# CE374 ENGINEERING HYDROLOGY

## Chapter 1 – Introduction

- Introduction (3 hours)
  - Scope
  - Hydrologic Cycle
  - 👂 System Concept
- Hydrologic Processes (9 hours)
  - 🦻 Basin
  - Precipitation
  - Streamflow
  - 🔋 Infiltration
- e Hydrograph Analysis
  - (10hours) Components of
  - runoff Hydrograph characteristics
  - Unit hydrograph theory
  - Synthetic unit hydrograph

Tentative Course Outline

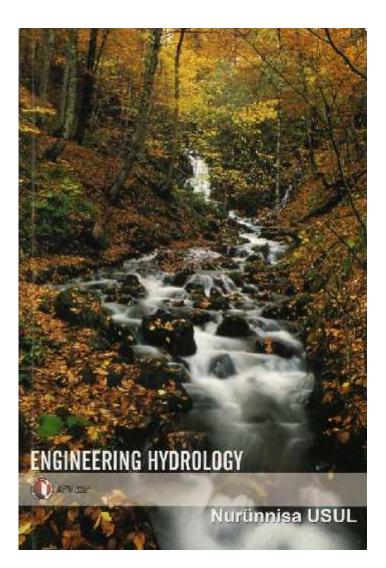
#### TEXTBOOK:

Question Office States of Control of Cont

#### **REFERENCES:**

 Linsley, Kohler, and Paulhus, *Hydrology for Engineers* (SIEd.), Mc Graw Hill, New York, 1982.

# OUR TEXT BOOKS



#### Supply versus Demand

- @ Existing Water = f (time, space, quality, quantity)
- Water Demand = f (time, space, quality, quantity)

Supply and demand need to be matched at any time

Daily matching: operationFuture matching: design

#### Nature of Water Resources Problems

#### Relationship between SUPPLY and DEMAND?

- 🍍 design
- 🌻 analysis

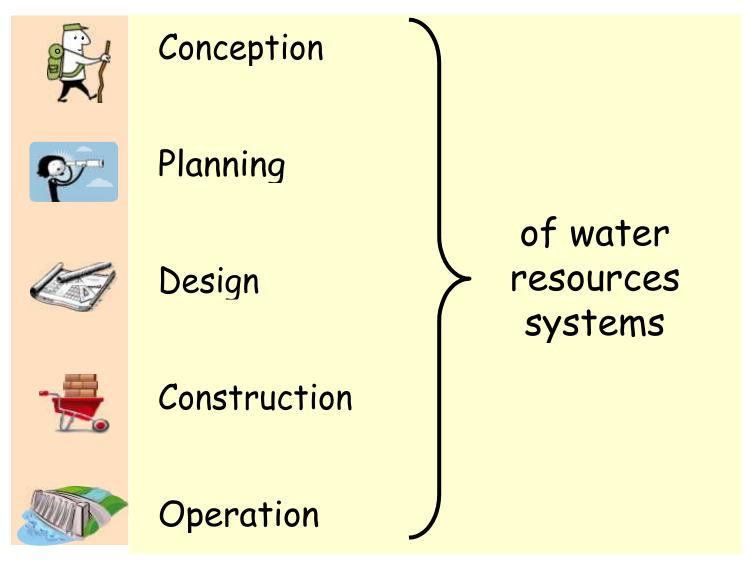
When we water of good quality is AVAILABLE?

demand

supply

When the second seco

#### Water resources engineering



#### Fields of Water Resources Engineering

- Water Control
  - Flood mitigation
  - Storm drainage
  - 🛚 Sewerage
  - Highway culvert design
- 🧕 Water use
  - Municipal water supply
  - Irrigation
  - Hydroelectric power development
  - Navigation
- Water Quality Management
  - For municipal and irrigation uses

