IWMI Water Accounting (WA) Dashboard
A User Manual for Lake Tana Basin

What is a WA dashboard?

The water accounting dashboard provides detailed multi-year water accounts of a basin's water resources including inflows, outflows, water use patterns and availability, to establish baseline conditions. It can also compare baseline and future water accounts (where available), to provide stakeholders with an understanding of the current and potential future water resources status.

The platform leverages advanced data visualization tools to offer user-friendly access to complex information, empowering stakeholders to understand the dynamics between various water-balance parameters. In addition, the dashboard was designed to ensure that it caters to stakeholders of diverse backgrounds and expertise, from policymakers to scientists. Stakeholder feedback was incorporated to enrich the platform's accessibility and user experience to enable active participation and engagement.

This web-based dashboard represents one of the tools that could be used in promoting effective stakeholder deliberation of water balance information for sustainable water resource management.

Why do we need a WA dashboard?

Water resource management is an essential global challenge, necessitating a comprehensive and inclusive approach to address the diverse needs of the stakeholders involved. Stakeholder deliberation is crucial in fostering cooperation and informed decision-making for sustainable water management. However, lack of hydrometeorological observations often limits our understanding on the complex interlinkages between competing demands for water in the basin or a country. To overcome the challenges of water data scarcity in managing water resources, the International Water Management Institute is generating reliable and systematic analysis ready water data products on water use, demand, water availability and scarcity using water accounting plus (WA+) framework. The water accounting plus (WA+) approach (Karimi et al., 2013) derives basin scale water availability and scarcity indicators using earth observation data products and limited in situ observations. The WA+ framework is an open source python programming based model that uses a collection of remote sensing data products and in situ data to quantify water accounting indicators such as a) water yield, b) irrigation/rainfed water use, c) productive/unproductive water use, and other water availability indicators at river basin scale. Continental water accounting plus (CWA+) is a modified version of WA+ where the water accounting indicators can be generated for any given boundary (catchment, or a country or a county).

The suite of water data generated by water accounting studies provide several new insights into water availability and scarcity indicators at continental scale. The availability of open source codes enables repeatable and rapid water accounting assessments without much effort. IWMI's WA dashboard is a web-based dashboard built using Tableau technology to enhance stakeholder engagement and facilitate effective deliberation by summarizing and communicating the key water accounts basin.

