# CE 361A

# Engineering Hydrology

# Lecture - 01

# Introduction

- Hydrology – “Science of Water”
- Scope – wherever there is water
  - 15 km up into the atmosphere to 1 km down into the lithosphere
  - so far restricted to Earth …

- The Blue Book “Opportunities in the Hydrologic Sciences” in 1991 ed. Peter Eagleson

  Hydrologic science deals with the occurrence, distribution, circulation, and properties of water on the earth.

# Classification of Hydrology

- Scientific Hydrology – academic aspects
- Engineering or applied hydrology – applied aspects

- Descriptive Hydrology – earth sciences and ecology
- Quantitative Hydrology – civil engineering

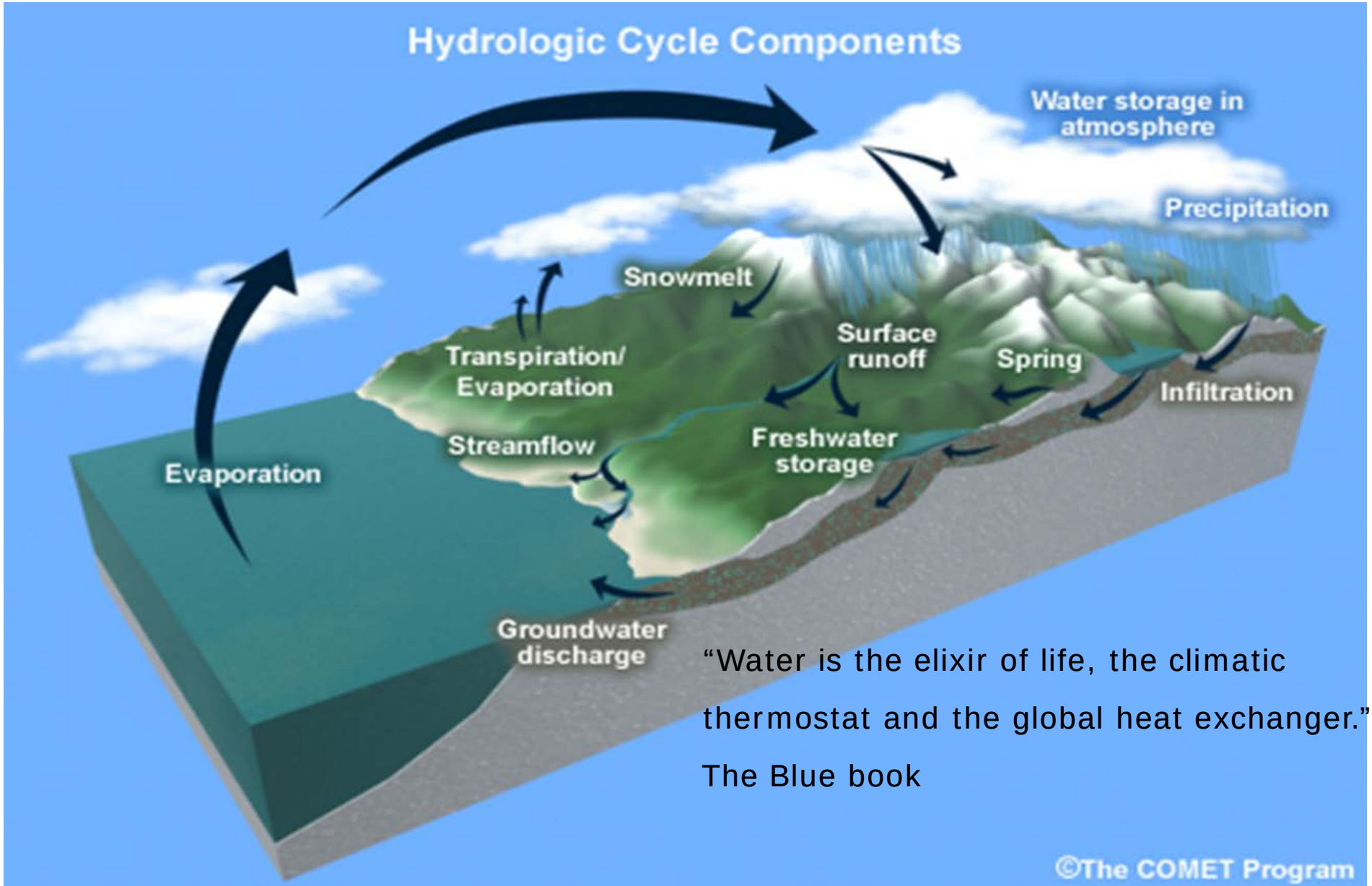
# Branches of Hydrology

- Eco-hydrology
- Isotope hydrology
- Socio-hydrology
- Archeo-hydrology
- Hydro-economics
- Hydro-meteorology
- Hydro-climatology
- Hydro-geology
- ...