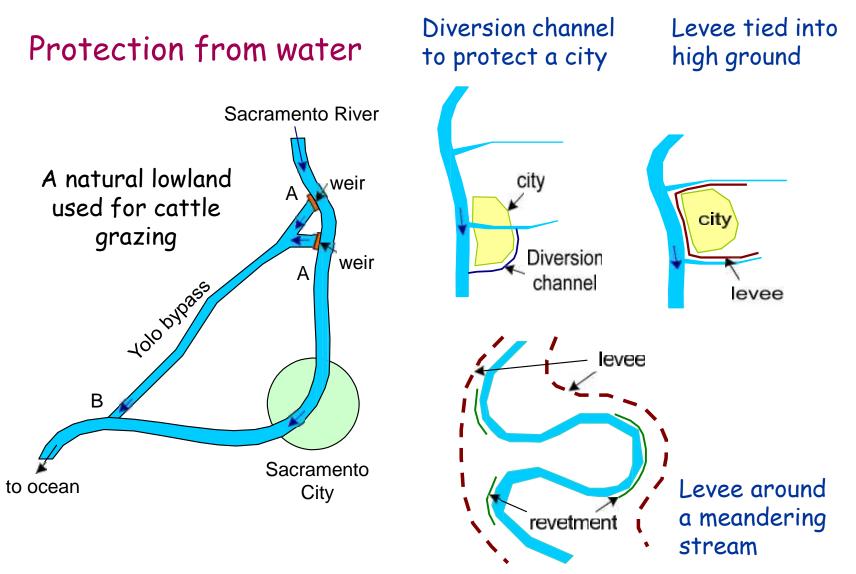




#### Water Control

- Water Control is necessary in order to prevent
  - the loss of lives,
  - the damage to the property, and
  - the difficulties in communities encountered due to water related problems (floods).
- Measures taken for the solution of these problems: The design and construction of
  - flood control structures for excess water,
  - storm drainage and sewerage systems to get rid of the unwanted water, and
  - culverts for the roads and highways.

# WATER CONTROL





#### **Quantity of Water**

How much water can be expected?

- Peakrates€Controlofwater€Design/operation
- Volume of flow € Water use € Design/operation
- Location problem € Water transmission
- Time problem € Water storage

Existing water = f (time, space) (application of hydrology)

- Who may use this water?
  - 🔋 Water law

#### Who will use the water?

- Q All the legal aspects (national and international laws) enter the picture.
- Water is a commodity to be sold or bought just like any other natural resource, such as oil or mineral.
- In dealing with water problems justice and fairness should be observed both nationally & internationally, since it is vital for mankind.
- Water related problems become more important with time because
  - while water resources stay the same on the Earth,
  - world population and water contamination are increasing continuously.

Water Quality

Problems related to

- Municipal water supply
- Irrigation
- Oisposal of waste water



http://www.durhamcountync.gov/departments/ceng/images/ Utility\_Division/Wastewater\_Treatment\_Plant-001.jpg



http://www.play-with-water.ch/d4/experiments/images/img\_26.jpg

### Water Quality Management

- Amount and character of impurities Chemical, bacteriologic tests
- Effects of these impurities Standards of acceptable quality
- Necessary facilities to remove these impurities Physical, chemical, biologic methods



## Characteristics of water resources problems

**@** Uniqueness

**Uncertainty** 

- Socio-economic aspect
- Forecasting
- @ Economy of scale
- Irreversibility

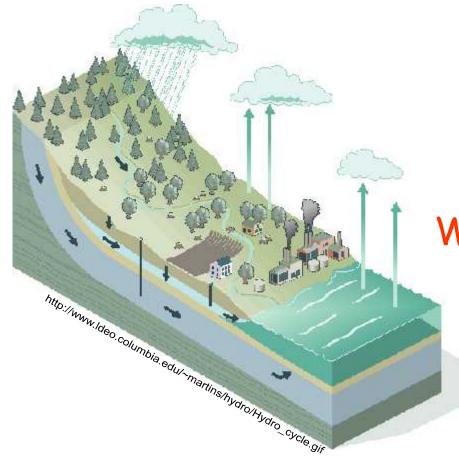
# **Design of Hydraulic Structures**

- 1. Hydrologic Design
- 2. Hydraulic Design
- 3. Structural Design

# **Applications**

- Reservoir capacity (water use)
- Spillway design (water control)
- e Highway drainage (water control)
- Irrigation and drainage (water use)
- e Hydropower (water use)
- Navigation (water use)
- Recreation (water use)

