RAINWATER HARVESTING (B22EDO601)

OPEN ELECTIVE- SEMESTER-VI

MINAKSHI MISHRA
SCHOOL OF CIVIL ENGINEERING

Course Content

Unit -2

- **Introduction:** Advantages of Rainwater Harvesting, Natural Water Resources.
- **Agricultural Practices**, integrated farming, Soil erosion and conservation techniques.
- Concept of Arid and Semiarid Regions. **Drought Management-** introduction, Drought assessment and classification, drought mitigation planning, Concept of **watershed**, introduction to watershed management.

Natural Water Resources

Natural Water Resources

- Surface Water
- Under river flow
- Groundwater
- Frozen Water

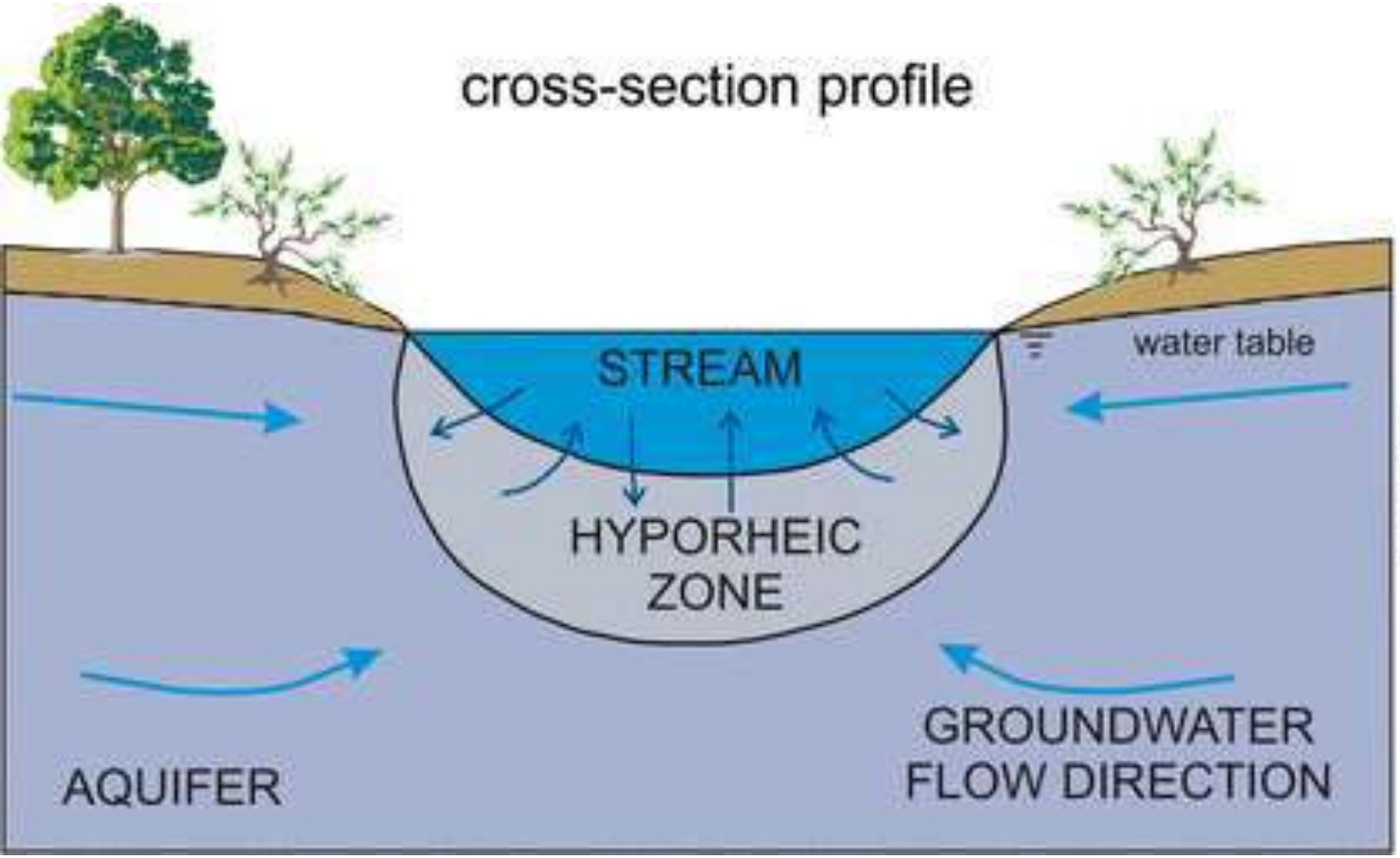
Natural Water Resources - Surface Water

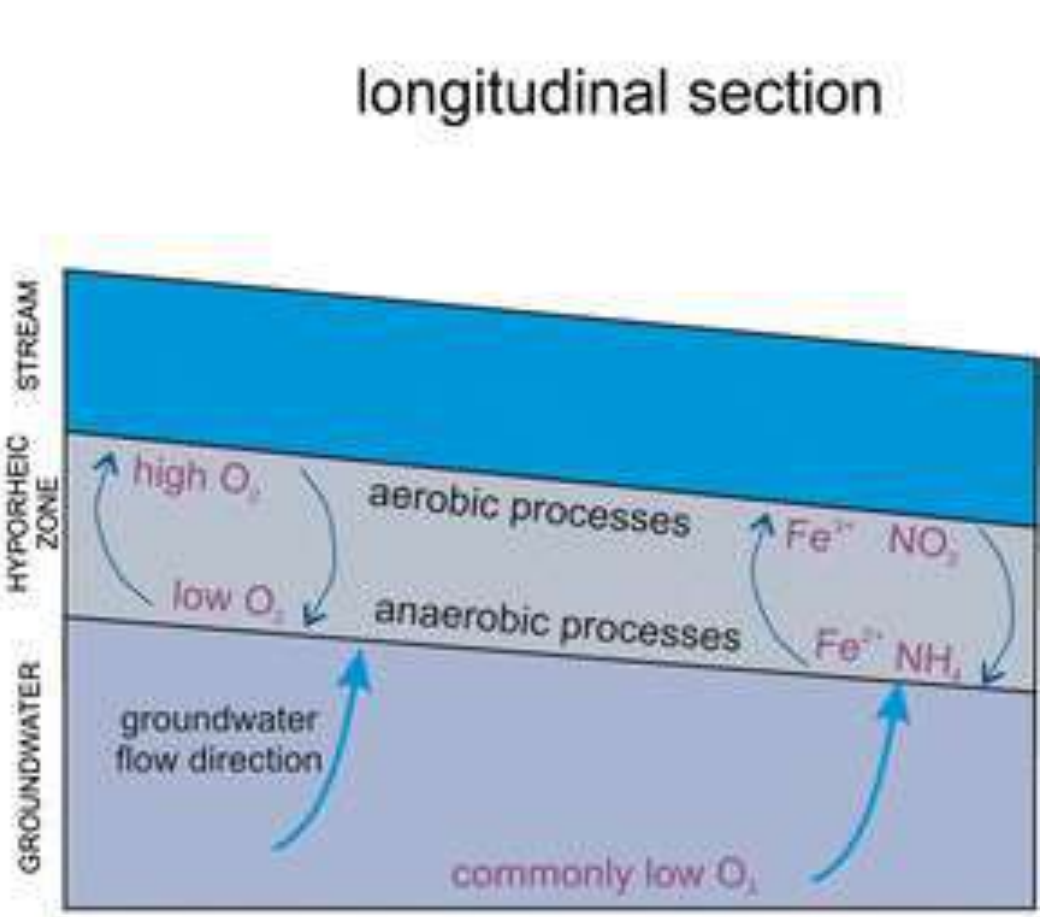
- Water **in a river, lake, or freshwater wetland** is known as surface water.
- Precipitation refills surface water. Although precipitation within a watershed is the only natural input to any surface water system, the **overall amount of water in that system** at any given time is influenced by a variety of other **factors**.
- **Storage capacity in lakes, marshes, and artificial reservoirs, permeability of the soil underlying these storage bodies,** runoff characteristics of the land in the watershed, precipitation timing, and **local evaporation** rates are among these aspects.