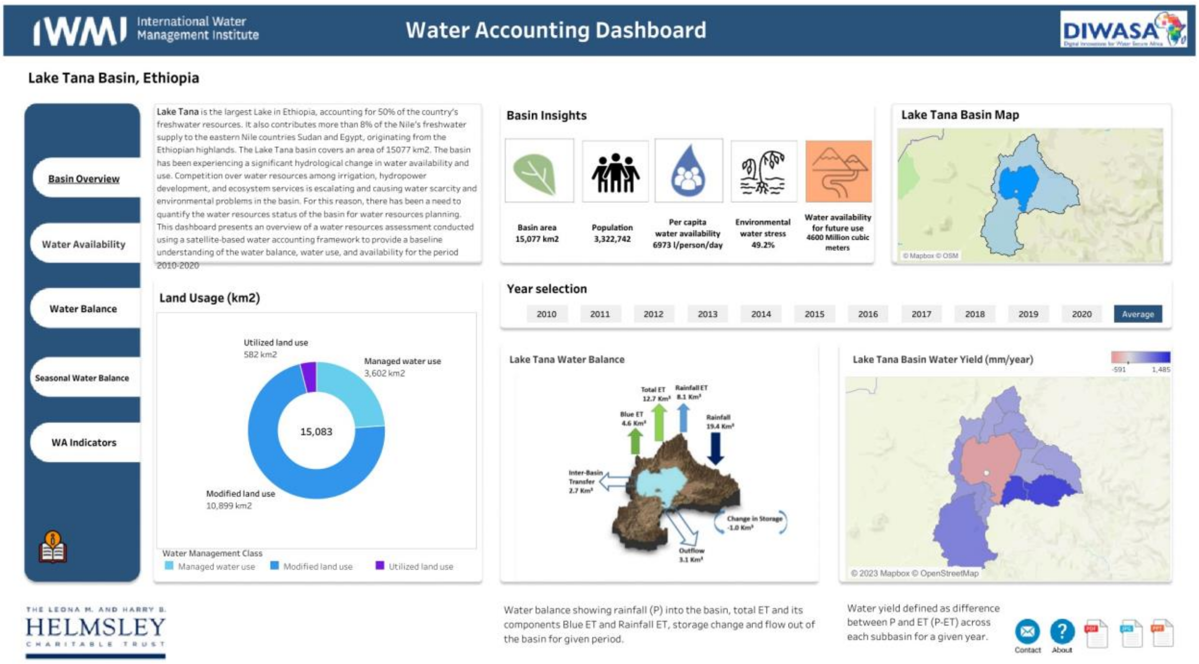


Figure 1. Illustration of the water accounting dashboard for Lake Tana Basin, Ethiopia.

Key Elements of the WA Dashboard

There are five key elements in a WA dashboard: i) basin overview ii) water availability iii) water balance iv) seasonal water balance and v) water availability indicators. The description of each element and the contents of water accounts displayed under each element are presented in detailed here.

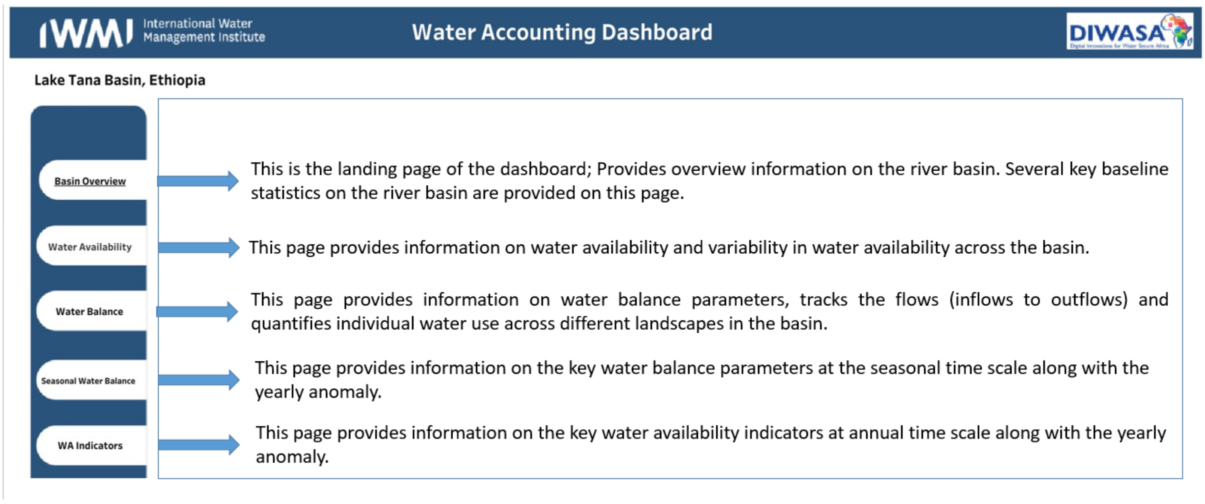


Figure 2. The key elements of water accounting dashboard.

1. Basin Overview

The landing page of the dashboard provides the basin overview information. Several key baseline statistics on the river basin are provided on this page. The description of each section is provided here.

Basin description: The basin overview page provides a brief synopsis of the dashboard. A basin description is provided to give a brief account of the basin hydrology and highlights important hydrologic challenges in the basin.

Figure 3. The description of the basin provided in the basin overview page

Basin Insights: The middle central portion of the basin overview page provides basic information on basin insights such as basin area, population, per-capita water availability, environmental water stress and water availability for future use.

