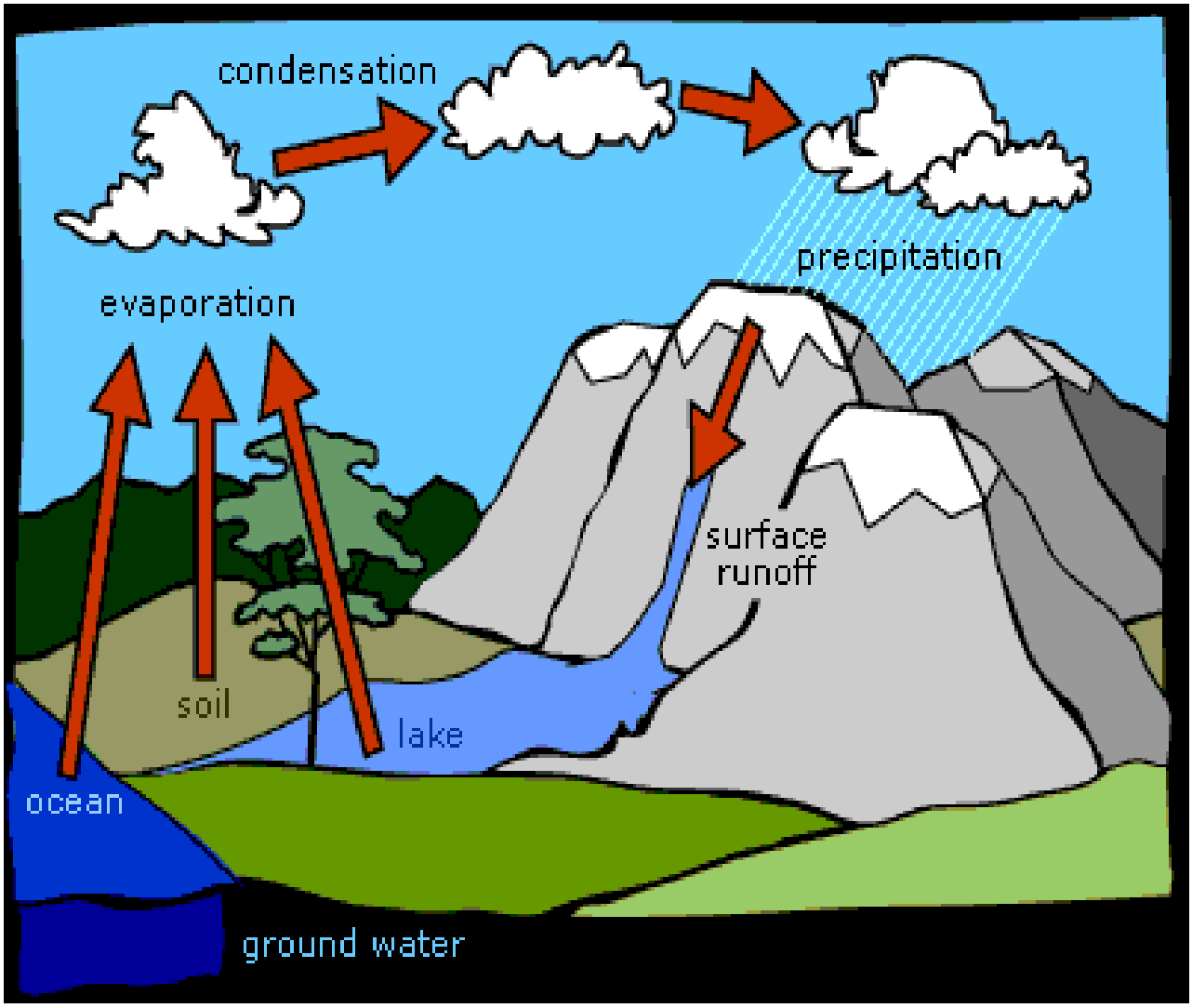
Ethiopia Meteorology Institute



Hydro Meteorological and Flood Monitoring Bulletin for Belg, 2025 assessment and Kiremt impact outlook 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

