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Chapter One : Introduction

- Definition
- Applications in Engineering
- Hydrologic Cycle and its component
- Water Budget Equation

Tip

Water in World

Water in Ethiopia

Definition

- Hydrology is a science that deals with the **space-time** interaction of the **quantity and quality** of water on earth including and its
  - Occurrence, Movement, Distribution, Circulation, Storage, Exploration, Development, and management
- deals chemical and physical properties of water, and their reaction with the environment, including their relation to living things.

CLASSIFICATION OF HYDROLOGY

- Scientific Hydrology
  - The study of water which is concerned chiefly with academic aspects
- Engineering Hydrology
  - a study concerned with Engineering application

ENGINEERING HYDROLOGY

It is an applied science and deals with those segments of the field pertinent to planning, design, and operation of engineering projects for the control and use of water.

In a general sense, it deals with:

- Estimation of water resources
- The study of processes such as precipitation, abstractions, runoff… and their interaction
- The study of problems such as floods and droughts and strategies to combat them

ENGINEERING APPLICATIONS

Hydrology finds its greatest application in the design and operation of water resources in engineering projects, such as

- *Water supply,*
- *Irrigation,*
- *Hydropower,*
- *Highway*
- *Flood control,*
- *Navigation*
- ……. *etc*

…APPLICATIONS

In all these projects hydrological investigations are crucial for the proper assessment of the following:

- The capacity of storage structures such as reservoirs
- The magnitude of flood flows to enable safe disposal of the excess flow
- The minimum flow and quantity of flow available at various seasons
- The interaction of the flood wave and hydraulic structures, such as dams, levees, weirs, bridges, and culverts.

The hydrological study of a project should or it involves the collection of relevant data and analysis of the data by applying the principles of hydrology to seek solutions to practical problems.

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HYDROLOGICAL CYCLE and CONCEPTS

1. Standard Concepts (Physical)
   - Precipitation
   - Evaporation/Evapotranspitation
   - Surface Water
   - Groundwater

2. Ecosystem and Use Related (Basin/Watershed Perspective)

   Green water (Terrestrial ecosystems, Crops, Wetlands)

   Blue water (Throughflow, Consumptive use & return flow)

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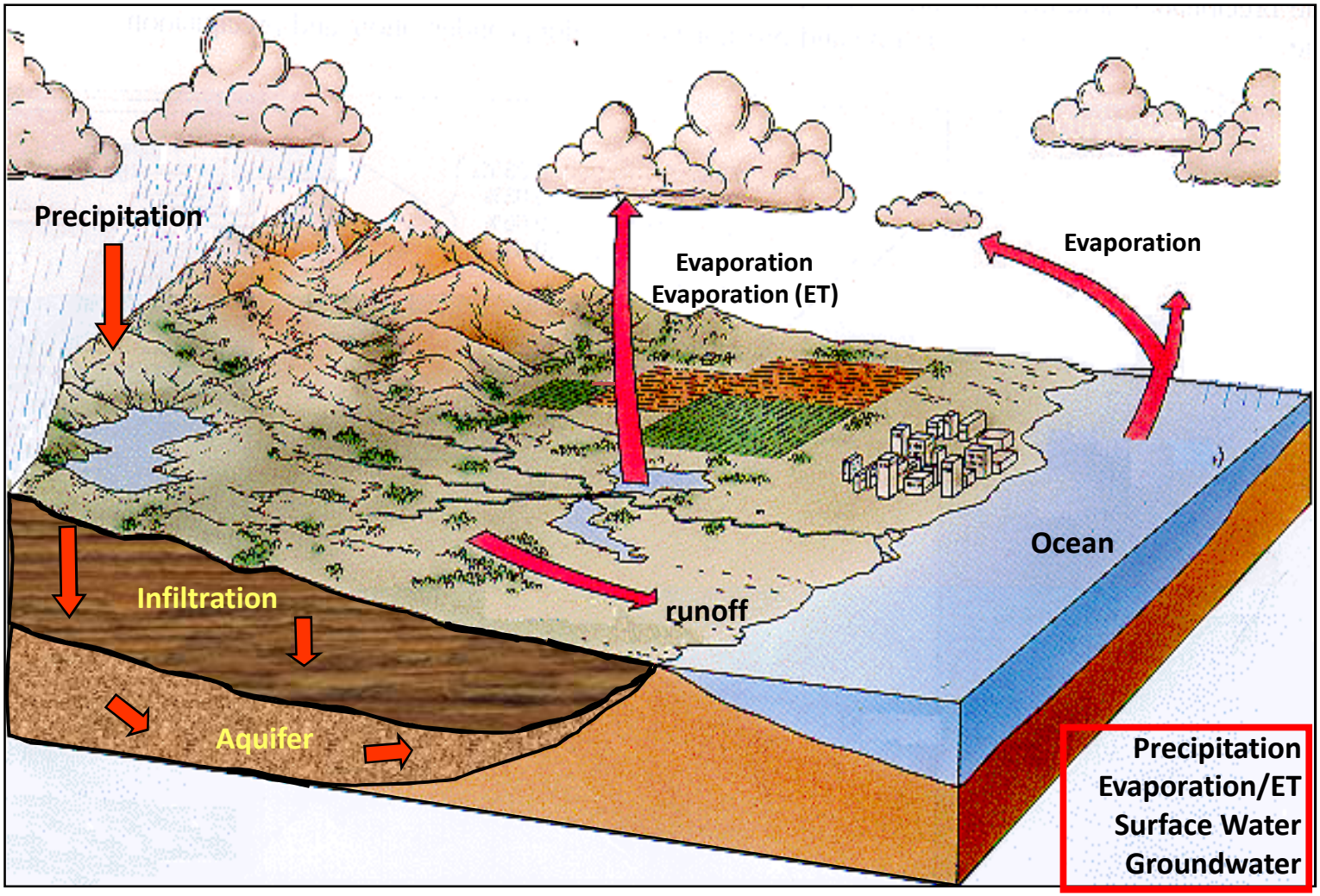
HYDROLOGICAL CYCLE:

Standard concept



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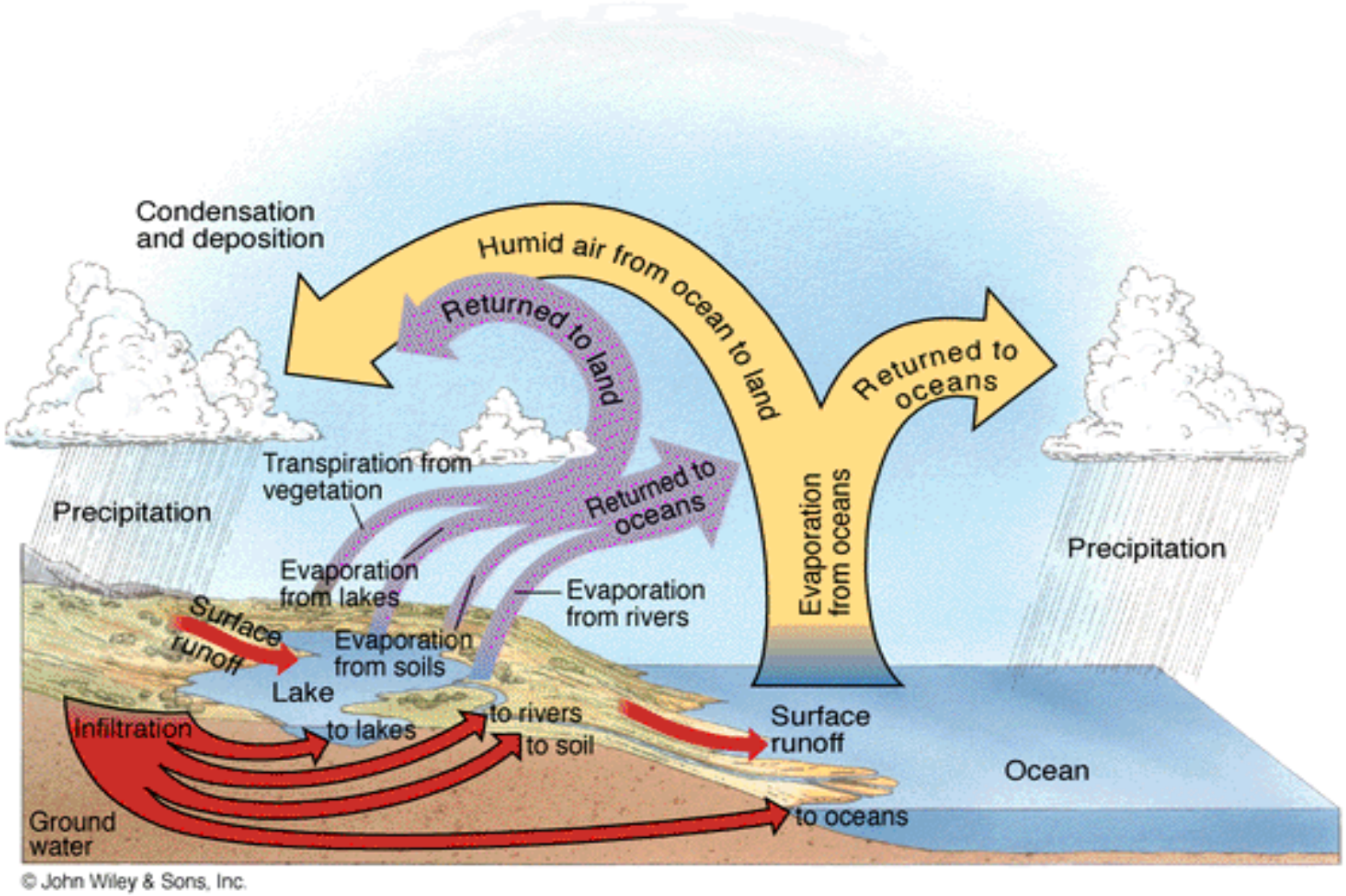
HYDROLOGICAL CYCLE:

System Circulation



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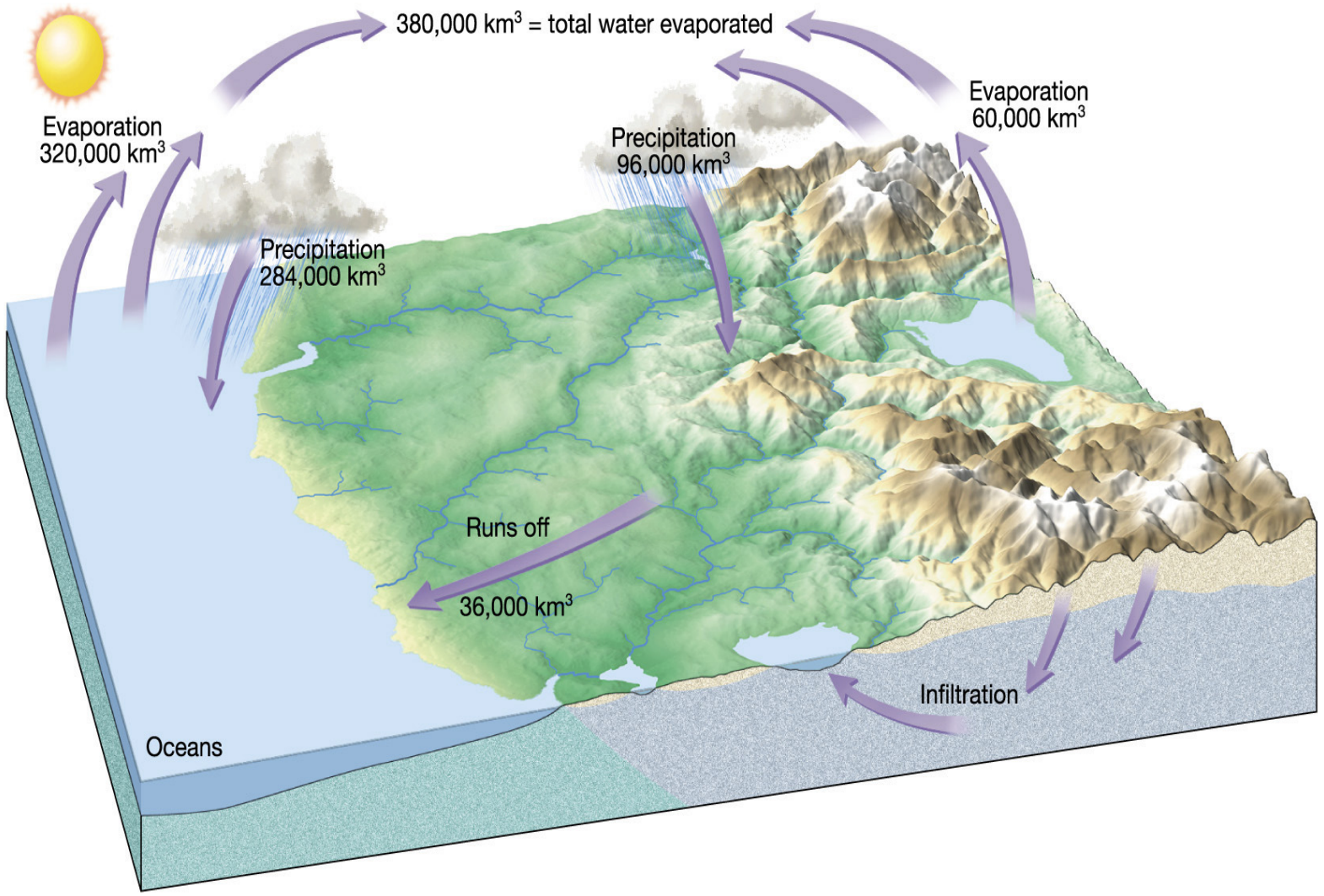
HYDROLOGICAL CYCLE: Quantified



