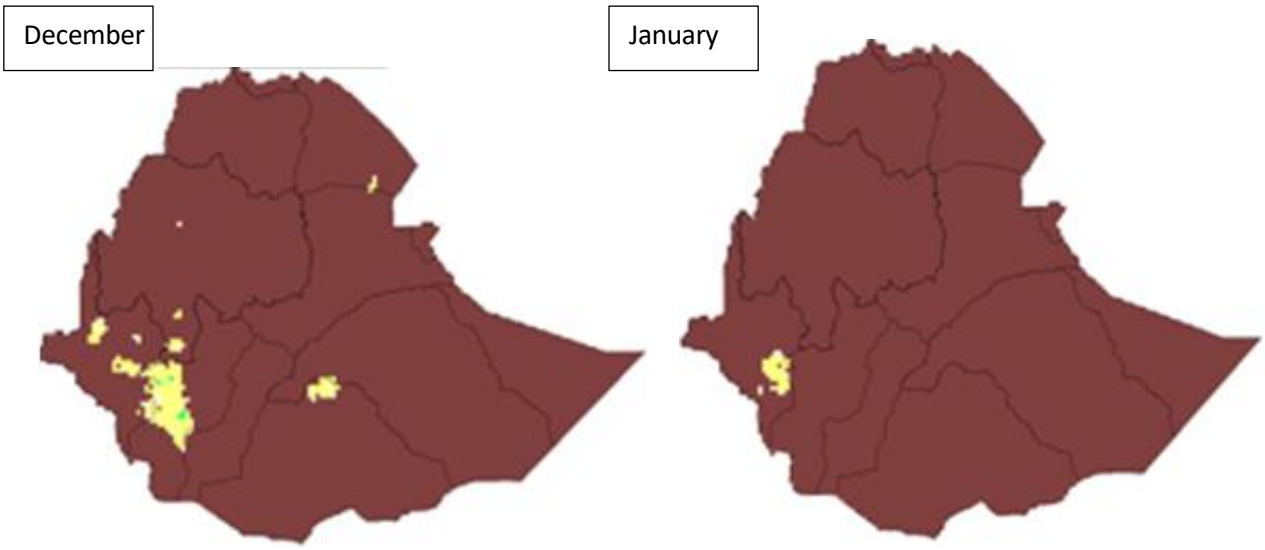
Where RF= monthly rainfall in mm; T= monthly mean temperature in °C.

Aridity status for Bega 2024/25 at different river basins

When analyzing the effects of the four-month Bega season on the water sector, particularly in October, regions such as the Abay Basin, Baro Akobo, Omo Gibe, Rift Valley, Genale Dawa, Wabi Shebelle, Ogaden, Awash, as well as the central and lower Tekezé tributaries, experienced moderate to high moisture levels. In November, exceptionally high moisture levels were recorded mainly in the Omo Gibe, Baro Akobo, Rift Valley, central and lower Abay, and some parts of the upper Genale Dawa tributaries.

Although the moisture levels in November decreased in terms of spatial coverage, hydrometeorological data indicate that the overall moisture remained significant. Particularly in Genale Dawa, Omo Gibe, central and lower Rift Valley, and upper and central Wabi Shebelle, the recorded Bega moisture contributed positively to increasing water availability in key tributaries. However, in December and January, most tributaries experienced dry weather conditions. Nonetheless, when considering the entire Bega season, human-made water reservoirs in most tributaries showed better water retention compared to long-term averages.