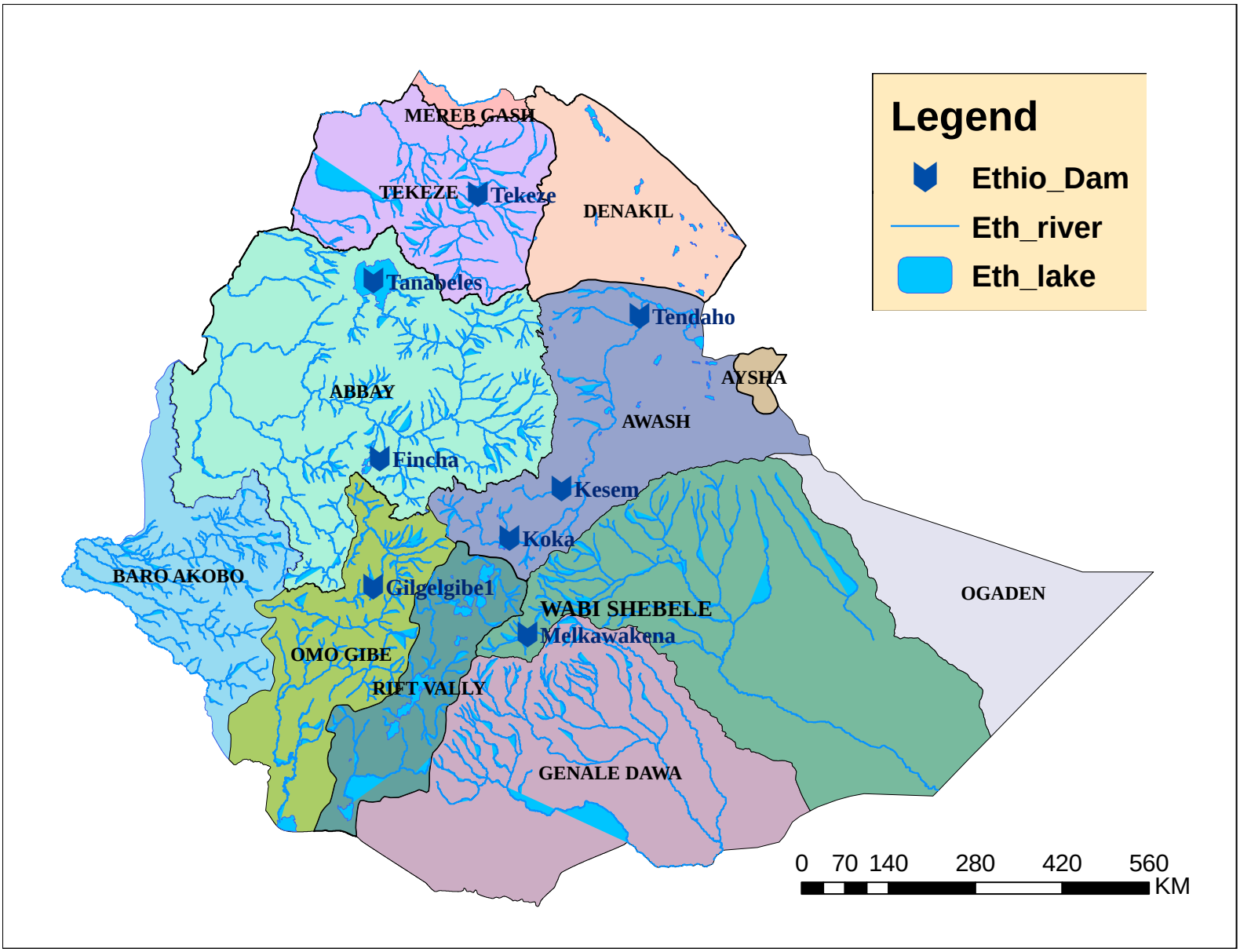
Catchment	**Location**
Mereb – Gash Catchment: -	Northwestern tip of Tigray.
Atbara-Tekeze Catchment: -	The Tekeze river basin is situated in the northwest of Ethiopia between 11 ^{0}40` and 15 $^0$12` N, and 36 ^{0} 30` and 39$^0$ 50` E. It is bordered by the Mereb river basin and by Eritrea in the 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 constitutes three river systems namely Dawa, Genale and Wabi Gestaro that meet each other before they cross the Ethio-Somalia border.

