CONCEPT OF BASIN AS A UNIT FOR DEVELOPMENT

DRAINAGE BASIN

- an extent or area of land where surface water from rain and melting snow or ice coverage"s to a single point, usually the exit of the basin, where the waters join another water body, such as a river, lake, reservoir, estuary, wetland, sea, or ocean.
- In closed drainage basins the water coverage"s to a single point inside the basin, known as a sink, which, may be a permanent lake, dry lake, or a point where surface water is lost underground.
- Includes both the streams and rivers that convey the water as well as the land surfaces from which water drains into those channels, and is separated from adjacent basins by a drainage divide.
- Acts as a funnel by collecting all the water within the area covered by the basin and channeling it to a single point.
- Each drainage basin is separated topographically from adjacent basins by a geographical barrier such as a ridge, hill or mountain, which is known as a water divide.
- Other terms used to describe a drainage basin are catchment, catchment area, catchment basin, drainage area, river basin, water basin and watershed.
- Drainage basins drain into other drainage basins in a hierarchical pattern, with smaller sub-drainage basins combining into larger drainage basins.

- Drainage basins are similar but not identical to hydrologic units, which are drainage areas delineated so as to nest into a multi-level hierarchical drainage system. Hydrologic units are designed to allow multiple inlets, outlets, or sinks.
- In a strict sense, all watersheds are hydrologic units but not all hydrologic units are watersheds.

IMPORTANCE OF DRAINAGE BASIN

Geopolitical boundaries

– Drainage basins have been historically important for determining territorial boundaries, particularly in reigns where trade by water has been important.

Hydrology

- In hydrology, the drainage basin is a logical unit of focus for studying the movement of water within the hydrological cycle, because the majority of water that discharges from the basin outlet originated as precipitation falling on the basin.

Geomorphology

- Drainage basins are the principal hydrologic unit considered in fluvial geomorphology. A drainage basin is the source for water and sediment that moves through the river system and reshapes the channel.

Ecology

- Drainage basins are important elements to consider also in ecology.
- As water flows over the ground and along rivers it can pick up nutrients, sediment, and pollutants.
- Like the water, they get transported towards the outlet of the basin, and can affect the ecological processes along the way as well as in the receiving water source.

WATER BUDGET AND DEVELOPMENT PLAN

WATER BUDGETS

- The development and utilization of water resources must be managed in a sustainable manner if in stream, recreational, municipal, agricultural, and other uses are to be accommodated.
- A water budget analysis starts with an evaluation of the existing water resources (water income), and then subtracts the existing water uses (water expenses) to arrive at the current water budget.
- The scale (i.e., sophistication or level of effort) of the water budget study is determined by the requirement that all major factors in the water budget be included within the area of study.
- The study area must include the recharge area for all major (greater than 100,000 gpd) groundwater withdrawals.

The development of a water budget will generally require the following information:

- The amount and seasonal distribution of precipitation
- The variation in precipitation due to year-to-year climatic variability
- The amount and seasonal distribution of stream flows
- The variation in stream flows due to year-to-year climatic variability
- The amount and seasonal distribution of stream base flows
- The variation in stream base flows due to year-to-year climatic variability
- A topographic map and/or database with
  - Locations and magnitudes of water withdrawals
  - Locations and magnitudes of water returns
  - Capture area for all high capacity wells
  - Wellhead protection areas
  - Areas of impervious cover
  - Soil drainage characteristics
  - Land use planning and zoning
  - Locations and nature of water quality problems
  - Total Maximum Daily Loads (TMDLs) for all streams
  - Aquifer types
  - Aquifer structure
  - Water table configuration
  - Storage facilities.

- Uncertainties in the water budget due to lack of data on the basin surface water and groundwater flow may require the acquisition of additional information from a network of surface water and groundwater monitoring points for an extended period.
- In some cases, this information will be available from similar, nearby watersheds, and can be scaled to the watershed under study.

- The area to be included in the study is determined by the hydro geomorphic setting, and the location of large withdrawals and discharges within that setting.
- It is essential to include the capture area and area of contribution for all surface water and groundwater withdrawals of 100,000 gallons per day or greater and all consumptive use withdrawals of 20,000 gallons per day or greater.