Natural Water Resources - Under river flow

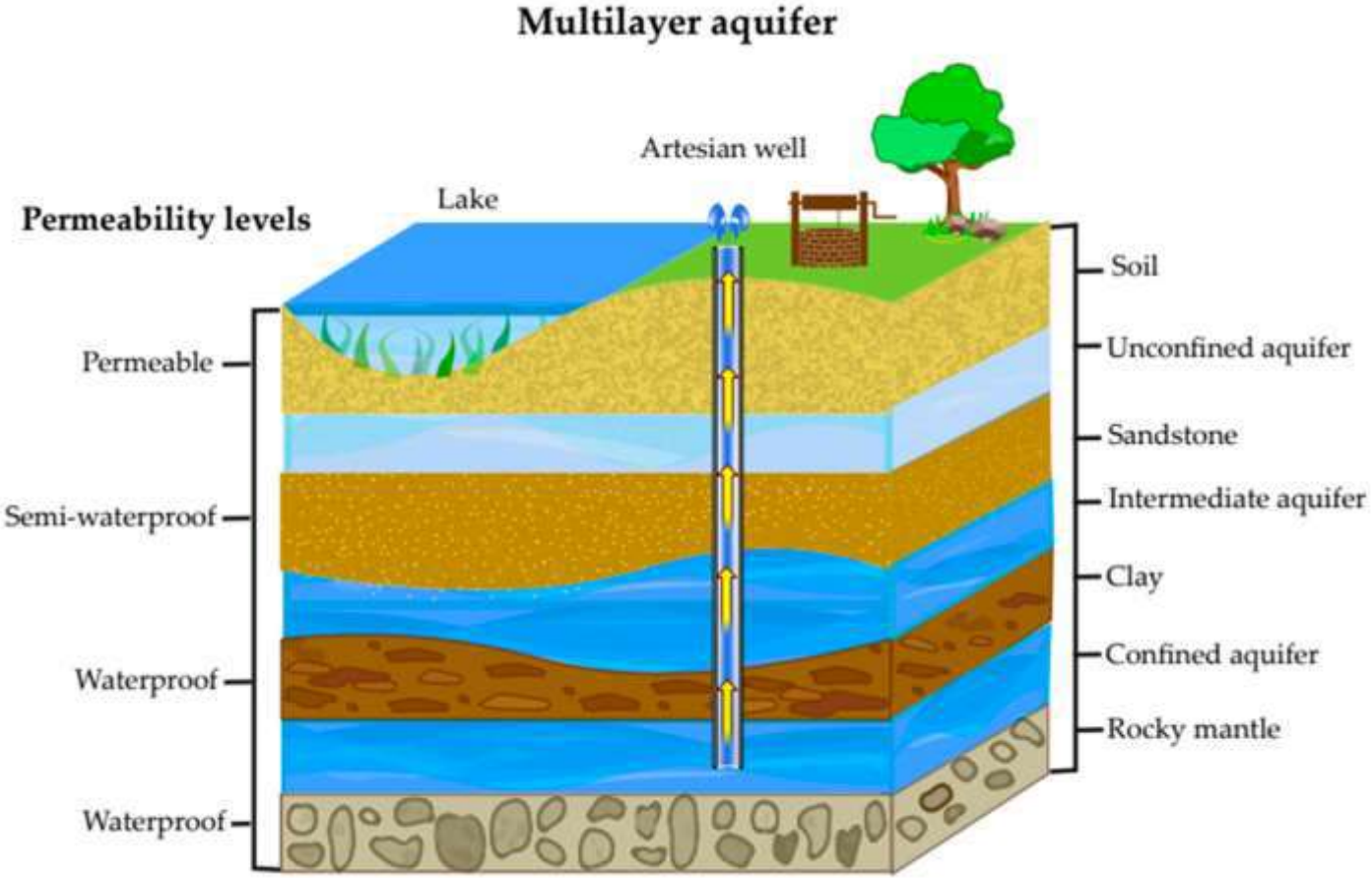
- The total volume of water delivered downstream by a **river** is typically a **combination of visible free water flow and a significant contribution flowing via rocks and sediments** that lay beneath the river and its floodplain, known as the hyporheic zone.
- The hyporheic zone is a dynamic interface that **exchanges flow between rivers and aquifers** that are either fully charged or depleted.