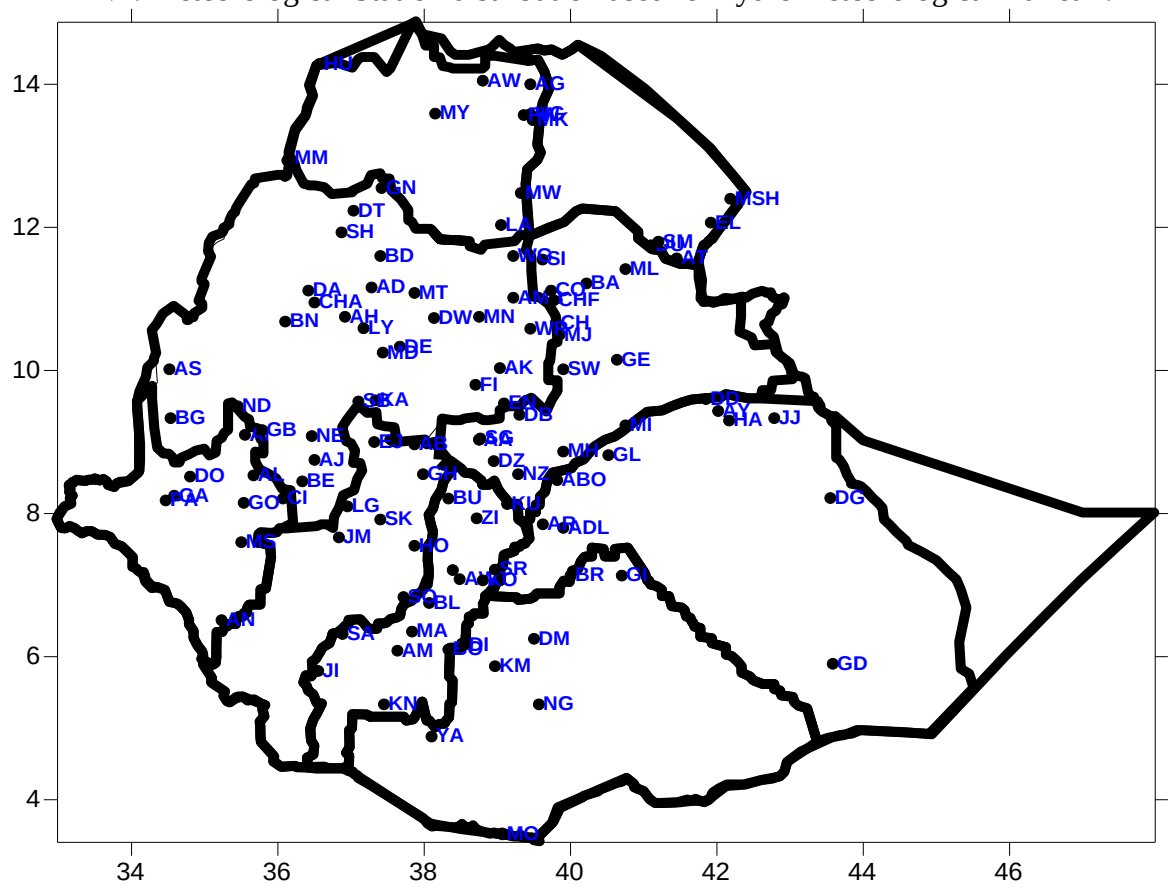
IV. Major River Catchments in Ethiopia, Location and Spatial Status

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 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. 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.

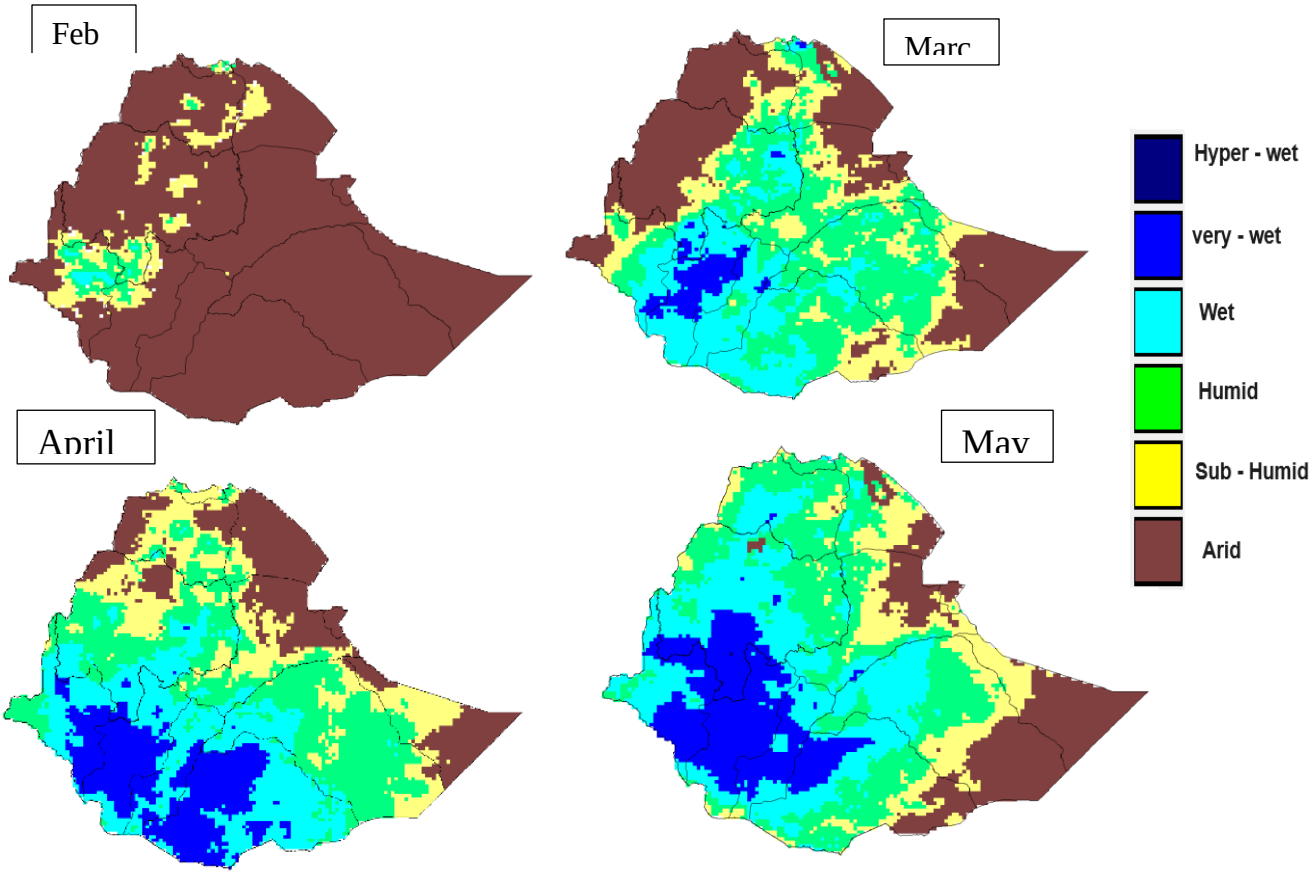
Methods

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 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