# Hydrologic Analysis in Water Resources Engineering



HYDROLOGY is an EARTH SCIENCE which deals with WATERS of the EARTH

# Hydrology deals with...

- Occurence
- Ø Distribution
- Movement
- Properties

... of WATER



### Hydrology is closely related with...

- Meteorology
- Climatology
- @ Geology
- Glaciology
- Limnology (lakes)
- Cryology (snow, ice)
- Potamology (rivers)
- Oceanology

#### Water resources engineering is linked to

- Why hydrology, hydraulics
- structural engineering
- @ materials engineering
- @ geotechnics
- @ transportation
- construction management, engineering economy
- surveying and topographic detailing
- environmental engineering, geological engineering
- @ sociology, politics, law  $\Rightarrow$  HYDROPOLITICS

## Hydrologic Cycle

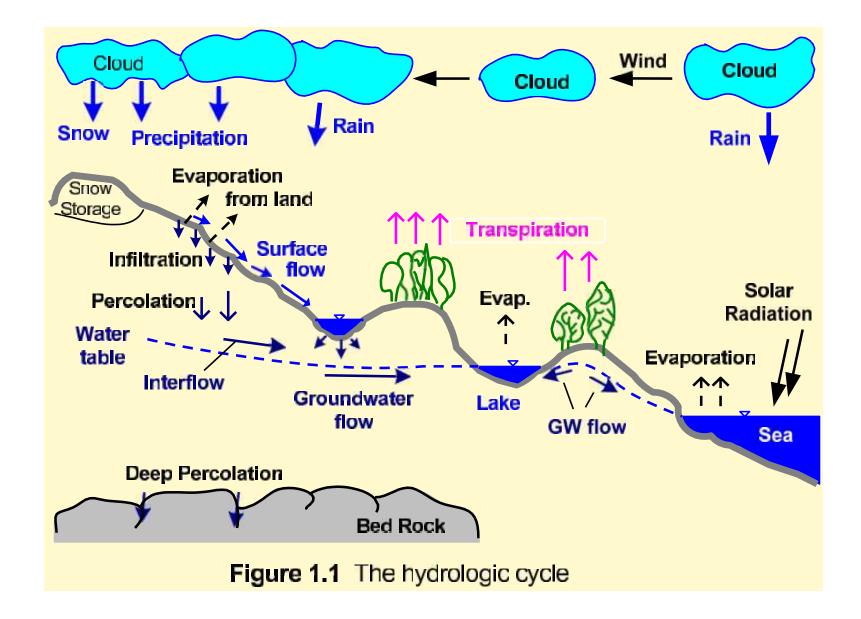
- The main concept of Hydrology
- It is, the cyclic movement of water

from SEA to ATMOSPHERE by EVAPORATION, & then back to EARTH by PRECIPITATION then runs to SEA through STREAMS or GW

Climatic (Hydrometeorologic) factors

solar radiation, temp., humidity, wind, atm. pres.

affect the elements of hydrologic cycle



# Hydrologic Cycle Elements

- Precipitation (humidity, temperature, wind)
- Interception
- Infiltration
- Surface Flow
- Subsurface Flow (interflow)
- Groundwater Flow (baseflow)
- Evaporation (temperature, wind, atm. pressure)
- Transpiration
- Percolation
- Ø Deep Percolation

# Most Important Elements of Hydrologic Cycle

- Precipitation
- Streamflow
- Evaporation
- Infiltration



/http://www.resimlihaber.com/gundem/ giresunda-sel-araclari-denize-surukledi\_2609.html#2

Problems for an engineer come from the extreme values of these elements

DROUGHTS (min. values) € WATER USE FLOODS (max. values) € WATER CONTROL Hydraulic Structures are built to solve the problems created by these extremes & to correct the maldistribution of water

in area€ WATER TRANSMISSION
in time€ WATER STORAGE
to fit the demands of people.