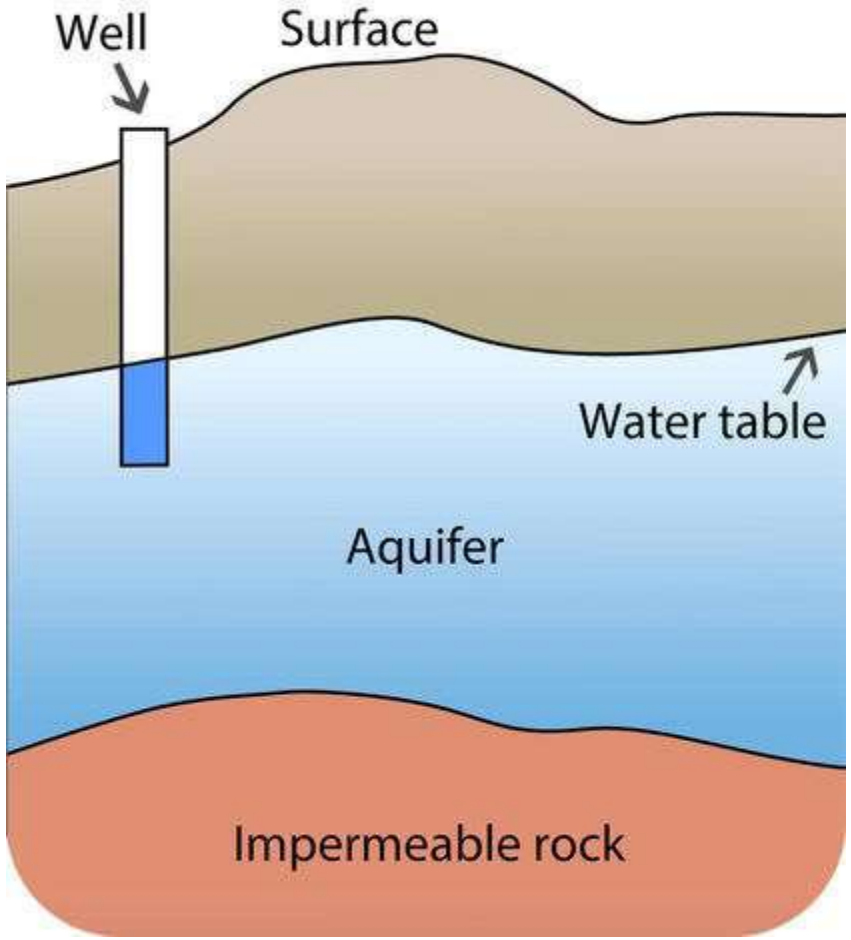
Natural Water Resources - Under river flow





Natural Water Resources - Under river flow





Natural Water Resources - Groundwater

- Groundwater is a type of freshwater that is found in the **pore space of soil and rocks under the surface.**
- It also includes water that flows **beneath the water table in aquifers**.
- It’s occasionally helpful to distinguish between surface water-associated groundwater and **deep groundwater** in an aquifer (sometimes referred to as “**fossil water**”).

Natural Water Resources - Groundwater

- Inputs, outputs, and storage are generally the same for groundwater as they are for surface water.
- Seepage from surface water is a **natural source of groundwater input**. Natural groundwater **outflows include springs and seepage into the oceans**.
- The crucial difference is that, due to its **slow turnover rate**, groundwater storage is often substantially **bigger (in volume)** than surface water storage when compared to inputs.

Natural Water Resources - Groundwater

- Because of this disparity, humans can utilize groundwater in an **unsustainable manner** for an **extended period** of time without **suffering serious effects.**

Natural Water Resources - Frozen Water

- Several strategies to use **icebergs** as a water source have been proposed, however this has only been done for research purposes so far.

Integrated farming

Integrated farming

- In recent years, **food security, livelihood security, water security** as well as **natural resources conservation** and environmental protection have emerged as major issues.
- Countries are **struggling** to deal with the dual burden of **climate change and globalization.**

Integrated farming

- It refers to an agriculture system that **integrates livestock and crop production.**
- Moreover, the system will **help poor small farmers**, who have very small landholding for crop production and few heads of livestock to **diversify farm production**, increase cash income, improve the **quality and quantity of food** produced and exploitation of unutilized resources.

Aims of Integrated Farming System

IFS aim to

- Sustain the productivity
- Efficient recycling of farm wastes
- Better resource utilization
- Employment generation and
- Risk reduction while maintaining environmental harmony

Elements of Integrated farming system

- Farm ponds
- Bio-pesticides
- Bio-gas
- Bio-fertilizers
- Solar energy
- Vermicompost making
- Green manuring
- Rainwater harvesting
- Watershed management

Dairy unit

Low cost Vermicomposting unit

Improved pig breed and housing

Winter vegetables using water from *Jalkund*

Ginger cultivation

Fish rearing in Jalkund & pumpkin on bamboo machan

Organic outlet near highway

Mushroom cultivation

Meghalaya, India

Goat-Fish Integration

Biogas plant

Chicken-Fish Integration

Tree Intercropping

Advantages of Integrated farming

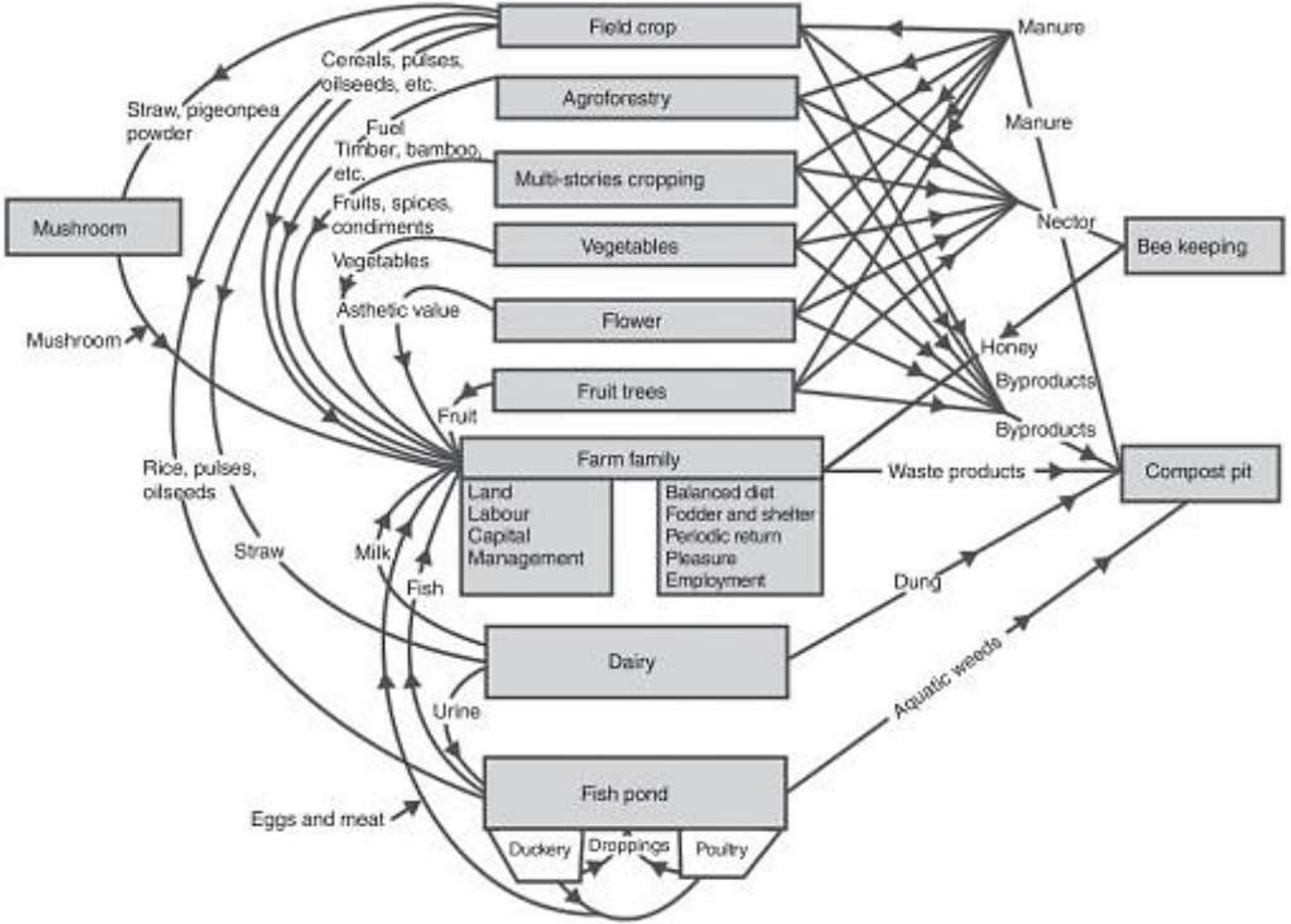
- **Increase in crop production** to supply the exploding population of our country.
- Increase in **farm income** due to proper utilization and recycling of residues and byproducts.
- Organic farming can be practiced for sustainable **soil fertility** and productivity.
- Environmental **pollution** can be reduced by the effective recycling of wastes from animal activities like dairy, piggery, poultry etc.