WATER-BUDGET EQUATION

The water-budget equation is simple, universal, and adaptable because it relies on few assumptions on mechanisms of water movement and storage.

A basic water budget for a small watershed can be expressed as:

$$P + Q_{in} = ET + \Delta S + Q_{out}$$

where

P - is precipitation,

Q_{in} - is water flow into the watershed,

ET - is evapotranspiration (the sum of evaporation from soils, surface-water bodies, and plants),

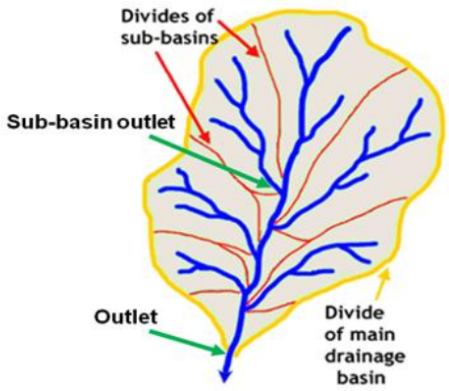
ΔS - is change in water storage,

Q_{out} - is water flow out of the watershed.

Types of Watersheds

Definition of Drainage Basin

It is defined as, “any portion of the earth's surface within a physical boundary defined by topographic slopes that divert all runoff to the same drainage outlet.”



Drainage basin with its sub-basins.

By definition, any point on the main drainage system can be selected as the basin outlet. Thus, a basin is defined with respect to the outlet.

The physical boundary of the drainage basin is called the drainage divide. The watershed area includes all the points that lie above the elevation of the outlet and within the drainage divide that separates adjacent watersheds.

Other terms synonymous with drainage basin are watershed, catchment, basin, river basin, runoff area, and stream basin. Watershed, catchment and basin are most commonly used terms by hydrologists.

Watersheds can be classified based on size, mean slope, length, land use, etc. Two hydrologically meaningful criteria are size and land use.

Classification of Watersheds by Size

Three types of watershed are distinguished according to size:

1. Small size: < 250 km^2
2. Medium size: between 250 km^2- 2500 km^2
3. Large: >250 km^2

This classification is vague, but the implication is in terms of spatial heterogeneity and dampening (averaging) of hydrological processes.

Runoff generation on these watersheds can be considered in two phases: i) land phase and ii) channel phase. Each phase has its own storage characteristics.

Large Watersheds

1) They have well-developed channel networks and channel phase, and, thus, channel storage is dominant.
2) They are less sensitive to high-intensity rainfalls of short duration.

Small Watersheds

1) They have dominant land phase and overland flow, have relatively less conspicuous channel phase.
2) They are highly sensitive to high-intensity, short-duration rainfalls.

Two watersheds of the same size may behave very differently if they do not have similar land and channel phases.

Small watersheds are usually least heterogeneous and large watersheds are most heterogeneous. In other words, spatial variability of watershed characteristics increases with size.

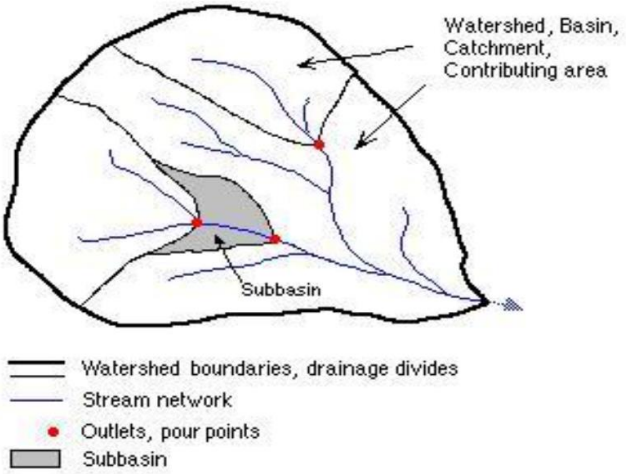
As the watershed size increases, storage increases and averaging of hydrologic processes increases as a result. The effect of averaging is to linearise the watershed behavior.