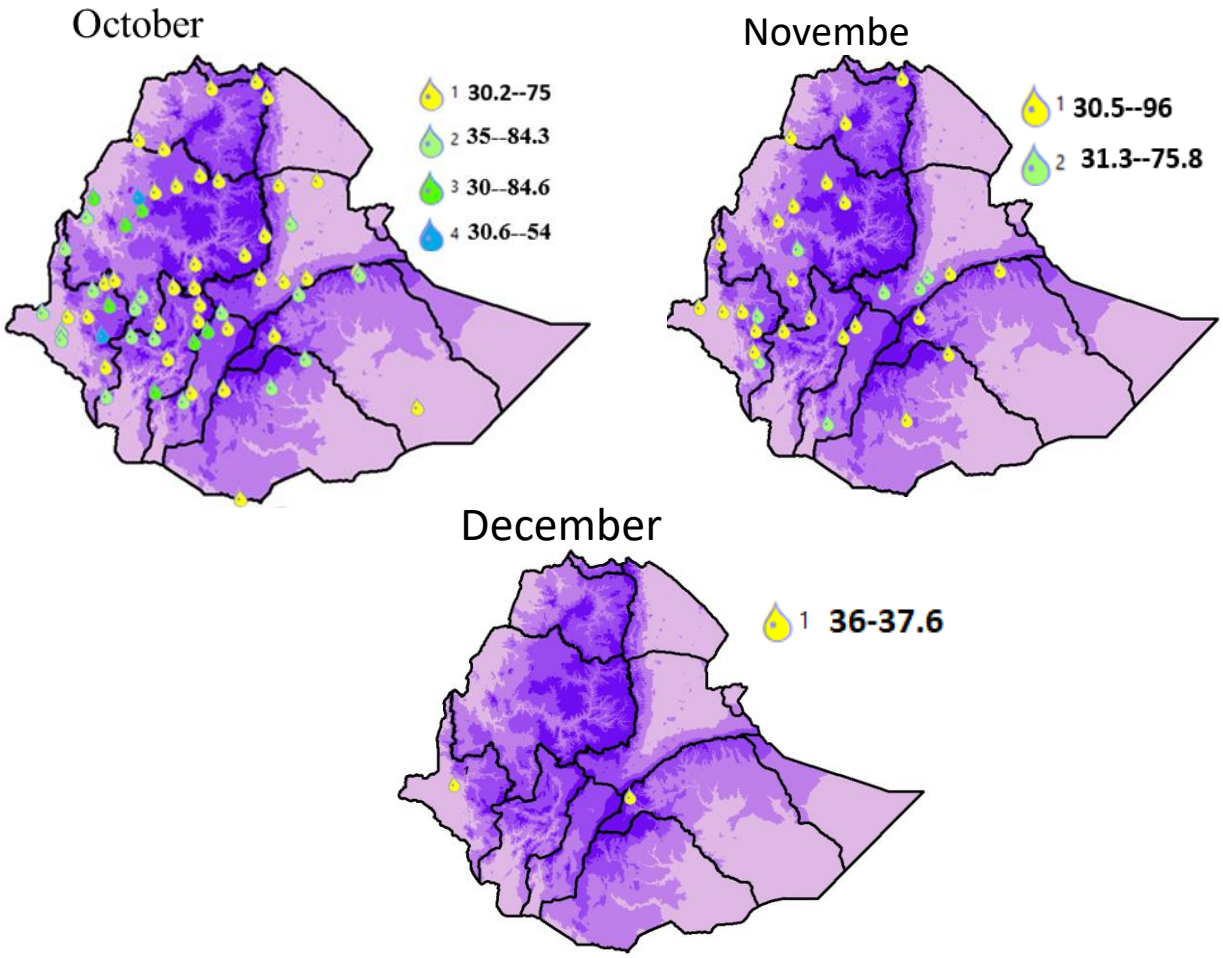




(Fig.1) Aridity Index for October to January 2024/25.

Distribution of heavy fall days exceeding 30mm during October to January 2024/25 over different river basins.

During the Bega season, most of the heavy rainfall was observed in October and November across several basins, including the Abay, BaroAkobo, and Tekeze stations, as well as the upper and middle Awash, Omo Gibe, Rift Valley, and parts of the upper Genale Dawa and Wabishebele basins. The maximum frequency of heavy rainfall occurred for 4 days over the Abay and BaroAkobo stations. In contrast, the frequency of heavy rainfall during December and January was much lower.