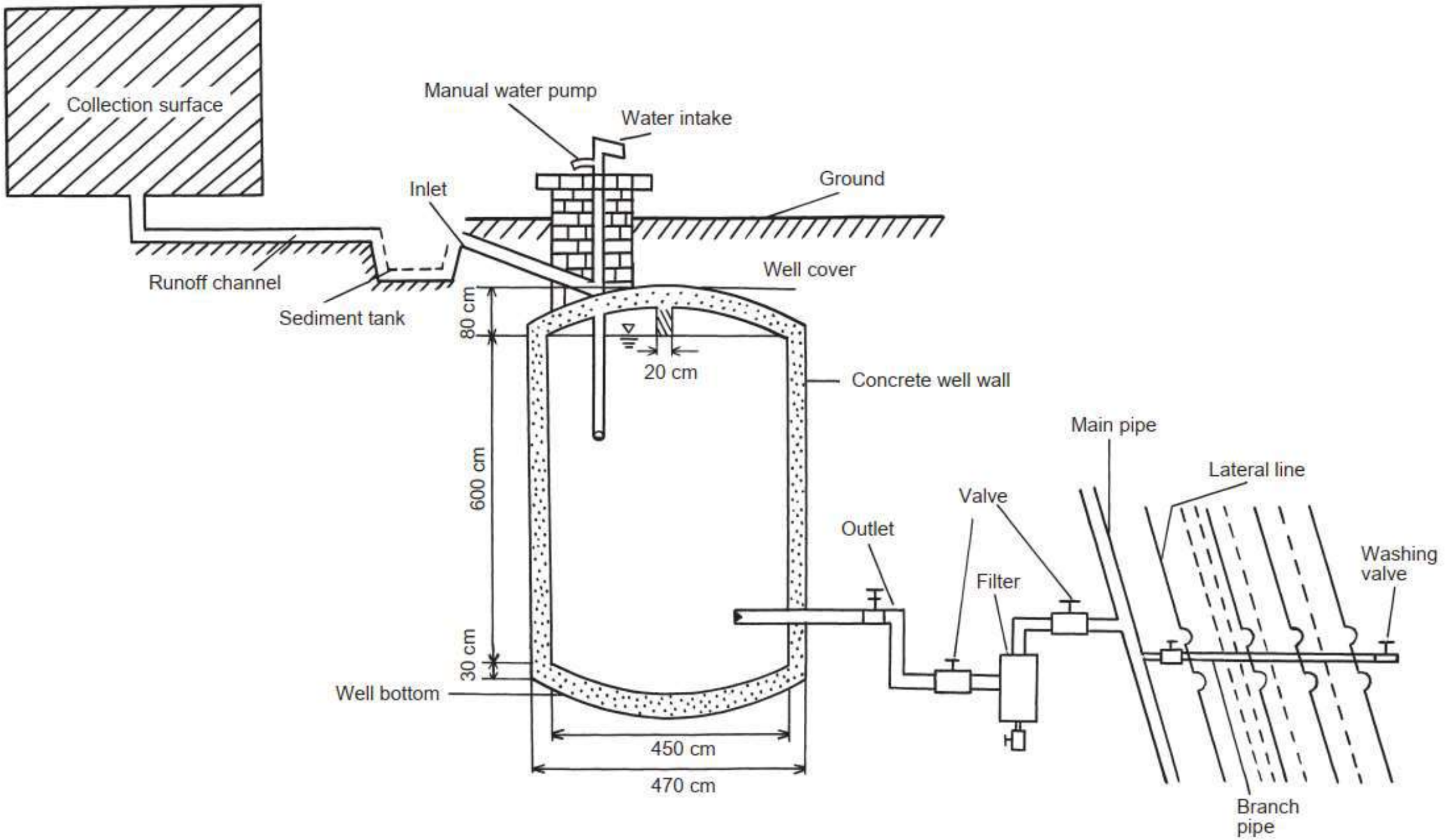
Advantages of Integrated farming

- **Decreased input cost** through recycling from the byproducts of allied activities.
- **Stable income** can be obtained through products like eggs, meat, milk, vegetables, silkworm cocoons from integrated farming.
- Cultivation of fodder crops such as intercropping, and border cropping will result in the **availability of nutritious fodder for animals**.

Types of Integrated farming

- Crop - livestock - farming system
- Crop - livestock - fishery farming system
- Crop - livestock - poultry - fishery farming system
- Crop - poultry - fishery - mushroom farming system
- Crop - fishery - duckery farming system
- Crop - livestock - fishery - vermicomposting farming system


Field crop
Agroforestry
Multi-stories cropping
Vegetables
Flower
Fruit trees
Farm family
Land
Labour
Capital
Management
Balanced diet
Fodder and shelter
Periodic return
Pleasure
Employment
Dairy
Fish pond
Ducklery
Droppings
Poultry
Mushroom
Bee keeping
Compost pit
Manure
Manure
Nector
Honey
Byproducts
Byproducts
Waste products
Dung
Aquatic weeds
Cereals, pulses, oilseeds, etc.
Straw, pigeonpea powder
Fuel
Timber, bamboo, etc.
Fruits, spices, condiments
Vegetables
Asthetic value
Fruit
Mushroom
Rice, pulses, oilseeds
Straw
Milk
Fish
Urine
Eggs and meat


Collection surface
Manual water pump
Water intake
Ground
Inlet
Runoff channel
Sediment tank
Well cover
80 cm
20 cm
Concrete well wall
600 cm
Main pipe
Lateral line
Valve
Outlet
Filter
Washing valve
30 cm
Well bottom
450 cm
470 cm
Branch pipe

Limitations of Integrated farming

- **Lack of awareness** about sustainable farming systems.
- Unavailability of varied farming system models.
- **Lack of credit facilities** at easy and reasonable interest rates.
- **Non-availability** of ensured **marketing** facilities especially for perishable products.