Aridity status for Belg, 2025 over different basins

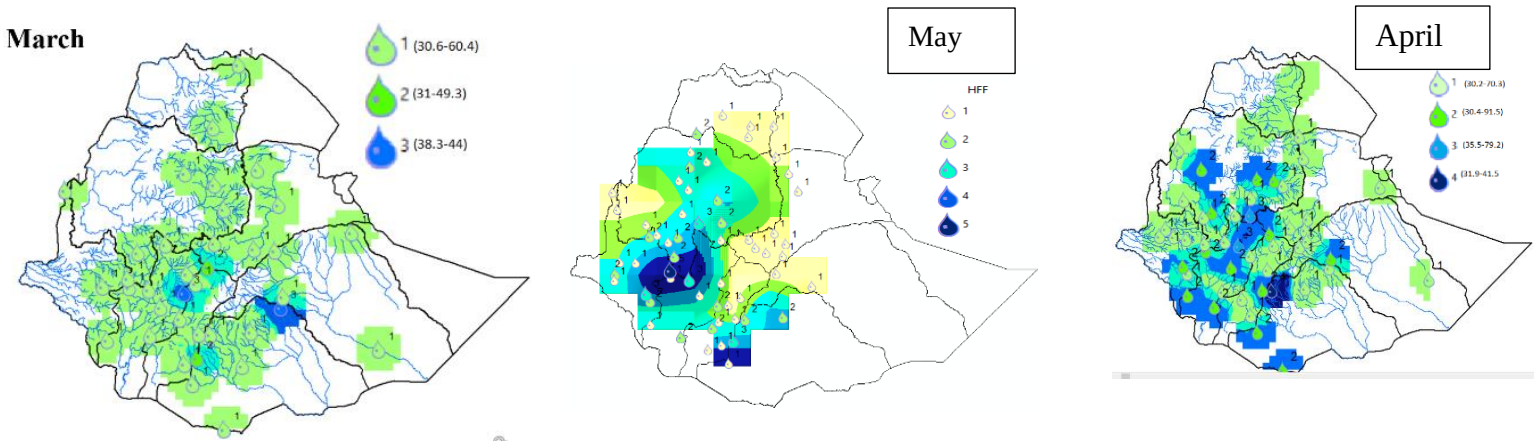
During the Belg season, moisture performance varied monthly across the river basins. In February, all catchments remained under dry conditions with insignificant rainfall. Starting from early March, some Belg-benefiting catchments began receiving rainfall, leading to humid to wet conditions in areas such as Omo Gibe, Rift Valley, Genale Dawa, Upper and Middle Wabe Shebele, and Awash. However, moisture stress persisted in many regions. In April, moisture conditions improved significantly, with most of Abay, Rift Valley, Omo Gibe, Lower Genale Dawa, Middle Awash, Eastern Abay, and parts of Upper Tekeze experiencing humid to wet conditions. The highest moisture performance was observed during April and May, with widespread rainfall across major Belg-benefiting catchments. By May, most areas, including Baro Akobo, Wabe Shebele, Awash, Omo Gibe, Rift Valley, Genale Dawa, and Middle and Eastern Abay, were under humid to wet conditions, supporting agricultural activities and easing earlier moisture stress.



(Fig.1a-d) Aridity Index from February to May, 2025.

Distribution of heavy fall days exceeding 30mm from February to May, 2025 over different river basins.