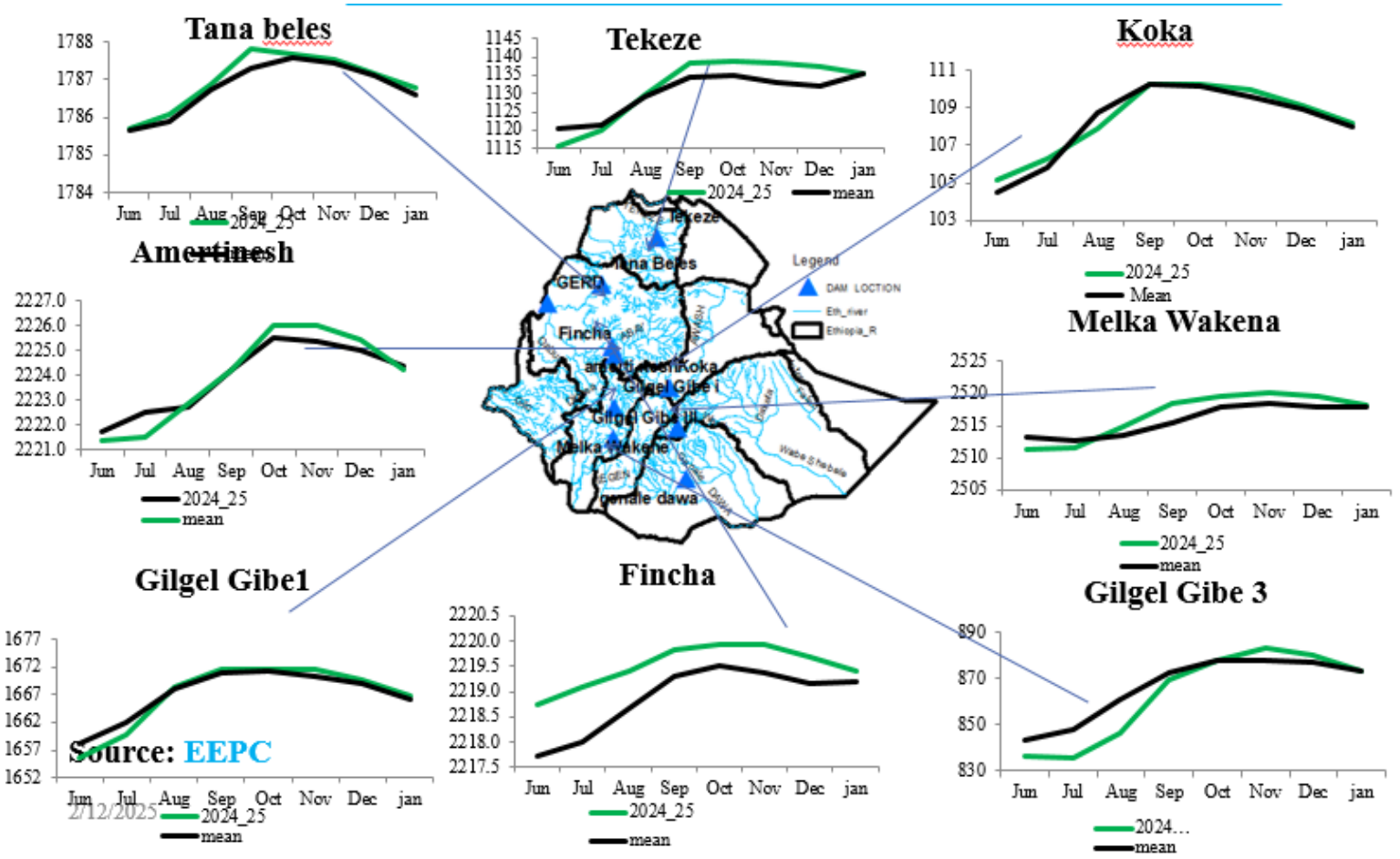


(Fig 2) **Distribution of heavy fall exceeding 30 mm per day over different river basins 2024/25**

Performance of Dams and Reservoirs water level in Kiremt 2024 season compared to long mean

The Bega season is generally considered a dry period in Ethiopia. However, certain catchments, including Omo Gibe, Baro Akobo, Rift Valley, Genale Dawa, and Wabishebele, benefit from rainfall during this season. This rainfall positively impacts the water levels in dams, such as the Gibe I AND III dams, Akobo dams, and others DAMS. These dams play a crucial role in supporting agricultural, hydropower, and domestic water needs. On the positive side, the Bega season's rainfall helps maintain water availability in these regions. On the negative side, the irregular distribution of Bega rainfall could lead to localized water shortages or flooding, especially in areas with insufficient drainage systems.

Data source: EPA (NGCC)



(Fig.3) Water level of different dams.

Hydro-meteorological outlook for Bega 2024-25 over different river basins

Introduction

The **Belg** season in Ethiopia, occurring typically between **March and May**, brings light to moderate rainfall, especially to the **eastern**, **southern**, and **central** river basins. This season plays a role in replenishing the water levels of certain rivers and reservoirs, particularly in areas like the Baro Akobo, Omo Geiba, **Genale Dawa**, **Wabishebele**, and parts of the **Rift Valley**. While Belg rainfall is not as abundant as the Kiremt (main rainy season), it is important for maintaining water flow and supporting agricultural and hydrological activities before the larger rainfall period in Kiremt.

Selected analogue Year

For the coming Bega season the selected analogue year1993 and 2017 Were compared based on probabilistic seasonal forecast for Belg 2025 and viewed out on catchments based map using geostatistical kriging method. Among those 2017 is the best analogue years that can inform the Aridity status in the coming Bega season.