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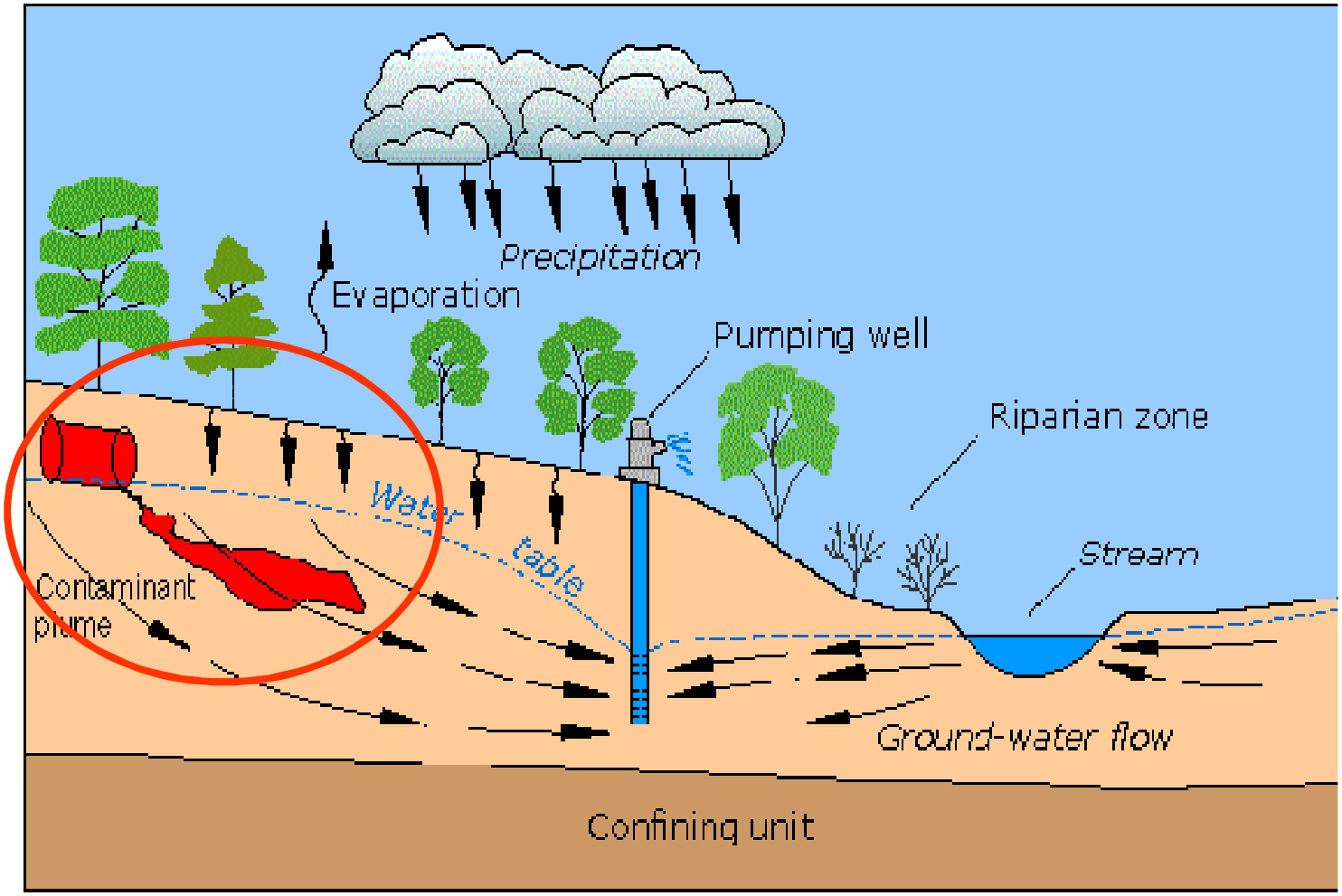
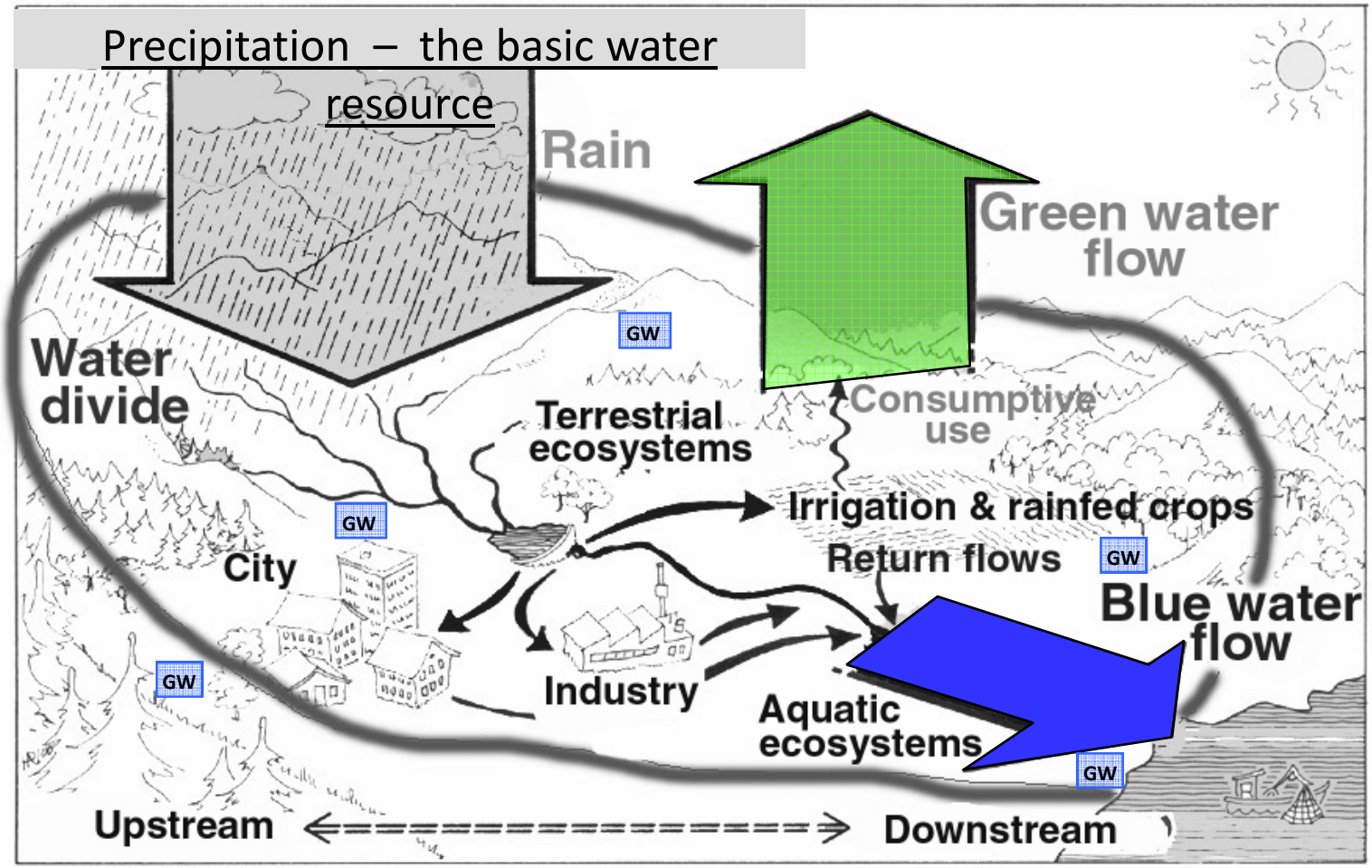
HYDROLOGICAL CYCLE:
Quality Aspect