- ENGINEERING HYDROLOGY includes those parts of hydrology related to design and operation of engineering projects (hydraulic structures) for the CONTROL and USE of water.
- HYDROLOGY studies water in its natural environment.
- HYDRAULICS studies water flow in all conduits.
- WATER RESOURCES DEVELOPMENT is the engineering works for the use and control of water.

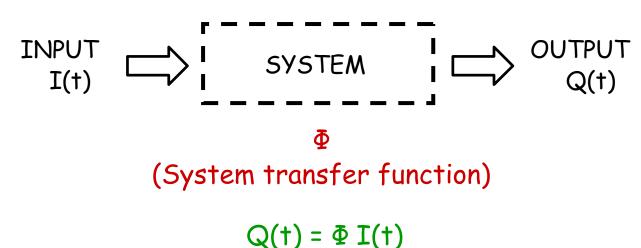
#### System Concept

In hydrology,

- the change of parameters in TIME and SPACE is difficult or impossible to determine.
- the knowledge of physical behaviour of system is inadequate.
- systems are heterogeneous.

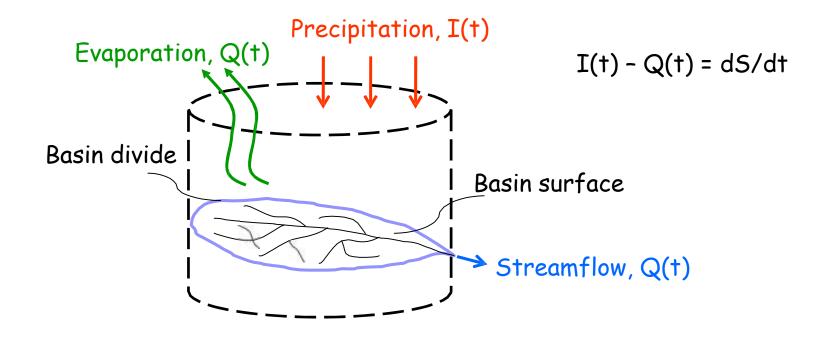
We use system concept...

System Concept

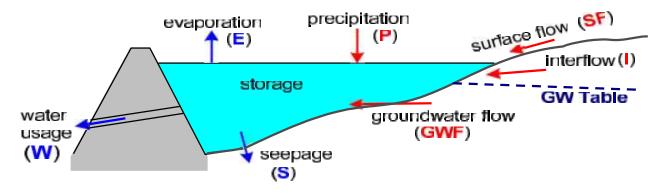


Transformation Equation

A hydrologic system €a structure or volume in space, surrounded by a boundary, that accepts water and other inputs, operates on them internally, and produces them as outputs [1] Question: Represent the storm rainfall-runoff process on a watershed as a hydrologic system [1]



- Continuity equation for a linear reservoir is a transfer equation linking its inflow and outflow
- @ dS/dt = I(t) Q(t)
  - I(t) : inflow Q(t) : outflow dS/dt : change in storage





PS = (P + SF + I + GWF) - (S + W + E)

## Subject Matter of Hydrology

#### DATA COLLECTION

- Depth and intensity of precipitation
- River discharge
- Snow depth and density
- 🧧 Lake level
- Infiltration rate
- @ GW table level
- e Evaporation rate

AVERAGE VALUES EXTREME VALUES TIME HISTORIES

DMI, DSI, EIE, Rural Services

# **METHOD of ANALYSIS**

- @ for the design
- @ for the operation
- Understanding the phenomena
- Oetermination of existing situation
- @ Estimation of future values