Integrated Farm Management
ORGANISATION & PLANNING
SOIL MANAGEMENT & FERTILITY
CROP HEALTH & PROTECTION
POLLUTION CONTROL & BY-PRODUCT MANAGEMENT
ANIMAL HUSBANDRY
ENERGY EFFICIENCY
WATER MANAGEMENT
LANDSCAPE & NATURE CONSERVATION
COMMUNITY ENGAGEMENT

Limitations of Integrated farming

- Lack of deep freezing and storage facilities.
- Lack of timely availabilities of inputs.
- **Lack of education/knowledge** among farming community especially of rural youth.

Soil erosion and conservation techniques

Soil erosion

- Soil erosion can be defined as a process of **detachment and transport of soil particles from one place to another.**
- Soil erosion is a **natural process** which has increasingly been exacerbated by human activities such as agriculture and deforestation.
- While erosion is a natural process, **human activities** have increased by **10–40 times** the rate at which erosion is occurring globally

Factors affecting soil erosion

- The factors affecting erosion can be divided into two categories; natural and human induced.
- **Precipitation and slope steepness** comprise natural factors for the most part.
- While human factors consist of development or activities related to **agriculture, mining and constructions.**

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Factors affecting soil erosion – Climatic factors

- The amount and intensity of **precipitation** is the main climatic factor governing soil erosion by water.
- **Wind** erosion requires strong winds, particularly during times of drought when vegetation is sparse, and soil is dry.
- Other climatic factors such as average **temperature** and temperature range may also affect erosion, via their effects on vegetation and soil properties.

Factors affecting soil erosion – Topography

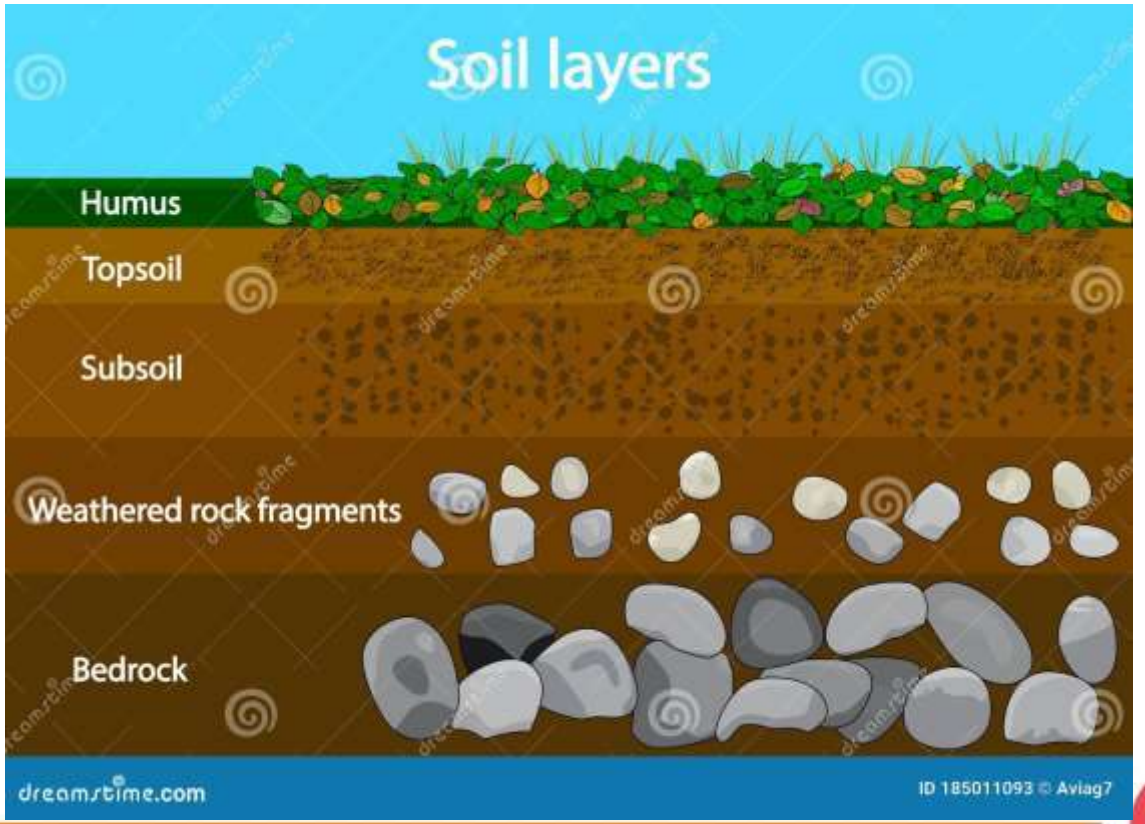
- The topography of the land **determines the velocity** at which surface runoff will flow, which in turn determines the erosivity of the runoff.
- Longer, **steeper** slopes (especially those without adequate vegetative cover) are more susceptible to very high rates of erosion

Factors affecting soil erosion – Soil erodibility

- Soil erodibility is an estimate of the **ability of soils to resist erosion**, based on the physical characteristics of each soil.
- Generally, soils with **faster infiltration rates, higher levels of organic matter and improved soil structure** have a greater resistance to erosion.
- Sand, sandy loam and loam-textured soils tend to be less erodible

Factors affecting soil erosion – Deforestation

- It causes increased erosion rates due to **exposure of mineral soil by removing the humus and litter layers** from the soil surface, removing the vegetative cover that binds soil together.



Factors affecting soil erosion – Agriculture

- It causes the worst type of soil erosion on farmland in the form of **wash-off or sheet erosion.**
  - Tilling
  - Continuous cropping
  - Monoculture

Monoculture

- A monoculture is the name given to single crop species grown over a large area

Continuous cropping

- This farming system involves putting a piece of land under permanent cultivation.
- The crops planted may either be annual or perennial.

Factors affecting soil erosion – Economic Activities

- The extraction of useful natural resources such as **metals, minerals and fossil fuels etc.,** from the land causes serious disturbance to the land leading to soil erosion and **drastic changes in the landscape**.