HYDROLOGICAL CYCLE:

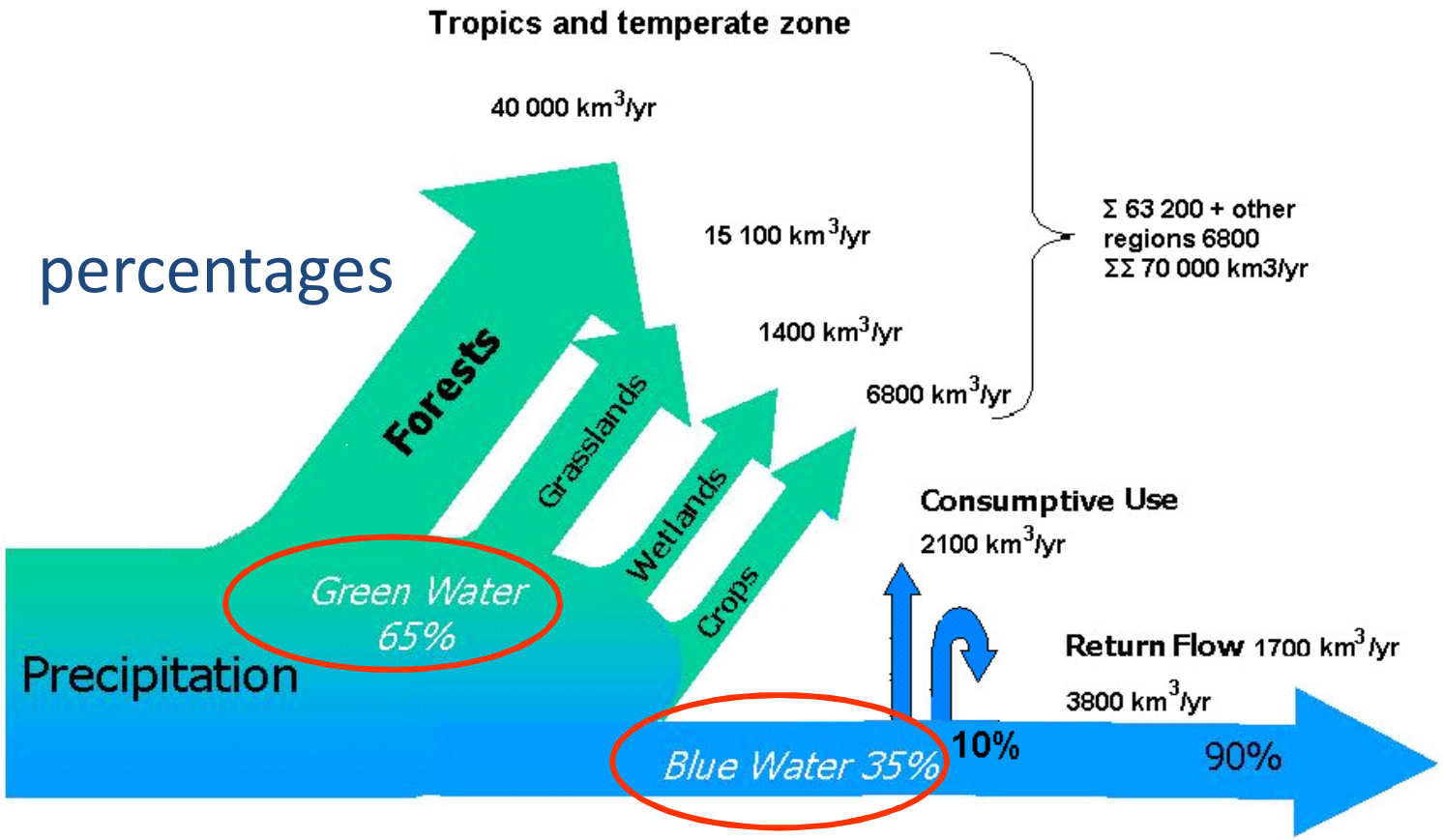
Blue and Green Water - perspective



Adapted from: GWP (M. Falkenmark), 2003, Water Management and Ecosystems: Living with Change

HYDROLOGICAL CYCLE:

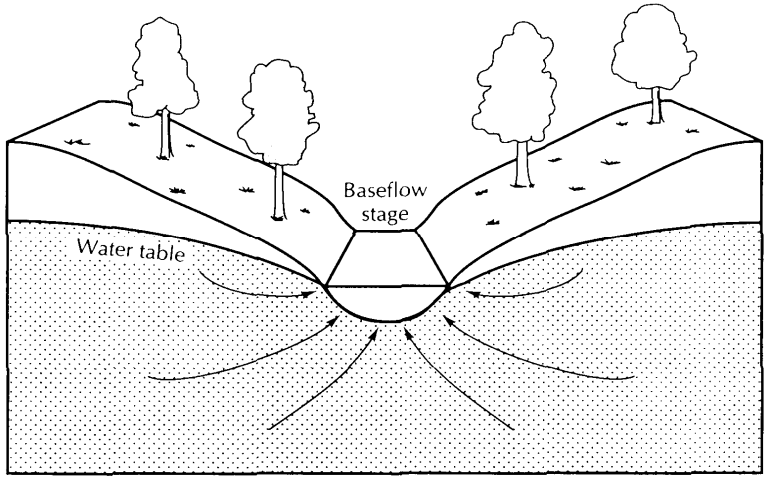
Blue and Green Water – Pathways



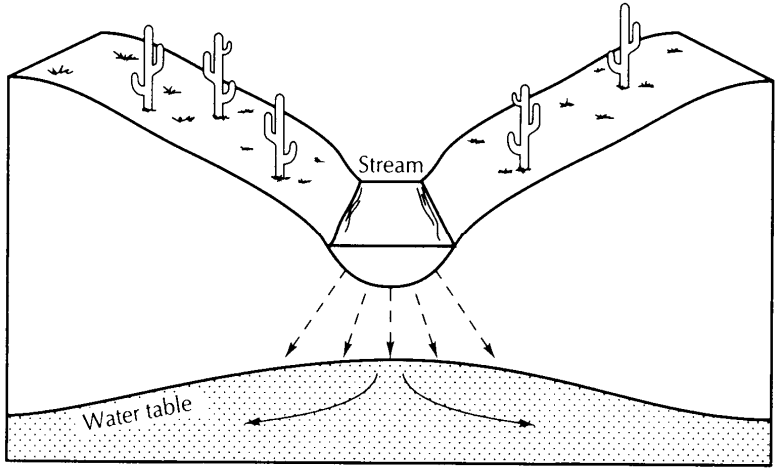
Consumptive water use by terrestrial ecosystems as seen in a global perspective. (Falkenmark in SIWI Seminar 2001).

HYDROLOGICAL CYCLE:

SW/GW relations - Humid vs Arid Zones

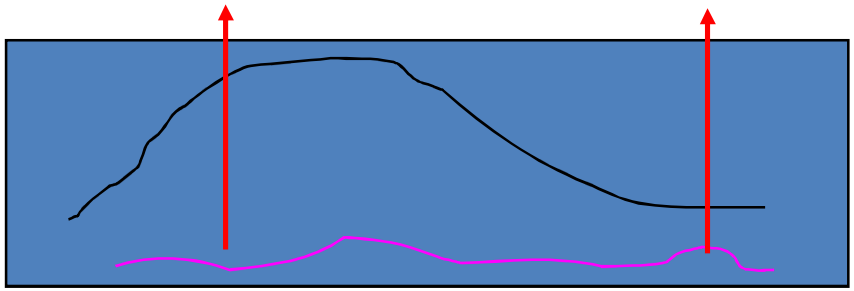


A. Cross section of a gaining stream, which is typical of humid regions, where groundwater recharges streams



B. Cross section of a losing stream, which is typical of arid regions, where streams can recharge groundwater

Base flow yield



COMPONENTS OF THE HYDROLOGIC CYCLE

The major components of the hydrologic cycle are:

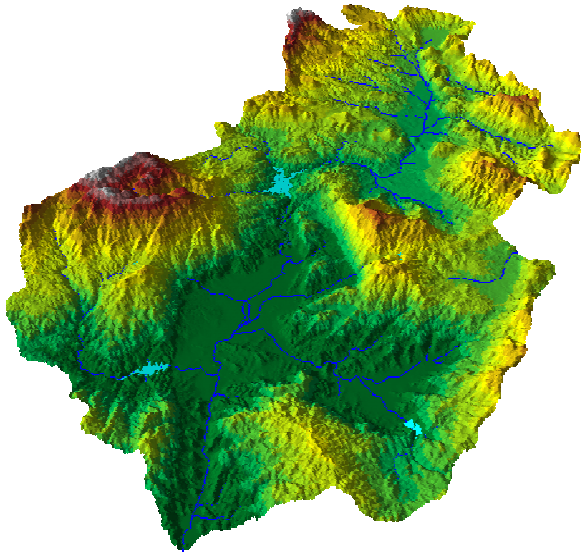
- **Precipitation**: water that falls in the form of rain or snow from saturated clouds
- **Evaporation:** the process whereby liquid water changes into gaseous form
- **Transpiration**: the process of water, formed during photosynthesis of plant, is released into the air
- **Interception**: part of a rainfall or snowfall which is retained by the plant leaves or buildings before it touches the ground
- **Depression storage/Surface detention**: the excess rainfall which is temporarily stored in surface depressions
- **Infiltration**: the process whereby water inters a few depths into the subsoil
- **Groundwater**: the water resource which is found deep in the ground
- **Runoff**: water which flows over or below the land surface from excessive precipitation

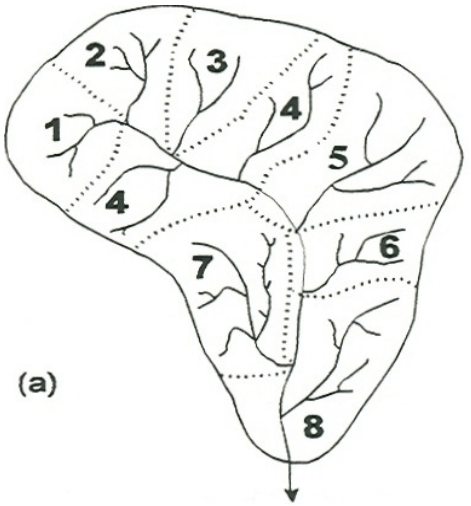
Water Budget Equation

Mass in flow – Mass outflow = Change in storage

$$P - Q - G - ET - \Delta S = 0$$

P = Precipitation
Q = Stream discharge
G = Groundwater Discharge
ET = Evapo-transpiration
ΔS = Change in Storage