Classification of Watersheds by Land Use

Land use defines exploitation of watershed. Accordingly, watersheds can be classified as agricultural, urban, mountainous, forest, desert, coastal or marsh, or mixed - a combination of two or more of the previous classifications. These watersheds behave hydrologically so differently that different branches of hydrology have arisen:-

1) Urban watersheds: urban hydrology
2) Agricultural watersheds: agricultural hydrology
3) Forest watersheds: forest hydrology
4) Mountainous watersheds: mountain hydrology
5) Desert watersheds: desert hydrology
6) Coastal watersheds: coastal hydrology
7) Wetland/marsh watersheds: wetland hydrology

WATERSHED MANAGEMENT



GENERAL

- Watershed – defined – as the land area that contributes runoff to a particular point along a waterway.
- A typical watershed can cover tens to hundreds of square miles and several jurisdictions.
- Watersheds are broken down into smaller geographic units called **sub-watersheds.**
- Sub-watersheds typically have a drainage area of 2 to 15 square miles with boundaries that include the land area draining to a point at or below the confluence of two second order streams and almost always within the limits of a third order stream.
- The terms "watershed "and "sub-watershed" are not interchangeable.

- The term watershed is used when referring to broader management issues across an entire watershed.
- While the term sub-watershed is used to refer assessment level studies and specific projects within the smaller sub-watershed units.

- The term watershed is used when referring to broader management issues across an entire watershed.
- While the term sub-watershed is used to refer assessment level studies and specific projects within the smaller sub-watershed units.
- Watershed is considered as a biological, physical, economical, and social system too.
- Watershed is a natural unit of land, which collects water and drains through a common point by a system of drains. Hence it comprise of a **Catchment area** (Recharge Zone), a **Command area** (Transition Zone), a **Delta area** (Discharge Zone).
- Topmost portion of the watershed is known as the "ridge" and a line joining the ridge portions along the boundary of the watershed is called a "ridgeline".
- A watershed is thus a logical unit for planning optimal development of its soil, water and biomass resources.

TYPE OF WATERSHED

✓ Common mode of categorization

- Size,
- Drainage,
- Shape
- Land use pattern.

✓ Categorization could also based on

- Size of the stream or river,
- Point of interception of the stream or river,
- Drainage density
- Its distribution.

✓ A watershed could be described as fan shaped (near circular or fen shaped (elongated). Hydrologically the shape of the watershed is important because it controls the time taken for the runoff to concentrate at the outlet.

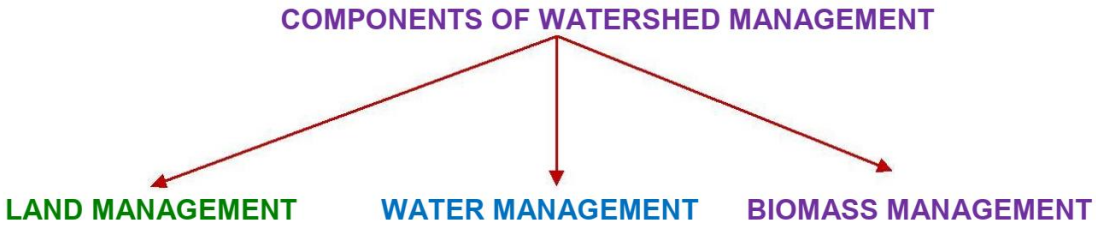
✓ Watersheds may also be categorized as hill or flat watersheds, humid or arid watersheds, red soil watershed or black soil watershed based on criteria like soil, slope, climate etc.

✓ Depending on the land use pattern watershed could again be classified as highland watersheds, tribal settlements and watersheds in areas of settled cultivation.

WATERSHED MANAGEMENT

- Watershed management has emerged as a new paradigm for planning, development and management of land, water and biomass resources with a focus on social and environmental aspects following a participatory approach.
- Watershed management is more a philosophy of comprehensive integrated approach to natural resources management.
  - It aims at integration of social resources management with natural resources management.
  - The approach is generally preventive, progressive, corrective and curative.
  - Watershed management involves the judicious use of natural resource with active participation of institutions, organizations, in harmony with the ecosystem.