# Importance of Engineering Hydrology

- Is there a need to manage the water resources of an area?
- What are the sources of water and their available quantity/quality?
- What should be the storage capacity of a reservoir?
- What is the safe limit for withdrawing water from groundwater?
- What kind of extreme hydrological events cauld be expected in an area and what is the probability of such occurrences?

# Hydrologic Cycle




"Water is the elixir of life, the climatic thermostat and the global heat exchanger."

The Blue book

# Hydrologic Cycle

- What drives hydrologic cycle?
  - Sun “the solar energy”

- Each path of the hydrologic cycle involves
  - transportation of water
  - temporary storage
  - change of state

# Water Budget

## Continuity equation or Conservation of mass

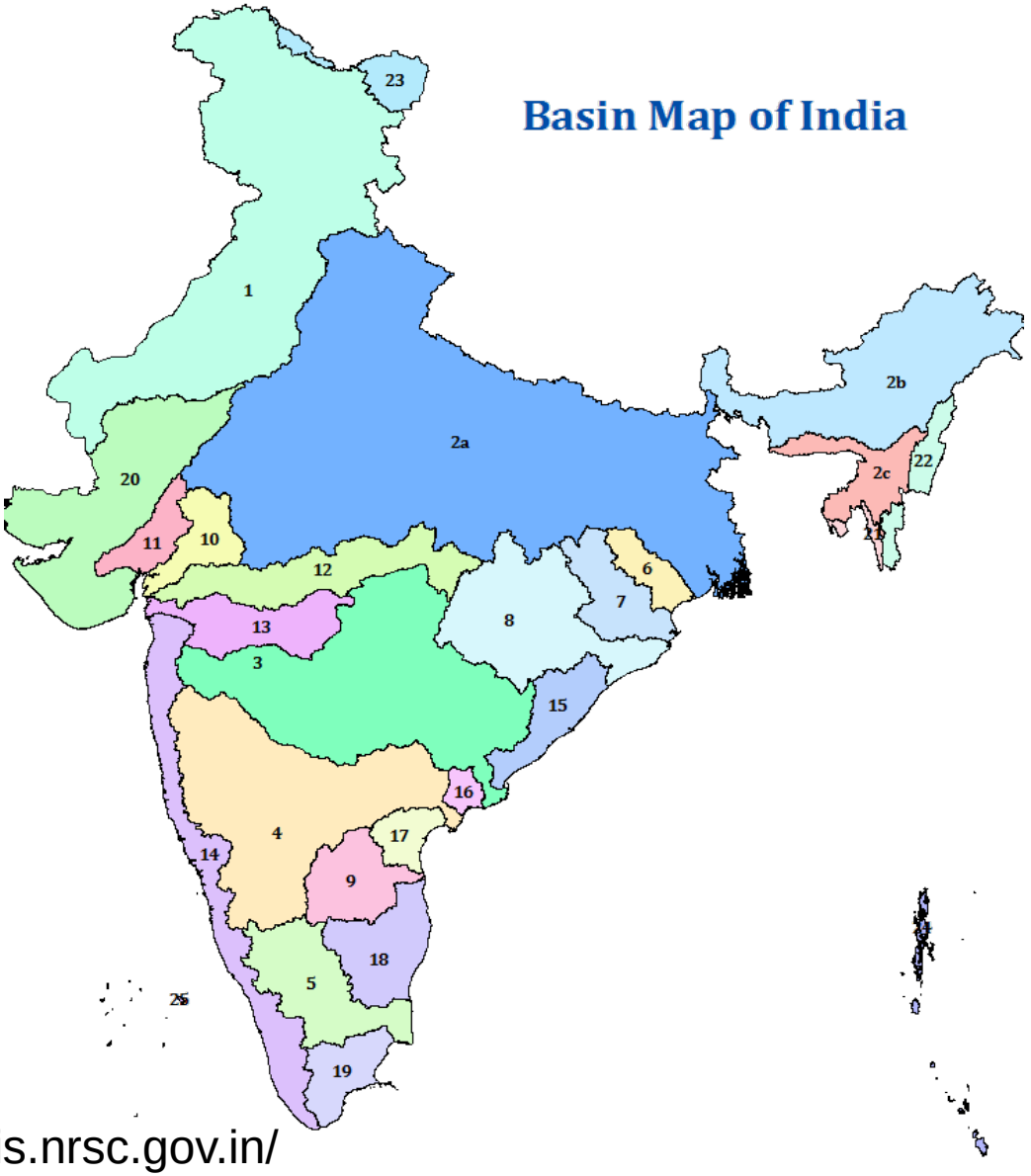
Inflow (I) – Outflow (O) = ± Change in storage (S)