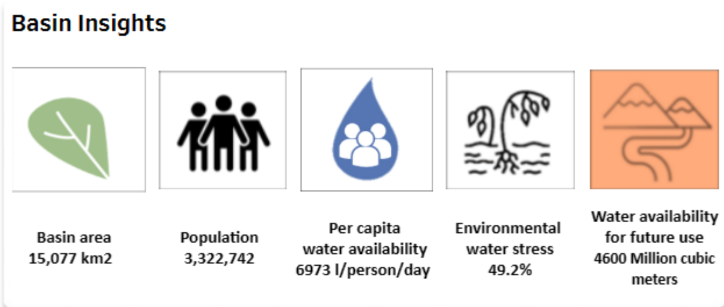


Figure 4. The basic information on basin insights

Basin Map: Here users can see an interactive map of the river basin. The users can zoom in and out of the basin area overlaid on the world map using the + and – symbols. The home icon on the map will reset the map to the full extent of the basin. The triangle icon offers additional features for interacting with the map.

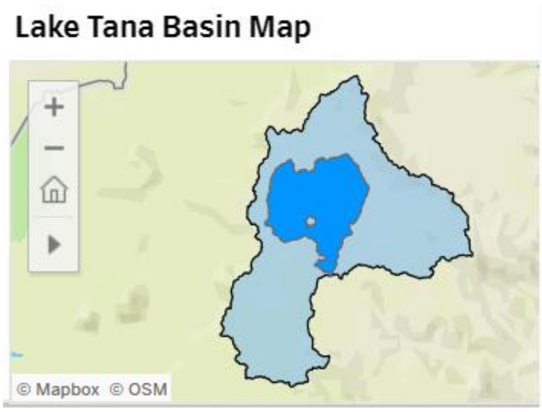
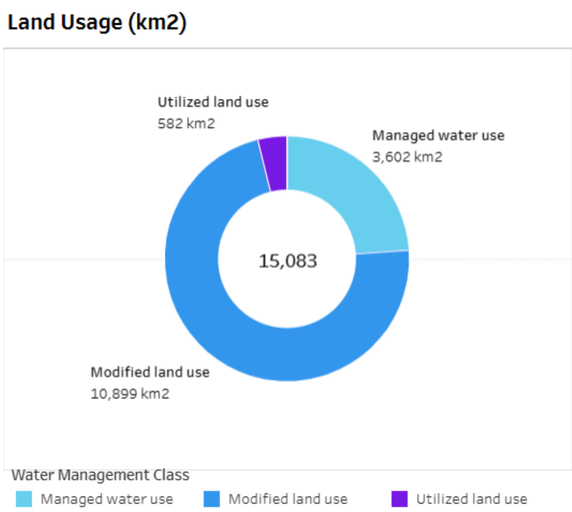
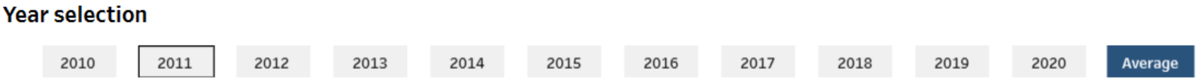