COMPONENTS OF WATERSHED MANAGEMENT



LAND MANAGEMENT

- Land characteristics like terrain, slope, and formation, depth, texture, moisture, and infiltration rate and soil capacity are the major determinants of land management activities in a watershed.
- Broad category of land management interventions can be as follow:
  - Structural measures
  - Vegetative measures
  - Production measures
  - Protection measures

- **Structural measures** – include intervention like -
  - Stone bunds
  - Contour bunds
  - Earthen bunds
  - Graded bunds
  - Compartmental bunds
  - Contour terrace walls
  - Contour trenches
  - Bench terracing
  - Broad based terraces
  - Centripetal terraces
  - Field bunds
  - Channel walls
  - Stream bank stabilization
  - Check dams etc.
- **Vegetative measures** – include
  - ✓ Vegetative cover
  - ✓ Plant cover
  - ✓ Mulching
  - ✓ Vegetative hedges
  - ✓ Grass land management
  - ✓ Agro-forestry etc.
- **Production measures** – include interventions aimed at increasing the productivity of land like
  - Mixed cropping,
  - Strip cropping,
  - Cover cropping,
  - Crop rotations,
  - Cultivation of shrubs and herbs,
  - Contour cultivation conservation tillage,
  - Land leveling, use of improved verity of seeds,
  - Horticulture, etc.
- **Protective measures** like
  - Landslide control
  - Gully plugging
  - Runoff collection etc. can also be adopted.

WATER MANAGEMENT

- **Water characteristics like**

Inflows	water use	outflows	storage
(Precipitation, Surface water inflow, Groundwater inflow)	(evaporation, evapotranspiration, irrigation, drinking water)	(surface water outflow, ground water outflow)	(surface storage groundwater storage root zone storage)

- Broad interventions for water management are
  - Rain water harvesting
  - Ground water recharge
  - Maintenance of water balance
  - Economic use of water
- Simple and cost effective rainwater harvesting structures are
  - Percolation pit/tanks
  - Recharge trenches/rain pits
  - Recharge wells
  - Ferro cement tanks
  - Farm ponds
  - V ditch

- Benching terracing

- Economic use of water and avoidance of affluence in use of water at individual and community levels may be the major concern for water management in the years to come.

BIOMASS MANAGEMENT

- Major intervention areas for biomass management are:

  - Eco – preservation
  - Biomass regeneration
  - Forest management and conservation
  - Plant protection and social forestry
  - Increased productivity of animals
  - Income and employment generation activities
  - Co ordination of health and sanitation programmes
  - Better living standards for people
  - Formation

CAUSES OF WATERSHED DETERIORATION

- Uncontrolled, unplanned, unscientific land use and interventions
- Cultivation on sloping land with adequate precautions
- Cultivation without agronomic measures to conserve soil and water
- Cultivation along susceptible nalla banks
- Cultivation of erosion-permitting crops
- Over-cropping without soil fertility replenishment
- Faulty agricultural techniques
- Grass lands:
  - Excessive and uncontrolled grazing
  - Growth of weeds
  - Development of cattle tracks causing damage and compaction of soil resulting in lower infiltration rates, fires, theft etc,
- Forest:
  - Excessive and uncontrolled grazing which inhibits regeneration from seed or stock
  - Clear felling on steep slopes
  - Destruction of forest land by fires and thefts
- Shifting cultivation: proved to be very damaging to protective and productive vegetation
- Unscientific mining and construction activities: damage the vegetation and the landscape. Natural drainage lines are often blocked by debris.
- Fire: intentional / accidental fires result in loss of vegetation, organic matter and micro-organisms.

- Non-cooperation of the community: Non – cooperation of the community in conserving, protecting and enriching then ecosystem.

REQUIREMEN OF WATERSHED MANAGEMENT

- To control damaging runoff
- To manage and utilize runoff for useful purposes
- To control erosion affecting reduction of sediment production
- To moderate floods in the downstream area
- To enhance groundwater storage wherever applicable
- To appropriately use land resources in the watershed, thus develop in forest and fodder resources

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