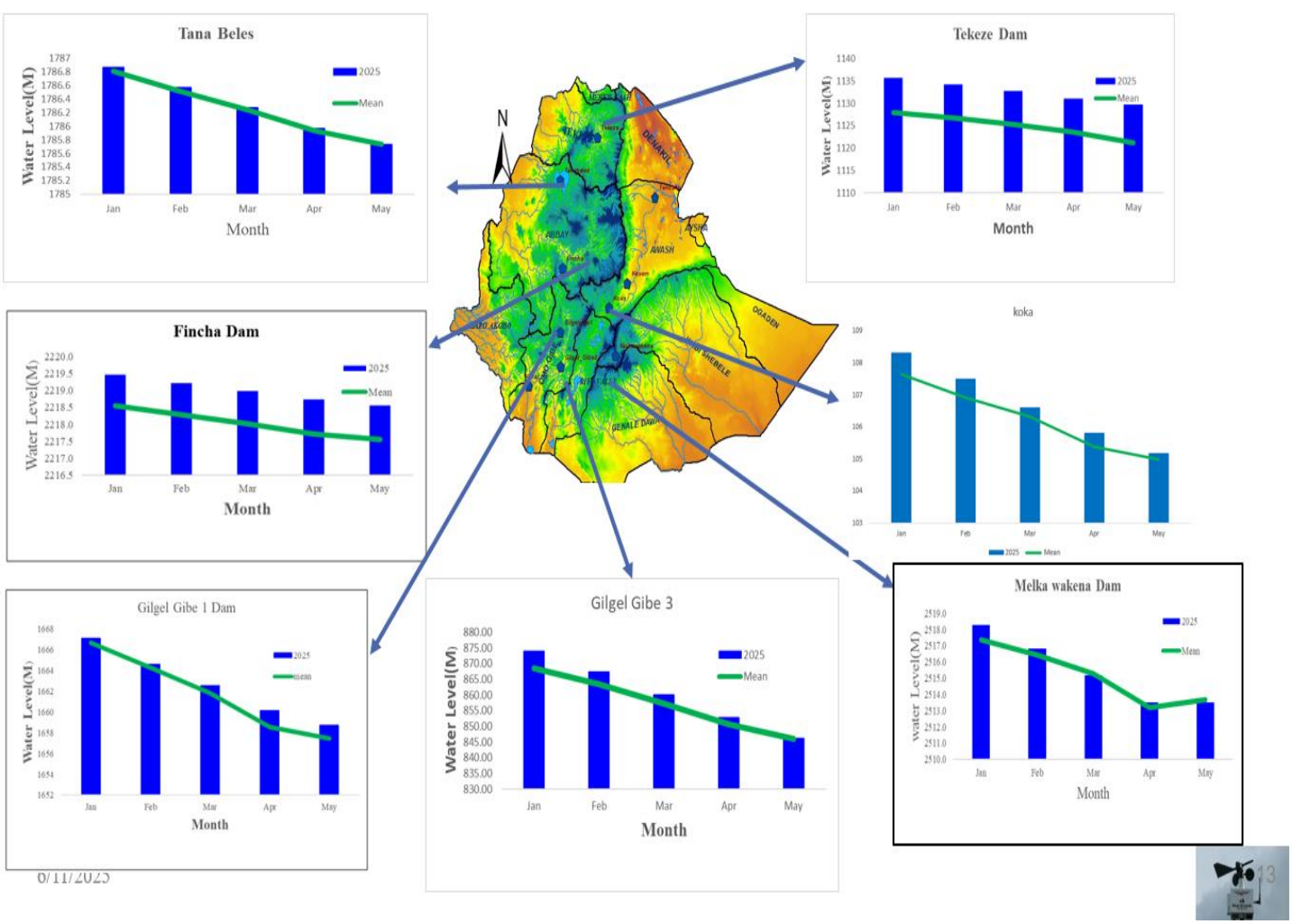
Heavy rainfall events during the Belg season were observed from February to May, with varying intensity and distribution across the catchments. In February, heavy rainfall was largely absent across most areas, except in parts of Upper Baro Akobo and Omo Gibe. In March, the occurrence of heavy rainfall increased compared to February. Notable events were recorded in adjacent areas of Upper Wabe Shebele, Genale Dawa, Omo Gibe, Baro Akobo, Middle and Eastern Abay, and Middle Awash catchments, with heavy rainfall reported for one to five days at several stations. The highest amount in March was 107 mm, recorded at Dalifagi station in the Awash catchment. In April, widespread heavy rainfall was observed across most Belg-benefiting catchments, including Wabe Shebele, Omo Gibe, Rift Valley, Genale Dawa, Eastern Baro Akobo, Upper and Middle Awash, parts of Southern and Eastern Abay, and Upper Tekeze. The frequency ranged from one to five days, with the maximum daily rainfall reaching 230 mm at Kebri Dehar station in the Wabe Shebele basin. In May, heavy rainfall was primarily recorded in the southwestern and western catchments, especially in most of Baro Akobo, Lower Abay, and Upper and Middle Omo Gibe. The highest daily rainfall in May was 100.6 mm, recorded at Hagermariam station.



(Fig.2a-d) Distribution **of heavy fall from February to May, 2025**

Performance of Dams and Reservoirs water level in Belg, 2025 season

Rainfall is the primary source of runoff, serving as a crucial input for rivers, dams, reservoirs, and ponds. However, from the Bega season through the end of the Belg season, runoff is typically minimal, resulting in reduced river flow and declining water levels in these water bodies. By the end of the Belg season, this often leads to notably low water levels. In contrast, during the 2025 Belg season, rainfall made a stronger contribution to water resources. As a result, there was a noticeable increase in water levels across most dams and reservoirs. Compared to previous years and the long-term average, the current performance at the end of the 2025 Belg season shows a positive trend in water storage, as illustrated in Figures 3a–f.