#### Problem : Inadequate Data

- Estimation of extremes which are rarely observed in a small data
- Hydrologic characteristics at locations where no data have been collected
- Estimation of the <u>effects of human actions</u> on the hydrologic characteristics of an area

#### EACH HYDROLOGIC PROBLEM IS UNIQUE specific basin + distinct set of physical conditions

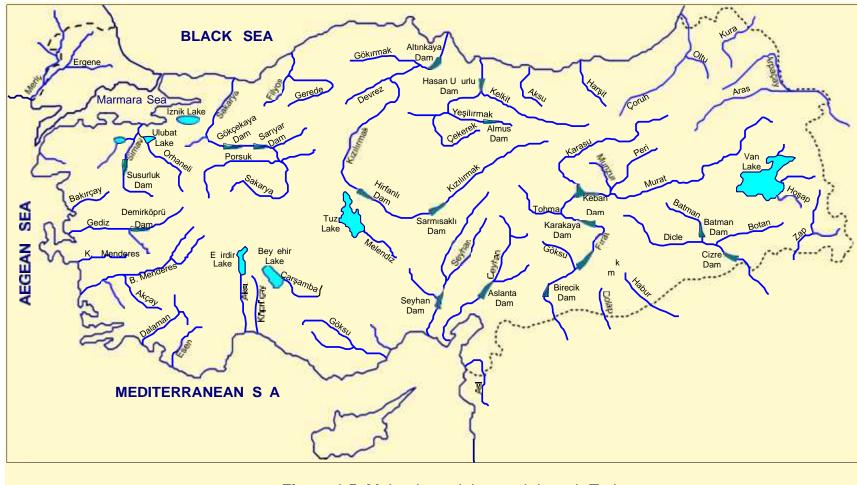
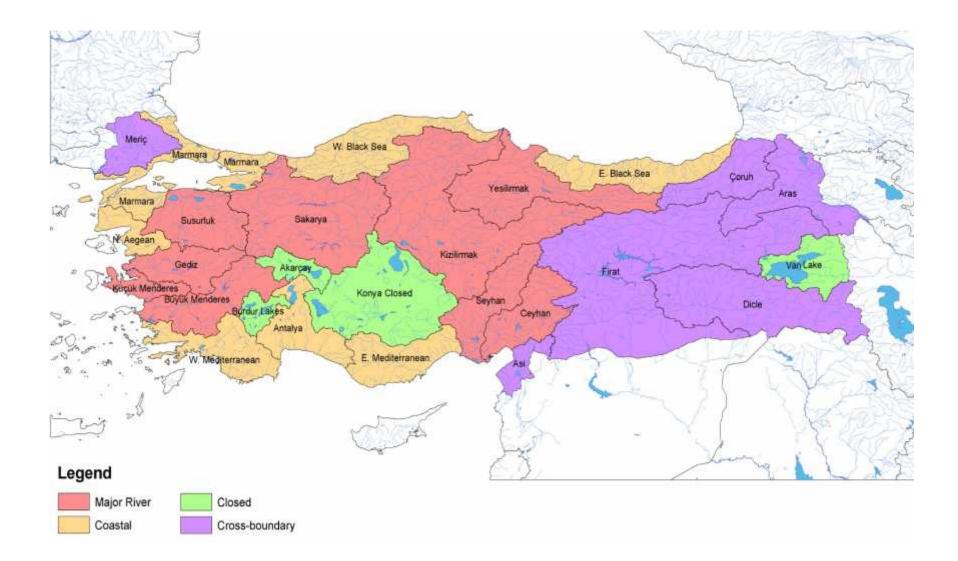


Figure 1.5 Major rivers, lakes and dams in Turkey



#### Land and water resources of Turkey

	Agricultural land Irrigable land	
0	Economically irrigable land	8.5*10° ha
	Mean annual precipitation depth Mean annual volume of precipitation	
	Annual surface runoff volume Average runoff coefficient	

@ Annual extractable groundwater resource...... 12.3 km<sup>3</sup>