or

$$I - O = \pm \Delta S$$

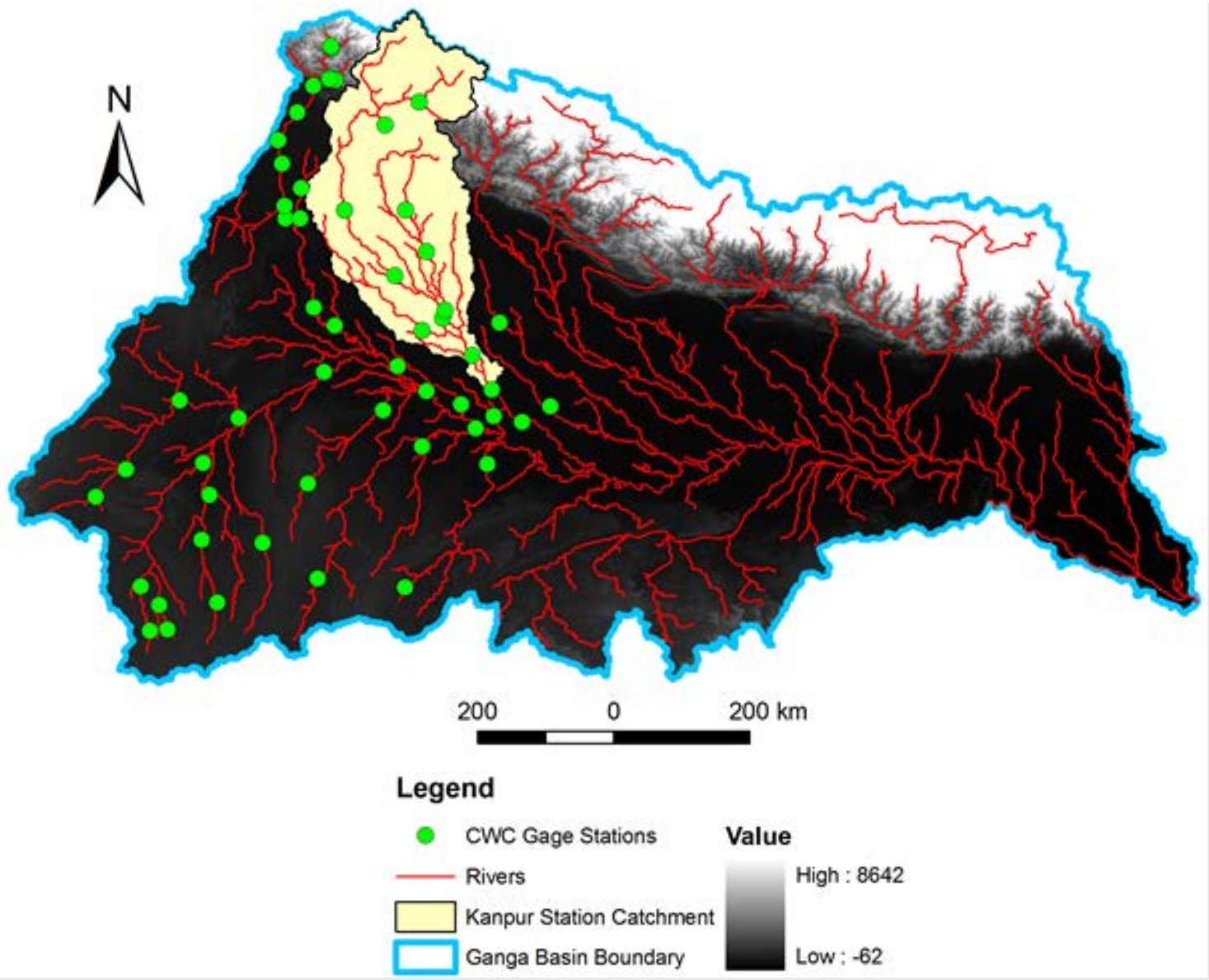
- What spatial scale?
  - catchment / watershed / basin
- Any convenient temporal scale?
  - water year