Figure 5. Interactive map of the basin

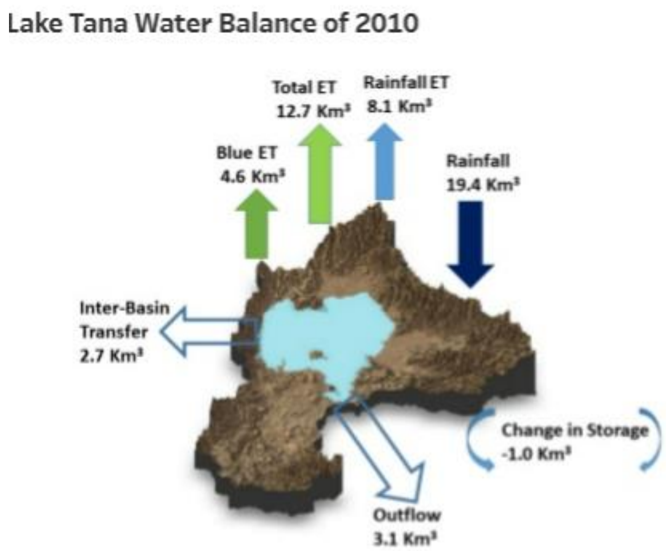
Land usage: The distribution of land use classes across the basin are provided in a pie chart. In pie chart, different landcover classes are reclassified into four broad classes of land use for water accounting (LUWA) classes. 1) The Utilized land represents natural landscapes that are utilized in their natural forms, without modifying or altering water and land resources. For example, humans utilize forests, grasslands, and shrub lands for grazing. 2) The Managed water class represents areas that are managed for agriculture where water is highly managed, such as irrigation. 3) The Modified land represents area where land is modified for human use. For example, the natural landscapes are cleared/modified to grow crops under rainfed conditions. 4) Protected land use defines the area that is classified as protected such as national parks or other preserved areas.



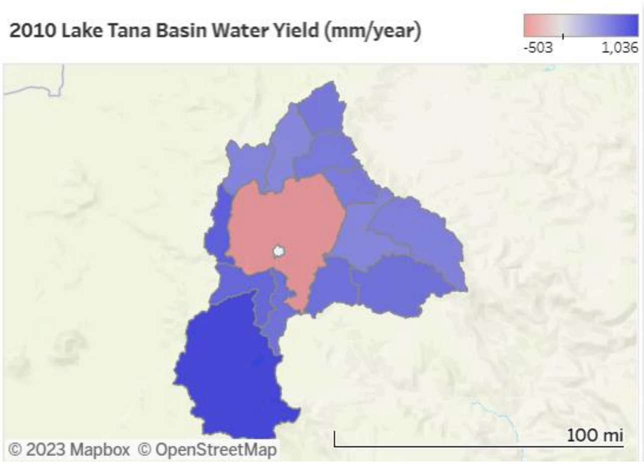
Year Selection: The year selection tab helps users access overview of water balance and basin water yield information. The users can click and toggle between years to compare how water balance can changes over time.



Water Balance: The water balance figure shows modeled estimates of key water balance terms. Each figure is specific to the year selected on the year selection tab. The dark blue colored downward arrow represents the total volumetric annual precipitation (P, in km3) received in the basin. The light green colored upward arrow represents total volumetric evapotranspiration (TotalET, in km3). The lighter blue upward arrow represents BlueET (Blue ET, in km3), a portion of total ET, occurring from the blue water sources (surface water bodies, river, lakes or shallow groundwater aquifers). The small dark green upward arrow represents, Rainfall ET or Green ET (in km3), a portion of total ET occurring from the green water sources (soil moisture replenished by the rainfall). The sum of Blue ET and Ranifall ET is equal to the total ET. The empty blue colored arrow represents basin outflow (in km3) and the storage change denotes the changes in the basin storage due to either groundwater abstraction (+ve value) or groundwater recharge (-ve value).



Water Yield: The map shows the water yield obtained from the water accounting analysis. The water yield is defined as water that is available after meeting landscape water requirement (landscape ET). This is the amount of water that can be exploitable for human needs. The map shows water yield for administrative regions with in the basin. Some regions shows negative values (shades of red), which indicate that at annual time scales there is not water available. Other regions show positive values (shades of blue) which indicate that at annual time scale, water availability for human needs is not a problem. Such information is important to understand spatial variability of water availability within the basin. The blue areas are also called water towers of the basin are the regions that provide most water to the river and where future activities such as irrigation development or canals for diverting water can be constructed.