Factors affecting soil erosion – Over grazing

- It means too many animals are allowed to feed on a piece of grassland.
- Trampling and grazing by cattle destroys the vegetation of the area.

Factors affecting soil erosion – Developmental activities

- Soil erosion may also occur because of various developmental activities such as **housing, transport, communication, recreation, etc**.
- Building construction also promotes soil erosion because accelerated soil erosion takes place during construction of houses, roads, rail tracks etc.

Soil Erosion – Remedial Measures

- **Biological measures**
  - Improving The Existing Surface Cover
  - Strip Cropping
  - Crop Rotation
  - Stubble Mulching
  - Using Organic Manures

Improving The Existing Surface Cover

Strip Cropping

- It is a method of farming in which two or more crops are grown simultaneously into long narrow strips wide enough to permit independent cultivation but narrow enough to interact agronomical. It means strips are alternated in a crop rotation system. It is the practice of growing the series of alternate strips of various crops in such a manner that all tillage and management practices are performed across the slope.

Crop Rotation

- **Crop Rotation** is an agricultural practice involving systematically planting different crops in a specific order on the same land over successive growing seasons. To maximize overall production, minimize pests and illnesses, and improve soil fertility, the order and combination of crops are carefully considered.

- The main idea is to break the life cycles of pests and illnesses that might have become dependent on a particular crop by not growing the same crop in the same spot every year.

Stubble Mulching

- Stubble mulching helps control water and wind erosion by leaving the maximum amount of residue from the previous crop—such as wheat, soy or corn—on the soil surface for fallow. This technique is especially useful in dryland cropping systems where residue cover can seal moisture into the soil. Stubble mulching can also be used in a crop rotation following a cover crop.

Soil Erosion – Remedial Measures

- **Mechanical Measures**
  - Contour Tillage
  - Contour Bunding
  - Terracing
  - Water Harvesting


COVER CROPS
ADDING ORGANIC MATTER
REDUCING TILLAGE
SOIL CONSERVATION METHODS
PRACTICING CROP ROTATION
BUILDING TERRACES
AVOIDING OVERGRAZING AND SOIL COMPACTION

Arid and Semiarid Regions

Arid Region

- Ecologically, an arid region, also known as **desert**, is an area having an annual rainfall of **10 inches (25 cm) or less.**
- It is usually partly covered by **sand and is almost devoid of vegetation**.
- Cold deserts are caused by extreme cold. They are often covered with perpetual **snow or ice** and are quite distinct from the deserts of warm regions.

Arid Region

- It is estimated that **cold deserts cover about one sixth of the world's surface** and **hot** deserts form about **one fifth** of the land surface of the world.
- **Mitigation Strategies –** Afforestation, controlled grazing, improved irrigation techniques, and sustainable water management help combat desertification and support livelihoods in arid regions.

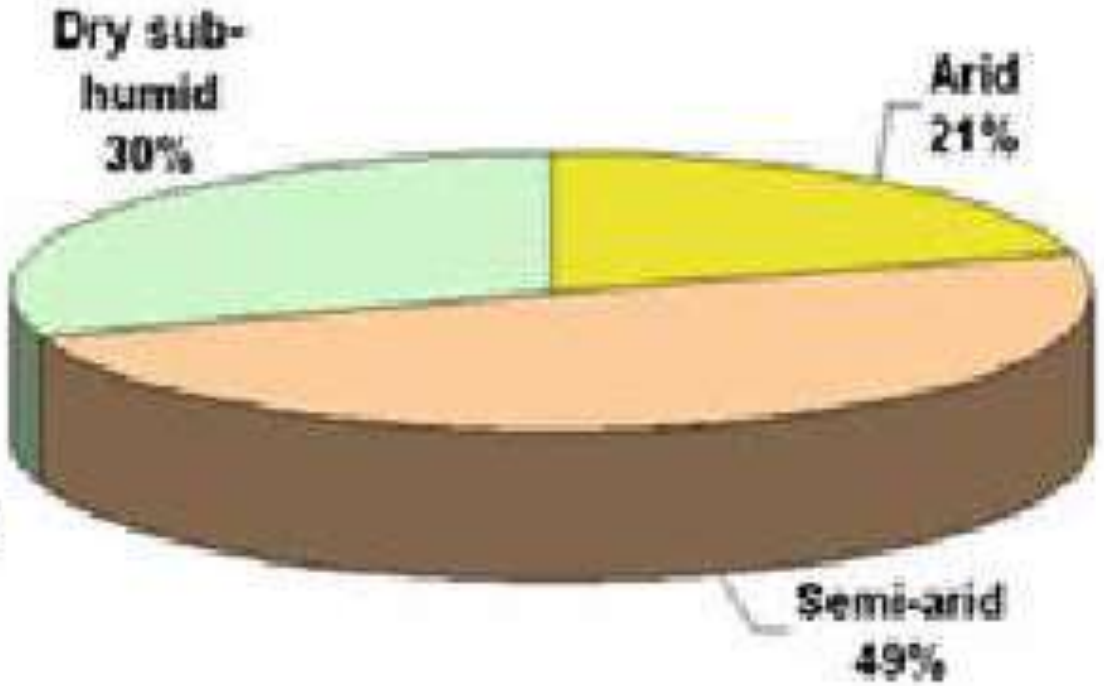
Semi Arid Region

- The semi-arid regions of the world are defined as transition zones **between arid and sub humid belts**, where annual rainfall is between **30 to 60 cms.**
- The vegetative cover is characterized mainly by shrubs, scrubs and grass.
- In both arid and semiarid areas, rainfall patterns are unpredictable.

Semi Arid Region

- Farmers cultivate **drought-resistant crops** such as millet, sorghum, and pulses, relying on irrigation and conservation farming practices.
- **Adaptation Strategies** – Agroforestry, water-efficient irrigation, conservation tillage, and afforestation help improve land productivity and reduce environmental degradation in semiarid areas.

Arid	50.94 m ha
Semi-arid	122.52 m ha
Dry sub-humid	75.42 m ha
Total Dryland	248.88 m ha
INDIA	328.76 m ha



Drought Management

Drought

- According to IMD, drought is said to have occurred over a region when total seasonal rainfall is **less than 75 percent** of the normal value of the region.
- Rainfall deficiency of 26 to 50 percent from normal over a region is termed as **moderate drought** and
- A deficiency of more than 50 percent of the normal as **severe drought**.

FIVE TYPES OF DROUGHT

1 **METEOROLOGICAL** drought refers to an extended period of dry weather patterns.

2 **HYDROLOGICAL** drought refers to low water supply in our rivers, lakes, aquifers, and other reservoirs that often follows meteorological drought.

3 **AGRICULTURAL** drought occurs when a water shortage significantly damages or destroys agricultural crops.