# River basins of India

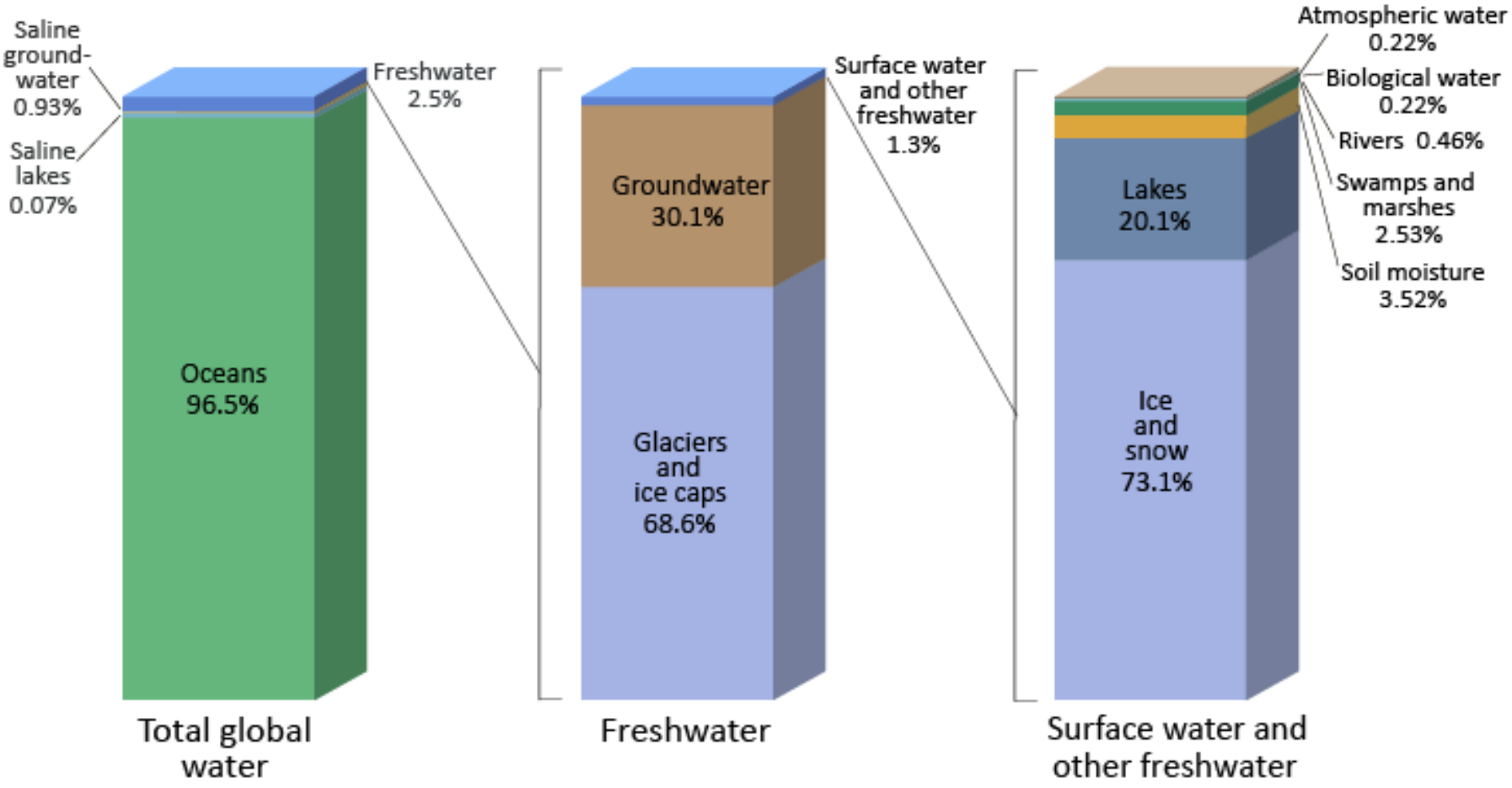



Source: http://india-wris.nrsc.gov.in/

# Basin with Kanpur as Outlet



# Distribution of Earth's Water




Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.

**Total usable fresh water : 0.00014 %**

# Residence Time

- The average duration of a water particle to pass through a phase of the hydrological cycle

$$T_r = V / Q$$

$T_r$ : Residence time

$V$ : Volume of water in that phase

$Q$ : Average flow rate in that phase

Shorter the $T_r$ greater the difficulty in predicting it

Rivers : 2 to 6 months

Atmospheric moisture: 9-10 days

# History of Hydrology: India

- Indus valley civilization
- Ancient India (Vedic Literature)
  - Arthashatra by Chanakya
  - The Grand Anicut or Kallanai dam on Cauvery ($2^{nd}$ century AD)
- Medieval India
  - Forts and palaces (Jal Mahal, Jaipur)
  - Land revenue

Shringverpur "water harvesting structure" ?