Data source: EEPU

(Fig.3a-d) DAM Water level performance May, 2025

Summary of Belg 2025 Season

During February, all catchments remained under arid conditions with minimal rainfall. In March, most Belg-benefiting catchments received humid to wet moisture, allowing for some rainfall harvesting and a modest recovery in water resources. April brought significant improvement, with all Belg-benefiting catchments experiencing wet to humid conditions. This enhanced moisture performance contributed positively to water availability, reducing water shortages and leading to noticeable increases in dam and reservoir levels across the region. In May, rainfall extended to many catchments, including those in the western and northwestern parts of the country. Heavy rainfall events occurred between March and May across all major river basins. These events had both positive and negative impacts. On the positive side, the high water volumes contributed to the replenishment of surface and groundwater resources. However, the short duration and intensity of the rainfall also led to flash floods and landslides, particularly in the Awash, Wabe Shebele, Rift Valley, Genale Dawa, and Omo Gibe catchments.

Hydro-meteorological Impact Outlook for Kiremt 2025 over different River Basins

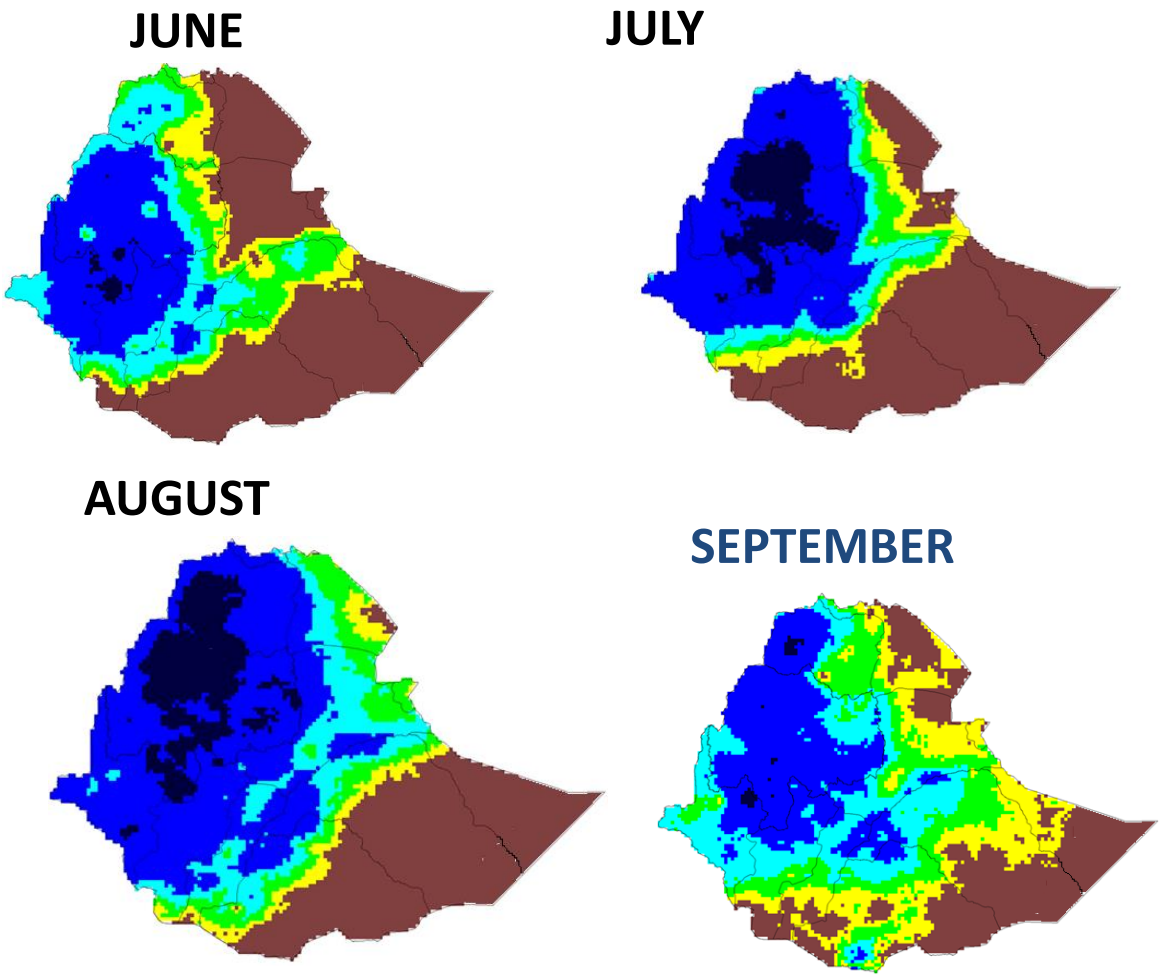
1. Introduction

Kiremt (June-September) is the main rainy season across most part of the river basins except middle and lower parts of Genale Dawa, lower Wabishebele, lower Rift Valley and Ogaden catchments. It has significant importance for water resource of the country. The main source of runoff is Kiremt season rainfall, which occur high flow period and the maximum availability of surface and ground water over those catchments. It is known that Kiremt season rainfall covers the water demand of all reservoirs and river basin water storage. 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 over flood prone areas and rugged surface of the country during Kiremt season respectively.