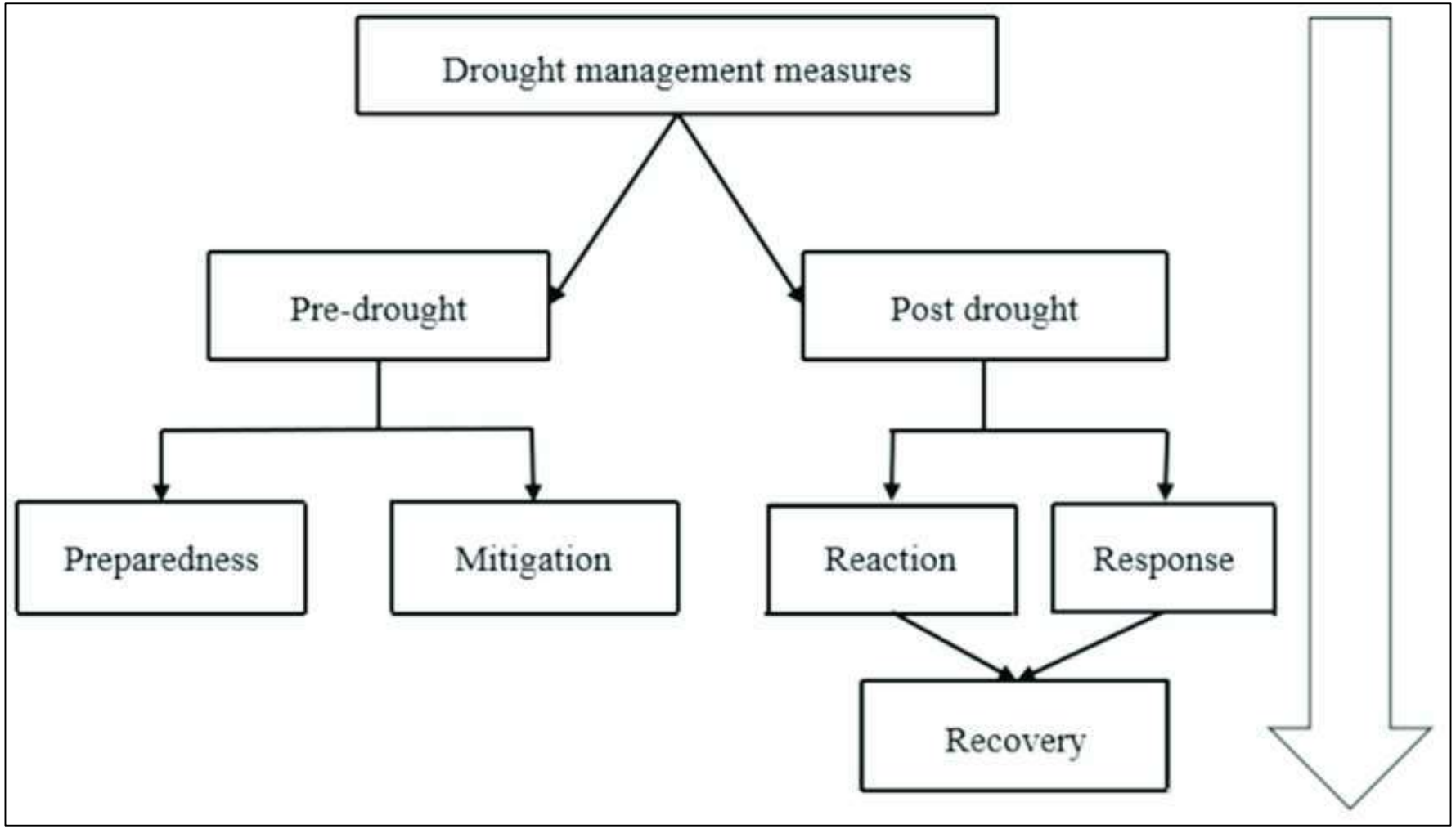
4 **ECOLOGICAL** drought is the most recently defined type of drought and refers to widespread ecological damage caused by the lack of soil moisture.

5 **SOCIOECONOMIC** drought refers to when a water shortage affects the supply and demand of drought commodities, such as water, food grains, and fish.

Drought

- Drought occurs due to
  - Climate variability
  - Deforestation
  - Poor water management and
  - Changing weather patterns influenced by global warming and regional atmospheric conditions.

Drought Management



Drought Mitigation and Planning

- Drought Mitigation and Planning
  - **Water Resources-**Enhancing Supply, Improving Demand Management
  - **Agriculture-**Agricultural Water Management, Crop Production
  - **Water Management-**Supply Augmentation, Demand Management

Drought Mitigation and Planning-Water Resources

Enhancing Supply:

- Storage capacity increase
- Water transfers
- Locating new potential resources
- Aqueducts and canals
- Groundwater recharge
- Small-scale water collection/harvesting
- Adjusting legal and institutional framework
- Artificial precipitation
- Desalination of brackish & saline water
- Water treatment & reuse of wastewater/recycling

Drought Mitigation and Planning- Water Resources

Improving Demand Management:

- Reducing use
- Reducing losses
- Reviewing water allocation
- Monitoring, metering, forecasting
- Conjunctive use (surface groundwater)
- Reviewing education curricula
- Adopting/reviewing water tariffs
- Adjusting legal & institutional framework
- Voluntary insurance, pricing, and economic incentives

Drought Mitigation and Planning- Agriculture

Agricultural Water Management

- Irrigation expansion if/where possible
- Improving demand management (more efficient systems):
- Water loss reduction
- Irrigation scheme modernization/conversion to more efficient systems
- Shift to less water-demanding crops and cropping systems
- Research of drought-tolerant crops/species/genotypes

Drought Mitigation and Planning- Agriculture

Agricultural Water Management

- Adjusting cropping calendars to avoid heat stress
- Use of non-conventional water resources
- Deficit irrigation, supplementary irrigation
- Conjunctive use of surface and groundwater
- Soil water conservation practices
- Adopting/reviewing water tariffs

Drought Mitigation and Planning- Agriculture

Crop Production

- Breeding for drought tolerance species & adaptation to short season
- Cultural practices and techniques for conservation agriculture:
- Proper fertilization
- No-till/reduced tillage systems
- Crop rotation/cropping systems

Drought Mitigation and Planning- Agriculture

Crop Production

- Seeding rate/density
- Weeding/adapted pest management
- Mulching/adapted soil preparation
- Strip farming
- Crop insurance

Drought Mitigation and Planning- Water Management

Supply Augmentation

- Mixing fresh & low-quality waters
- Exploiting high-cost waters
- Adjusting legal and institutional framework
- Locating new standby resources (for emergency)
- Providing permits to exploit additional resources
- Providing drilling equipment