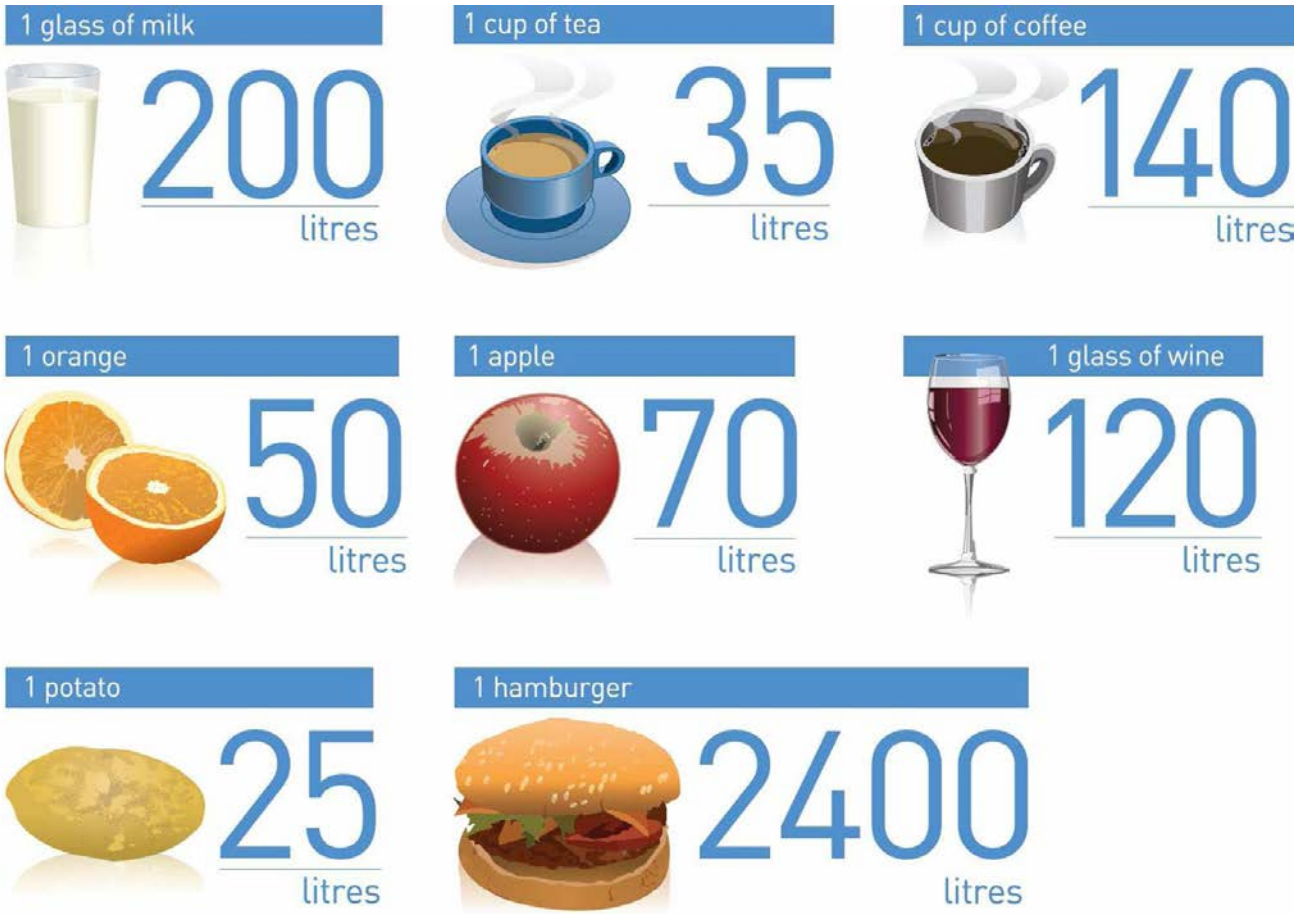
# Question

The solar energy which drives the hydrologic cycle is constant and so is the amount of water then why do we have events like flood and drought ?

-Hydrological cycle in not spatially uniform

-Hydrological cycle in not temporally steady

# Virtual Water




Source: http://www.sciencemediacentre.co.nz/wp-content/upload/2009/09/virtual-water3.jpg