Methodology

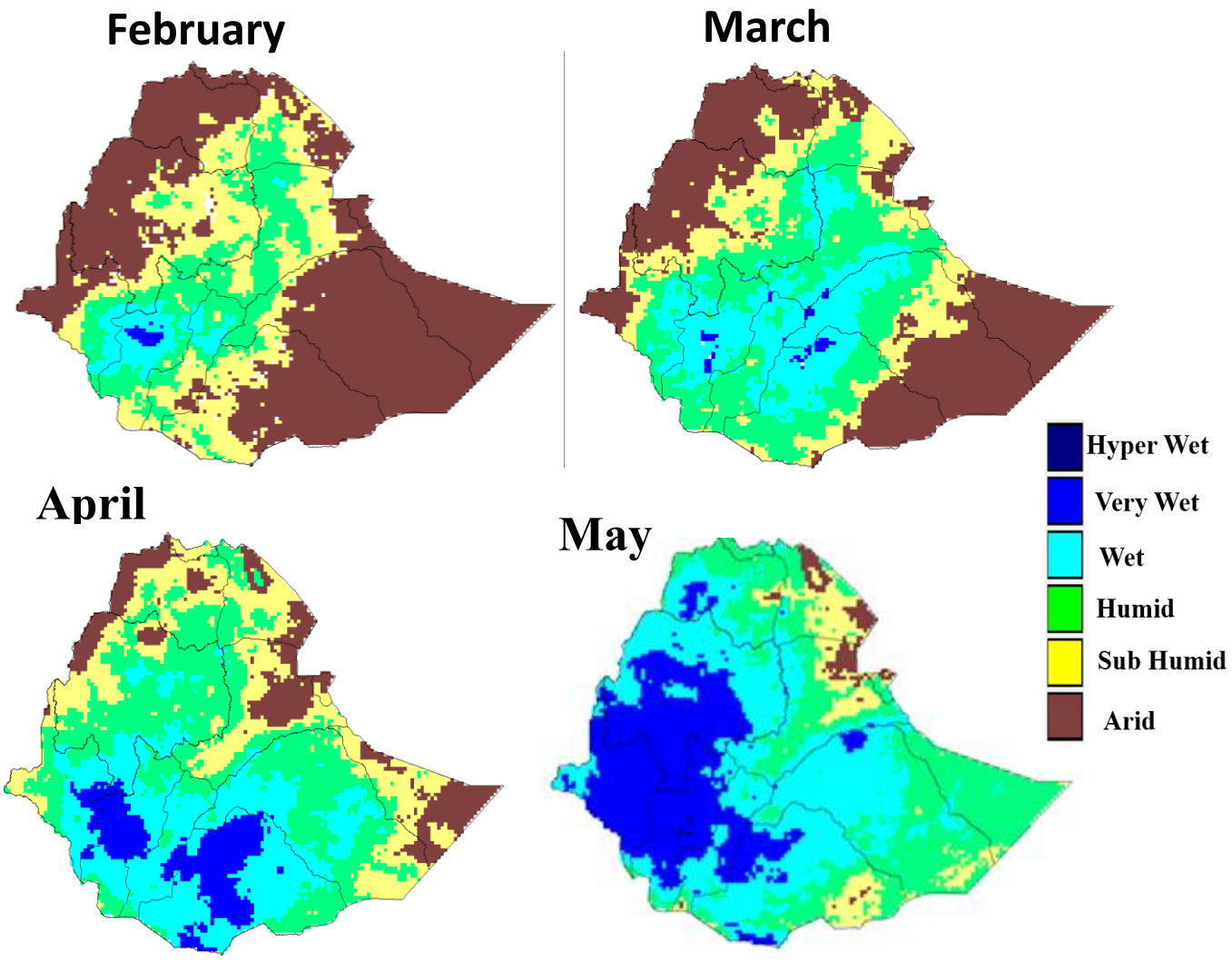
Thornthwaite introduced the concept of the precipitation effectiveness index, which is computed from the monthly values of rainfall and evaporation. The evaporation is computed empirically from mean monthly air temperature. In assessing the effectiveness of rainfall, in terms of water availability relationships 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°.

AI for Selected Analogue Year

When analyzing the effects of the four-month Belg season on the water sector, particularly in April, and May regions such as the Abay Basin, Baro Akobo, Omo Gibe, Rift Valley, Genale Dawa, Wabi Shebelle, Ogaden, Awash, Afare Dinakle as well as the central and lower Tekezé tributaries, experienced moderate to high moisture levels, positively impacting water availability in these areas. In May, exceptionally high moisture levels were recorded, particularly in the Omo Gibe, Baro Akobo, Rift Valley, central and lower Abay, and parts of the upper Genale Dawa tributaries.