2. Water Availability

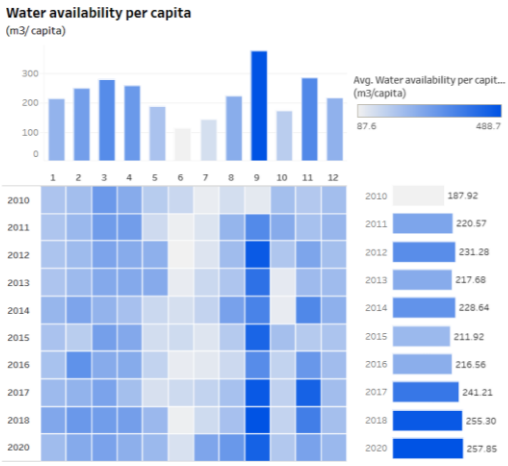
Information on water availability in a river basin is crucial for understanding various aspects of human, environmental, and economic well-being. Through this dashboard, water availability in a river basin is summarized using indicators of water availability for a) humans b) environment c) agriculture and d) other uses.

Water Availability Per Capita (m3/per capita): Water availability per capita refers to the amount of freshwater resources available for each person in a specific region or country. It is typically measured in cubic meters (m³) per person per year and is an important indicator of a region's or country's ability to meet the water needs of its population while also supporting economic and environmental demands. Calculating water availability per capita involves dividing the total annual freshwater resources of a region or country by its population. Within water accounting, we derive total annual freshwater resource as

$$Water\,Availability\,Per\,Capita = \frac{available\;water}{Population}$$

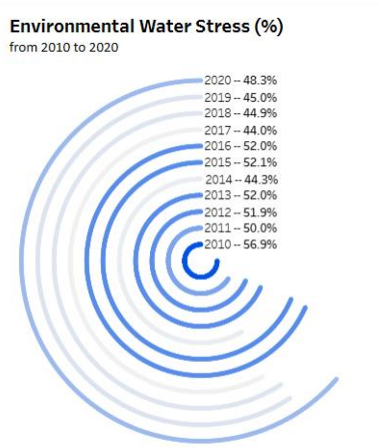
The water availability per capita is estimated is presented at monthly and annual timescales from 2010 to 2020.

The annual total per capita water availability is presented to the right side as horizontal bar plots. The monthly average per capita water availability is presented on the top as the vertical bar plots.



Environmental water stress (%)

Also known as ecosystem water stress or ecological water stress/scarcity, refers to a situation in which the demand for the freshwater by the ecosystems and environment exceeds the available supply of freshwater for a given region. Such stress can hav e detrimental effects on the health and sustainability of natural ecosystems, leading to various environmental and ecological problems.



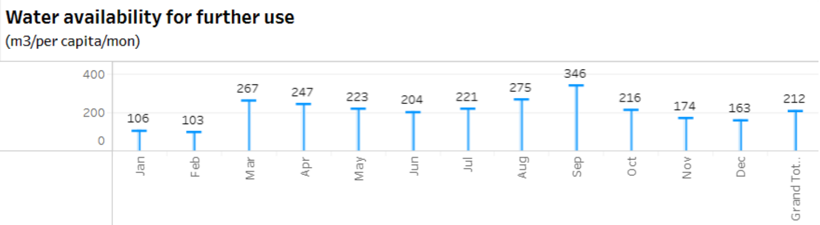
Within the water accounting framework, environmental water stress is estimated as

$$\text{Environmental water stress} = \frac{utilized\;flow}{exploitable - reserved\;flow}$$

The environmental water stress is presented as a circular bar lot. The numbers close to 100 indicate extreme pressure on renewable freshwater resources, and very little water is left available in the environment, whiles number closer to 0 indicate less pressure on the environment

Water Availability for further use (MCM)

The water available for further water resources development highlights the water scarcity in the basin. The estimates presented in the figure quantifies the amount of water available after meeting all the basin demands of nature via lands cape evapotranspiration, rainfed agriculture, domestic and industrial demand and irrigated water use. This is the volume of water that can be used for planning any basin developmental activities such as additional diversion for domestic and industrial water use, additional irrigation development etc.