Selected analogue Year

For the upcoming Kiremt 2025 season, the analogue years 2006 and 2018 were evaluated using a probabilistic seasonal forecast and spatially analyzed through a catchment-based map employing the geostatistical kriging method. Among the two, **2006 emerged as the most suitable analogue year**, offering valuable insight into the expected aridity conditions for the 2025 Kiremt season. This comparison suggests that the aridity patterns observed in 2006 can serve as a useful reference for anticipating moisture availability and potential drought risks in the upcoming season.

During this season, most river basins experienced favorable moisture conditions, which had a positive impact on water availability for various economic activities across the country. As a result, **dams, ponds, and reservoirs received sufficient inflow**, helping to replenish key water resources. Notably, **some dams recorded particularly high water volumes**, especially at **Tekeze, Abbay, Tana-Beles, Gibe, and Koka**, indicating improved storage levels and enhanced support for irrigation, hydropower, and other water-dependent sectors.



Hydro-Meteorological Summery and advisory for coming Kiremt (JJAS), 2025

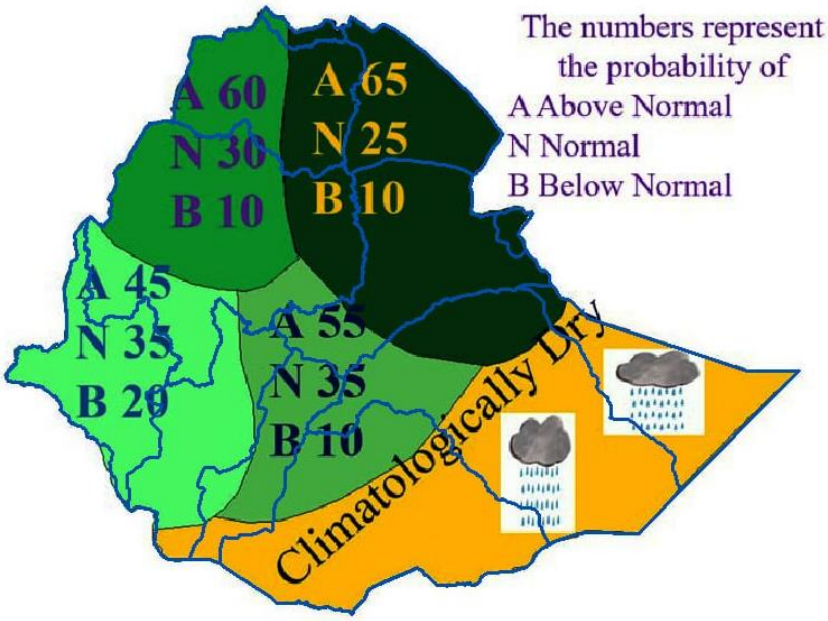
Aridity status for June, 2025

During the Kiremt 2025 season, wet moisture conditions were observed across different regions of the country with notable monthly variations. In **June**, wet conditions prevailed over the south, southeast, and northeastern parts, affecting most of the **Abay, Omo Gibe, Baro Akobo**, upper and middle **Rift Valley**, lower and middle **Tekeze**, upper **Wabe Shebele**, **Awash**, and **Genale Dawa** catchments. In **July**, the moisture condition intensified to wet and very wet levels across most of the **central, southern, western, northern, and northwestern** catchments, including **Abay, Tekeze, Baro Akobo, Omo Gibe, upper and middle Awash**, and **upper Wabe Shebele**. **August** continued with widespread wet to very wet conditions in **Abay, Tekeze, most of Omo Gibe, Rift Valley, upper and middle Awash, Genale Dawa**, and **Wabe Shebele** catchments, with aridity receding and moisture spreading further into the **southern, southwestern, northern, and northwestern** regions. In **September**, although wet conditions persisted, the spatial coverage began to decrease, particularly shifting from **northern to southern catchments**, as indicated by trends from the selected analogue year.

Tercile rainfall probability for Kiremt (JJAS), 2025 season

The rainfall tercile probability map for Kiremt 2025 indicates that most Kiremt-benefiting catchments are expected to remain under **normal to above-normal** rainfall conditions, except for the **northeastern and southeastern lower catchments** of **Wabe Shebele** and **Genale Dawa**, which may receive below-normal rainfall (Figure 5a). In **June**, wet to humid moisture conditions are likely across most catchments, with the exception of some parts of **Upper Tekeze, Middle Awash, Wabe Shebele**, and **Eastern Abay**. From **July to September**, nearly all Kiremt-benefiting catchments are expected to remain under wet conditions. This favorable moisture outlook provides a good opportunity for **reservoirs and dams to capture sufficient water**, supporting agricultural and hydropower needs. However, the **occurrence of heavy rainfall is expected to be significant** across many regions, which increases the **risk of flooding,**

flash floods, river overflows, and landslides, particularly in flood-prone areas and rugged terrains. Therefore, **water resource management, disaster risk reduction, and early warning sectors must remain vigilant and prepared** to mitigate potential impacts from intense rainfall during the season.