Although the moisture levels in February and March showed a decrease in spatial coverage as compared with the rest of the two months, the overall moisture remained substantial, continuing to influence hydrological conditions. Key regions such as Genale Dawa, Omo Gibe, central and lower Shebelle Valley, and upper and central Wabi Shebelle were still marked by significant moisture, resulting in increased water availability in the tributaries. But total this Belg season overall led to increased water retention in human-made reservoirs, especially in regions affected by Belg moisture, showing better water storage compared to long-term averages.

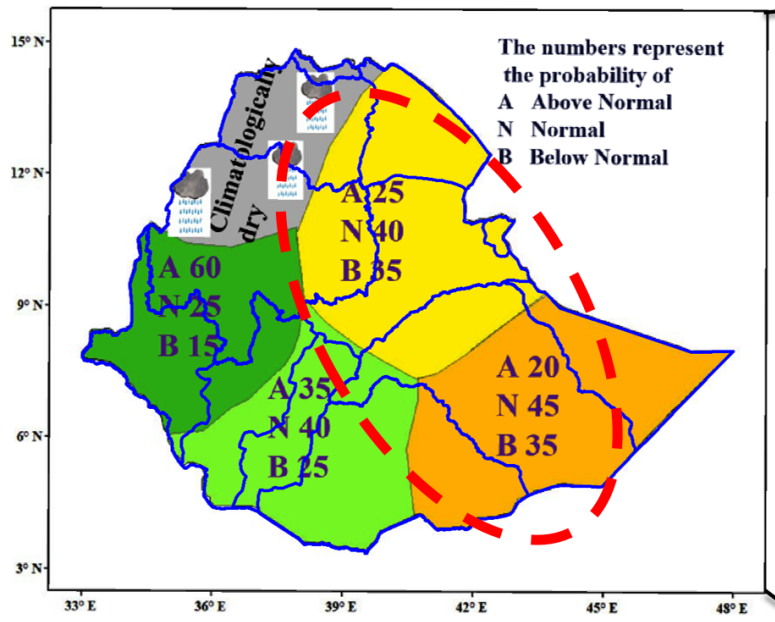
2017



(Fig.4) Aridity Index for February to May for selected Analogue year 2025.

Hydro meteorological Impact Outlook for Belg 2025

Tercile probability map of Belg 2025

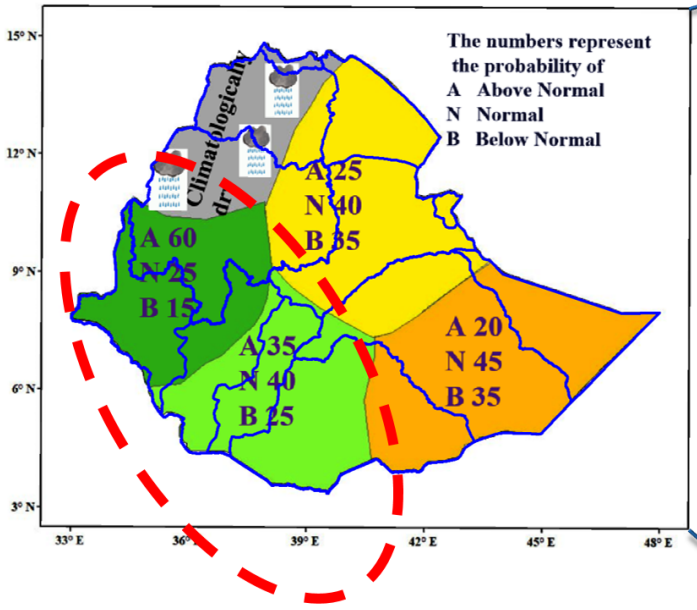


Positive

- Near noral dam water level over Malkawakena , Koka and Kesem.

Negative

- Reduce surface and ground water flow.
- Enhance the loss the available surface water through increasing evaporation
- Scarcity of drinking water
- Water stress over the certain dams
- Challenges of water supply for domestic, livestock and irrigation.
- Less hydropower production
- Inadequate water for irrigation dams
- Insufficient water available until next rainy season.



Positive

- Good opportunity recharging surface and ground water.
- Better Opportunity to harvest rain water.
- Good hydropower production (Genale, GERD, Alwero, Gibe 1 and 3).
- Enhanced water availability for irrigation and other uses.
- Enhanced outflow to downstream areas.

Negative

- High cance of flash and flood risk.
- Chance of surface water flow.
- Chance of urban flooding.
- Property and infrastructure damage.

Advisory and Recommendation

- Maximize the use of positive side the season over southern, southern western parts of basin.
- Collect and store the available rain water
- Improve drainage systems.
- Flood risk mitigation measures
- Improved planning for hydropower operations
- Proper water management
- Close monitoring of dam levels
- Keep flow up the weather update