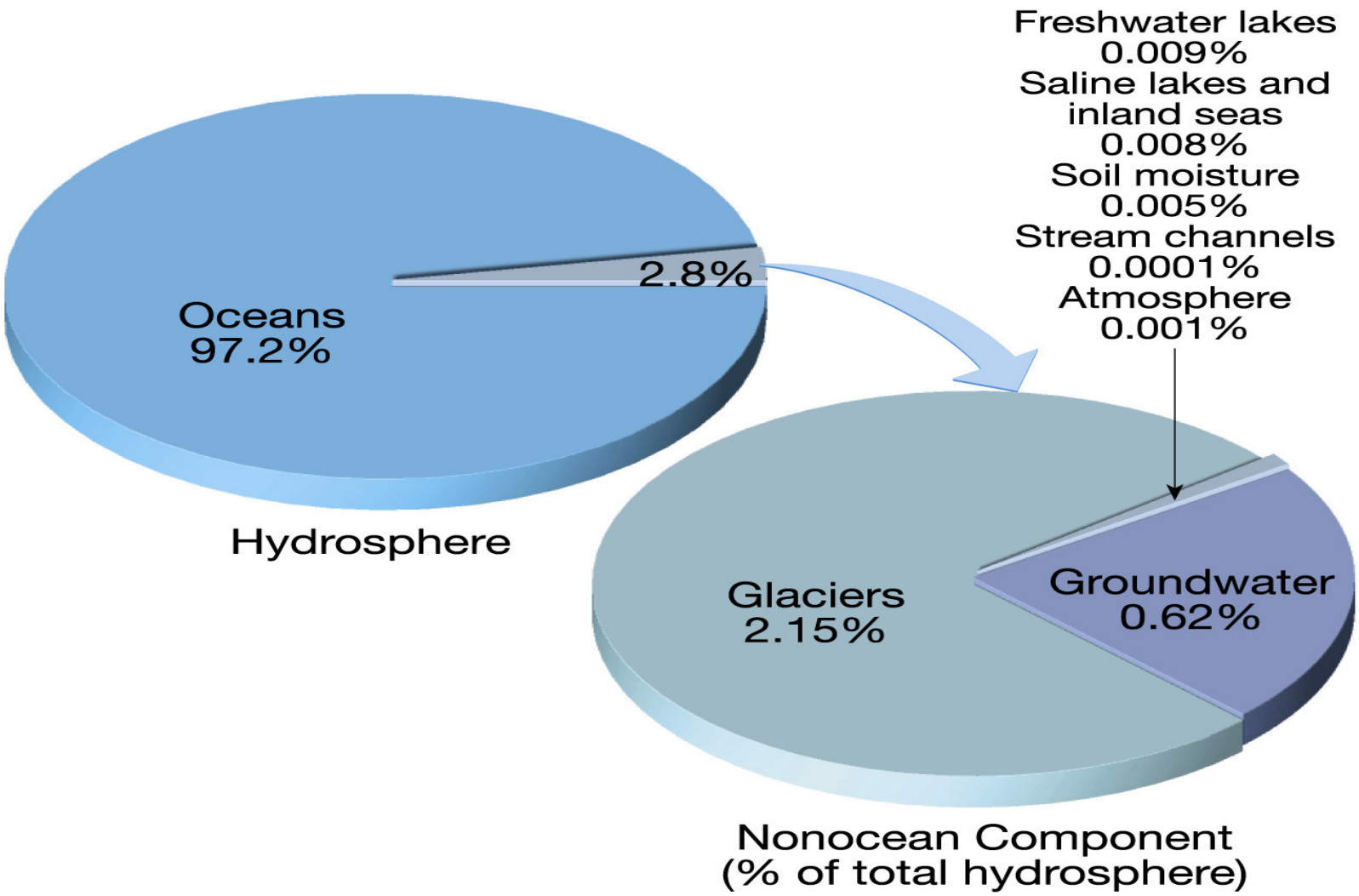
Example

A lake had a water surface elevation of ***103.2m*** *above datum at the beginning of a certain* ***month****. In that month, the lake received an average inflow of* ***6.0m³/s*** *from surface runoff sources. In the same period, the outflow from the lake had an average value of* ***6.5m³/s****. Again, in that month, the lake received a rainfall of* ***145mm*** *and the evaporation from the lake surface was estimated* ***as 6.10cm****. Write the water budget equation for the lake and calculate the water surface elevation of the lake at the end of the month. The average surface area can be taken as* ***5000ha****. Assume that there is no contribution to or from the ground water storage.*

The Earth's Water Distribution

- 97% of the water on earth is in the oceans
- Only 3% of the water on earth is freshwater
- About 2.4% of the freshwater on earth is permanently frozen in glaciers and at the polar ice caps
- About 1/2 of 1 % of the water on earth is groundwater
- Only about 1/100 of 1% of the water on earth is in the rivers and lakes

World Water


Freshwater lakes
0.009%
Saline lakes and
inland seas
0.008%
Soil moisture
0.005%
Stream channels
0.0001%
Atmosphere
0.001%
2.8%
Oceans
97.2%
Hydrosphere
Glaciers
2.15%
Groundwater
0.62%
Nonocean Component
(% of total hydrosphere)