Basin closure (%)

The basin closure is calculated as total amount of water available that is utilized within a basin.

$$Basin\ closure = \frac{utilized}{available\ water}$$

Any basin with estimates closer to 100% indicate basin closure – indicating most to all water availability in the basin is currently consumed with in the basin. A smaller value indicates that water is available in the basin.

3. Water Balance

The Water balance, also known as the hydrologic balance or water budget, is a fundamental concept in hydrology. It refers to the equilibrium or accounting of water inputs, outputs, and storage within a defined area, such as a watershed, catchment, or region. The water balance equation helps quantify the movement and distribution of water in various forms through the Earth's hydrological cycle.

Within the water accounting framework, water balance of a river basin is quantified and presented using a number of hydrologic variables. Unlike most hydrologic studies where the water balance is mostly represented by the key hydrologic variables such as Precipitation, evapotranspiration, discharge and change in storage, the water accounting framework derives a variety of hydrologic parameters. A full list of water balance indicators quantified in the water accounting framework are presented in Table 1.

The figure below shows basin input parameters on the left side and basin output parameters on the right side. The WA+ framework tracks both the flow and consumption (depletion) that occur within the basin as water moves from the inlet to the outlet of the basin. The depletion accounting is used to estimate how much of water us consumed over different landscapes. This is summarized under four broad categories of land cover/land use – Protected- conservation areas with minimal changes in land and/or water management, Utilized- are areas with limited human influence and can include forest, natural pastures, savannahs and deserts, Modified- areas that are significantly modified by human activities usually for rainfed agriculture and Managed water use- are land use classes that are significantly modified for agriculture and include water purposefully withdrawn from the surface or groundwater sources for use The flow accounting derives a bunch of parameters such as exploitable water, available water, managed water use, utilizable flows, non-utilizable outflows, reserved outflows, and non-consumed water.