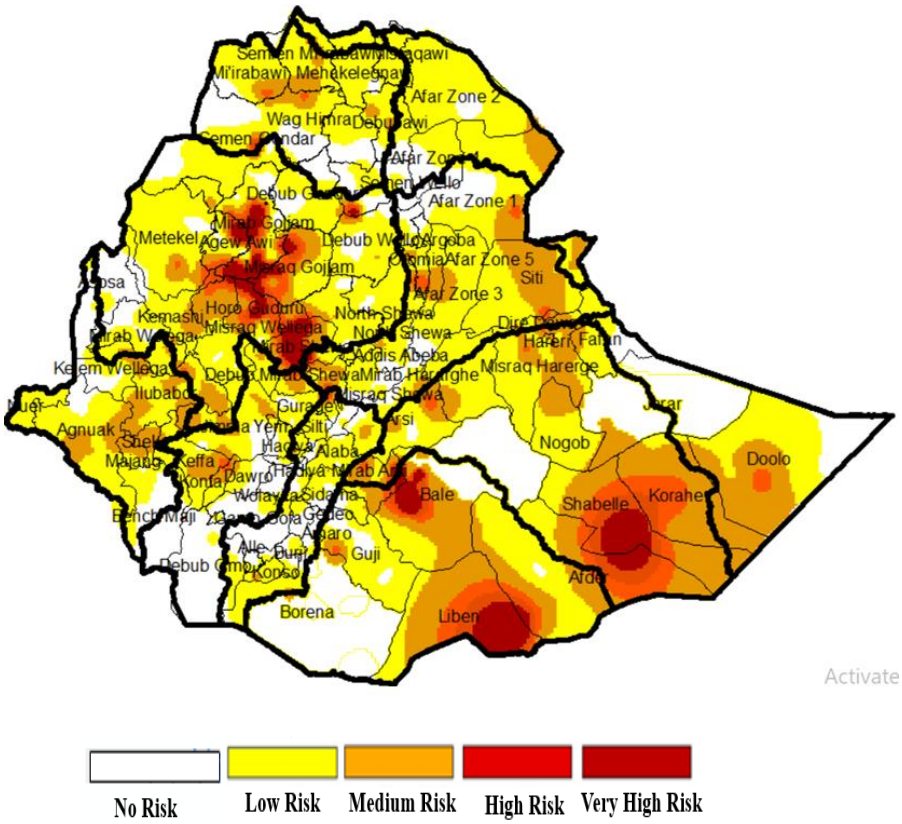


Positive

- Increased Water Supply – Rivers, lakes, DAMs and groundwater sources are replenished.
- Better Opportunity to harvest rain water.
- Good hydropower production (Tekeza, Tana Beless, Genale, GERD, Alwero, Gibe 1 and 3.....etc).
- Enhanced water availability for irrigation and other uses.
- Enhanced outflow to downstream areas.
- Increased water for livestock and rural use
- Temporary recharge of seasonal ponds and wells

Flood risk map for coming Kiremt 2025

The risk map of Ethiopia, when viewed through the lens of **flood risk due to high-frequency rainfall**, highlights significant vulnerabilities across several major river basins. The **Abay (Blue Nile), Tekeze, and Awash basins** in the central and northern highlands show **high to very high flood risk**, driven by frequent and intense rainfall that causes flash floods, river overflows, and severe soil erosion, especially in steep and densely populated areas. Importantly, the map also reveals **substantial riverine flood risk in the lower reaches of the Omo, Wabi Shebele, Genale-Dawa, and Ogaden basins**, particularly in **southern and southeastern Ethiopia**. These regions, though generally dry, experience **downstream flooding** due to heavy upstream rainfall and poor drainage in low-lying areas such as **Afder, Liben, and Shabelle** zones. This underscores the need to address not only highland flood risks but also **downstream impacts in arid basins**, where flood hazards are often underestimated but can be devastating.



Negative

- Flash floods and soil erosion in steep areas
- Risk of flash floods in dry channels
- Urban flooding
- River flooding in lowlands
- Landslides in highlands
- Overflow from dams
- Rising lake levels(Tana and Turkana)
- Soil erosion and sedimentation in reservoirs and farmlands.
- Property and infrastructure damage.

Advisory

- ❑ **Regularly check river levels and dam storage to detect flood risks early.**
- ❑ **Prepare flood plans with early warnings and emergency shelters.**
- ❑ **Improve drainage systems in cities and rural areas to prevent flash floods.**
- ❑ **Manage dams to generate power while avoiding overflows.**
- ❑ **Plant trees and build terraces to reduce erosion and sediment in rivers.**
- ❑ **Use updated weather forecasts to adjust flood response plans.**