ETHIOPIA

- **Area:** 1.13million square kilometer
  (1,119,683km^2 of dry land and 7,444km^2 water)
- **Altitude:**
  - 125m below sea level (Danakil Depression) and
  - 4600m above sea level (Ras Dashen Mountain)
- **Temp:**
  - Mean annual temperature between 15^0 – 20^0
- **Rainfall:**
  - Mean annual rainfall 200– 2200mm
- **Population:** > 73 million

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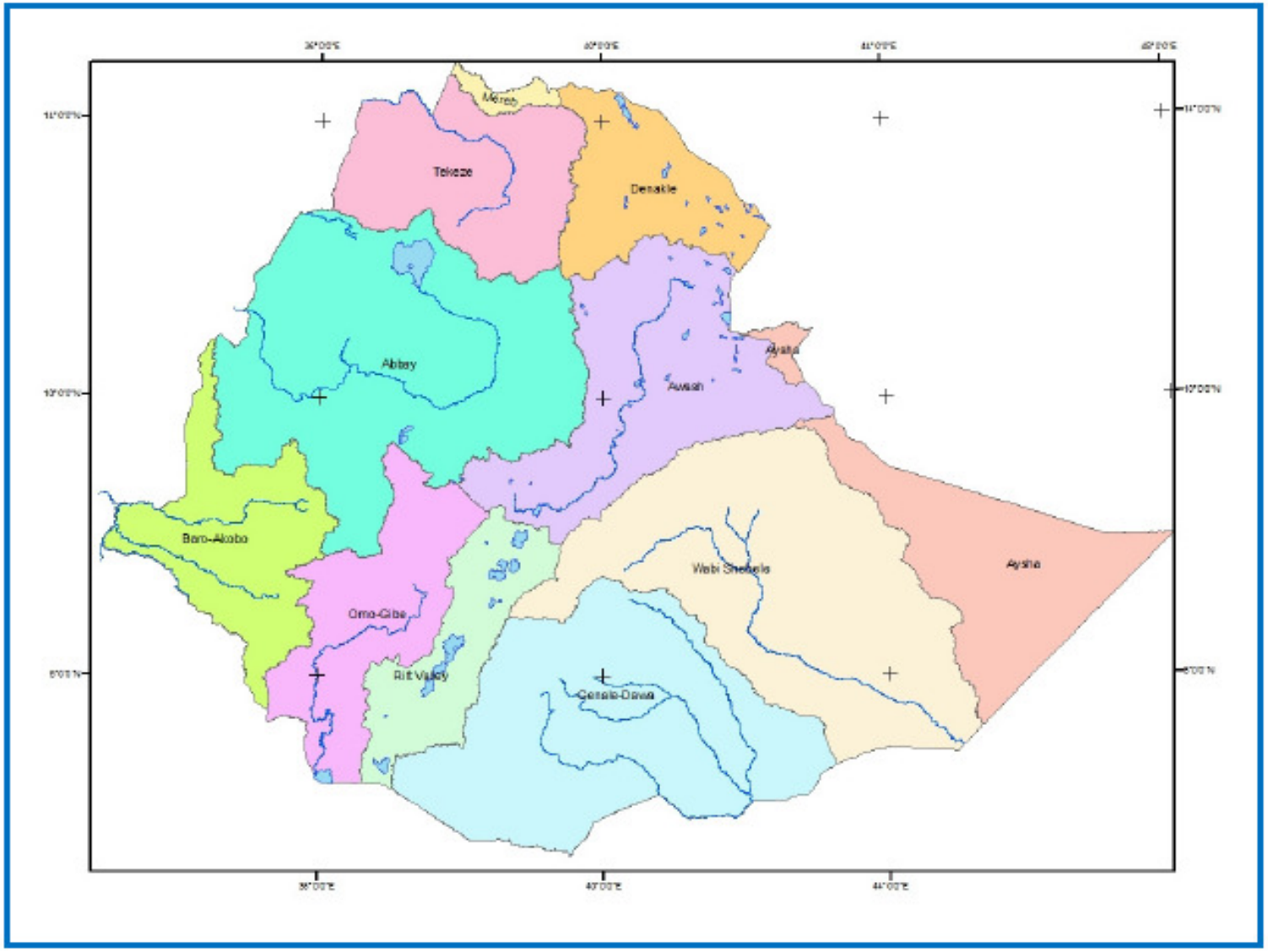
ETHIOPIA MAJOR BASINS



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ETHIOPIA WATER RESOURCE

Basin	Basin Area		Surface water potential		Ground water potential	
	Sq.Km	% of total	$X10^9$ m3/yr	% of total	$X10^6$ m3/yr	% of total
Abbay	204000	18.00	52.62	47.07	1800	70.86
Omo-Ghibe	79000	7.00	17.96	16.06	100	3.94
Baro-Akobo	75912	6.70	11.81	10.56	130	5.12
Tekeze	86500	7.63	8.20	7.33	200	7.87
Genale-Dawa	171042	15.10	5.88	5.26	30	1.18
Rift Valley	52739	4.65	5.63	5.04	100	3.94
Awash	112696	10.00	4.60	4.11	140	5.51
Wabi Sheble	202697	17.84	3.16	2.83	40	1.57
Ogaden	77121	6.80	0.86	0.77	-	-
Denakil	62882	5.54	0.86	0.77	-	-
Mereb	5900	0.52	0.65	0.58	-	-
Aysha	2223	0.20	0.22	0.02	-	-
	1133880		111.8		2540	