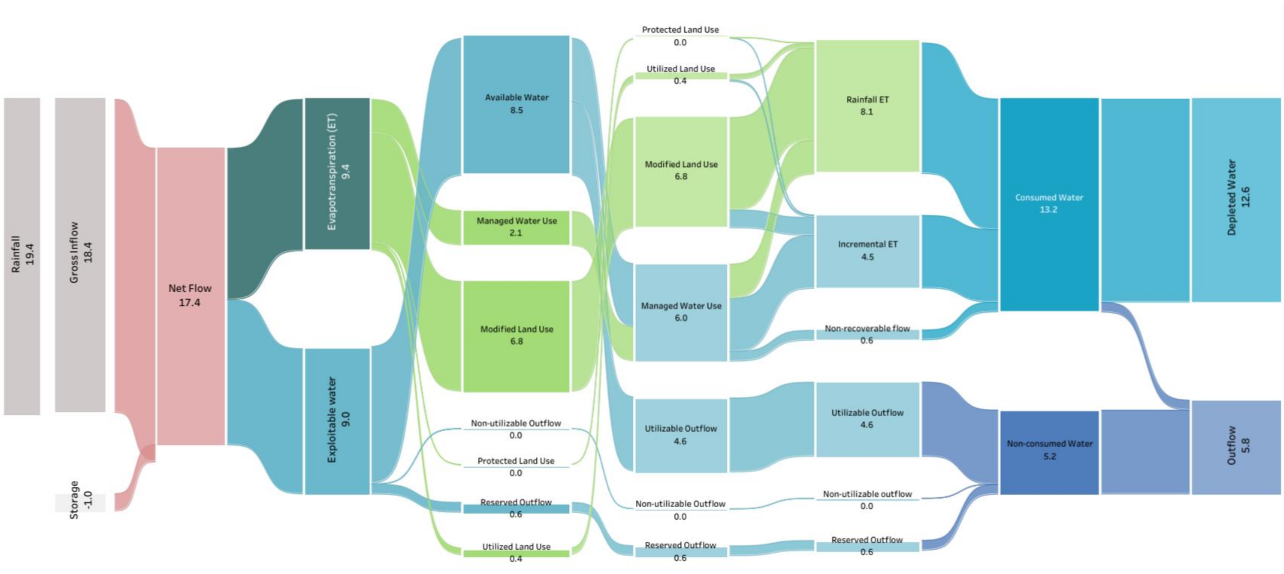


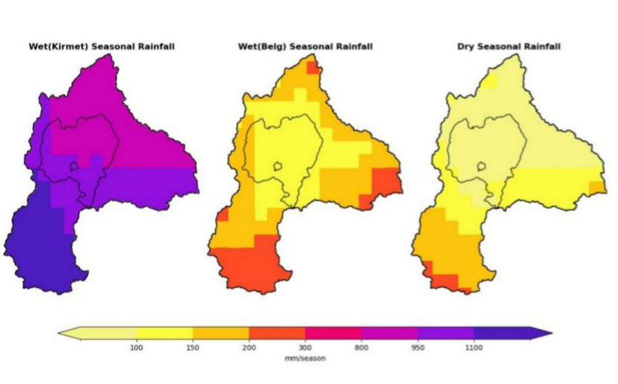
Table 1. List of hydrological variables and indicators quantified in the water accounting framework.

No	Flux/Indicators	Description	Equation
1	P advection	Precipitation received in the basin, aggregated over the hydrologic year	$\sum_{i=1}^{12} P$
2	Basin inflow (interbasin transfer)	Surface water or groundwater diverted into the basin	Q_{in}^{sw} and Q_{in}^{gw} (Measured estimates)
3	Gross Inflow, GI	Total inflow from all sources	$P + Q_{in}^{sw} + Q_{in}^{gw}$
4	Change in the soil moisture, ΔSM	See equation 2.	See equation 2.
5	Net Inflow, NI	The gross inflow plus the change in soil moisture	$GI \pm \Delta SM$
6	ET rainfall, ET_{rain}	ETa that occurs from effective precipitation and canopy interception, summarized for all land cover classes (1 to n classes).	$\sum_{i=1}^{n} ET_{rain}$
7	ET incremental, ET_{incr}	ETa that occurs from other sources except effective precipitation and interception. Includes ET from irrigation water, groundwater abstraction, open water sources, summarized for all land cover classes (1 to n classes).	$\sum_{i=1}^{n} ET_{incr}$

8	Landscape ET, ETa_{land}	ETa from natural landscapes (protected, utilized and modified land use classes); not due to water management.	$ET_{rain} + ET_{incr}$
9	Consumed water, C_{water}	Total ETa that occurs from all landscapes over all months	$\sum_{i=1}^{12} ET_a$
10	Utilized flow, $Uzed_{flow}$	ETa from managed water use (irrigated crops, managed reservoirs).	ET_{incr} from the managed water use class
11	Exploitable water, EX_{water}	The exploitable water is the amount of water that can potentially be used within the basin	$NI - ET_{landscape}$
12	Available water, AW	The water that is left after meeting ET and reserve flow requirements	$GI - ETa_{land} - Reserve\ Flows$
13	Utilizable outflow, $Uzble_{flow}$	The water that can be reallocated for further uses after accounting for reserved flows and utilized flows.	$EX_{water} - ER_{flow} - Uzed_{flow}$
14	Qsw outlet	The river outflow at the outlet of the basin	Q^{sw}_{outlet}
15	Basin outflow (interbasin transfer)	Surface water or groundwater diverted to areas outside the basin	Q^{sw}_{out} and Q^{gw}_{out}
16	Non-consumed water, NC_{water}	Total outflow	$Q^{sw}_{outlet} + Q^{sw}_{out} + Q^{gw}_{out}$

4. Seasonal Water Balance

Seasonal water balance refers to the dynamic relationship between water inputs (precipitation) and outputs (evapotranspiration, flow) within a specific area over time, with fluctuations occurring throughout the year. Understanding and analysing seasonal water balance plays a critical role in managing water resources, ensuring agricultural productivity, monitoring environmental changes, and reducing disaster risks. By utilizing this knowledge effectively, communities can achieve sustainable water management practices and safeguard water resources for future generations.

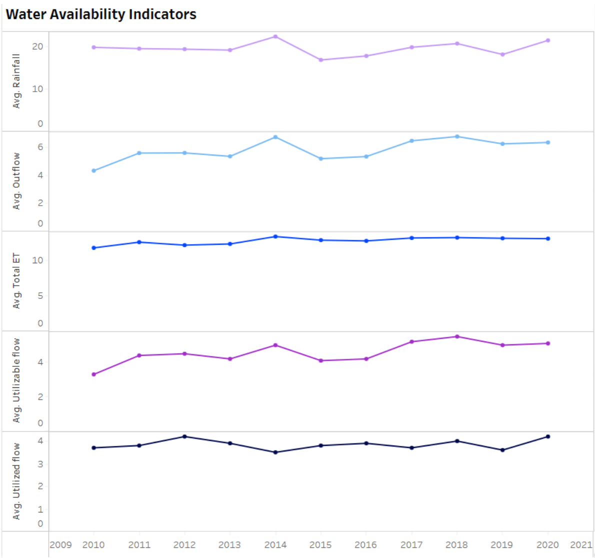


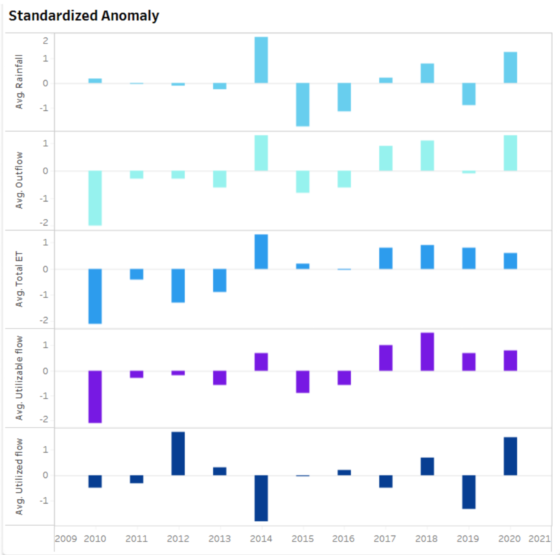
In this page, the spatial-temporal variability of the key water balance components (rainfall, ET, and water yield) of the basin are presented. For seasonal timescale, the water accounts of the basin are summarized into three seasons namely the main rainy season from June to September (Kiremt), a short rainy season from March to May (Belg), and a dry season from October to February (Bega). Kiremt (June to September): The main rainy season brings heavy rainfall and thunderstorms to the basin. The Kiremt rainy season is crucial for agriculture in the Lake Tana Basin, as it provides the water needed for crops to grow.The short rainy season brings less rainfall than Kiremt but is still important for agriculture. The Bega season is the driest season with little to no rainfall.

In addition, the standardized anomaly for the mentioned water balance components are presented on this page. A standardized anomaly is a statistical measure used to describe how much a particular the key water balance components of the basin for a given period deviates from its historical average. The result is a standardized score, expressed in units of standard deviation. For example positive standardized rainfall anomaly (SRA) indicates above-average rainfall, while a negative SRA indicates below-average rainfall.

5. Water Availability Indicators

The key water availability indicators of the basin are summarized at annual timescale (left side) along with the corresponding standardized anomaly (right side). These indictors include rainfall, utilized flow, utilizable flow, total ET, and total outflow. Understanding inter-annual variability of water availability in the basin is crucial for developing sustainable water management plan.





Additional features on the dashboard:

There are several additional features available on the dashboard. A brief description and purpose of each of the icons located on the lower right corner are presented here.

Contact: The contact icon is located on the lower right corner of the dashboard and it would provide email information on whom to contact in case you have any questions on the dashboard.

About: The about icon provides more info on the project.

Printing options: The dashboard can be printed or saved using three options. The current view of the dashboard can be saved to the local computer in three different formats – PDF, JPG or PPT. Please use appropriate icon as per your need.