Drought Mitigation and Planning- Water Management

Demand Management

- Restricting agricultural uses (rationing, subjecting certain crops to stress, etc.)
- Restricting municipal uses (lawn irrigation, etc.)
- Reviewing operations of reservoirs
- Diverting water from given uses
- Over-drafting aquifers (temporarily)
- Reviewing water tariffs
- Rationing water supply
- Sensitizing and awareness campaigns

Drought Mitigation and Planning- Water Management

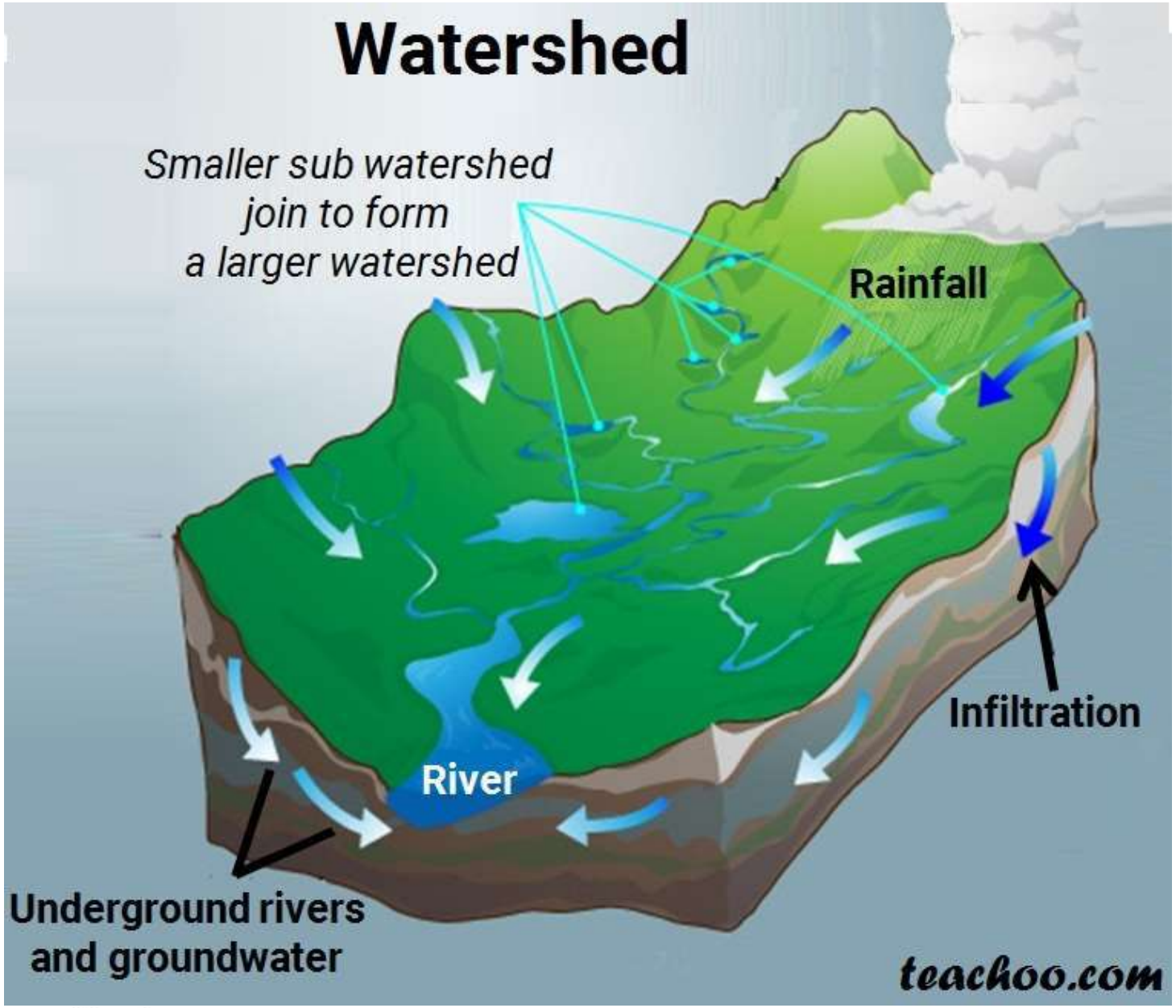
Demand Management

- Adjusting legal and institutional framework
- Negotiating transfer between sectors
- Dual distribution networks for drinking water supply
- Adopting carry-over storage
- Conjunctive use

Watershed management

Watershed

- A "watershed" is a geographical area where **all the land drains into a single body of water**, like a river or lake, defined by its highest points and natural boundaries.
- Therefore, watershed is the area encompassing the catchments, command and delta area of a stream.


Watershed
Smaller sub watershed
join to form
a larger watershed
Rainfall
Infiltration
River
Underground rivers
and groundwater
teachoo.com

Watershed

- A watershed can be **very large** (e.g. draining thousands of acres to a major river or lake or the ocean), or
- **Very small**, such as a 20-acre watershed that drains to a pond.
- A small watershed that lies inside a larger watershed is sometimes referred to as a **sub watershed.**

Types of Watershed

- Watershed are classified depending upon the size, drainage, shape and land use pattern.
  - Macro watershed (> 50,000 Ha)
  - Sub-watershed (10,000 to 50,000 Ha)
  - Milli-watershed (1000 to 10,000 Ha)
  - Micro watershed (100 to 1000 Ha)
  - Mini watershed (1-100 Ha)

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Objectives of Watershed Management

- To control damaging runoff and degradation and thereby **conservation of soil and water.**
- To manage and **utilize the runoff water** for useful purpose.
- To **protect, conserve and improve the land** of watershed for more efficient and sustained production.
- To **protect and enhance the water resource** originating in the watershed.

Objectives of Watershed Management

- To **check soil erosion** and to reduce the effect of sediment yield on the watershed.
- To **rehabilitate** the deteriorating lands.
- To **moderate the floods peaks** at down stream areas.
- To **increase infiltration** of rainwater.

Objectives of Watershed Management

- To improve and **increase the production** of timbers, fodder and wildlife resource.
- To **enhance the ground water recharge**, wherever applicable.


provision of an adequate amount of drinking water
stabilising & protection of natural resources
maintenance of the quality of drinking water
Principles of WM
increasing of productivity of resource use in sustainable manner
participation of local community
harmonising economic development with environmental requirements

Components of Watershed Management

- Soil and water conservation
- Plantation
- Agronomical practices
- Livestock management
- Renewable energy
- Institutional developments

Factors affecting the Watershed Management

Watershed characters

- Size and shape
- Topography
- Soils

Watershed operation

Climatic characteristics

- Precipitation
- Amount and intensity of rainfall

Land use pattern

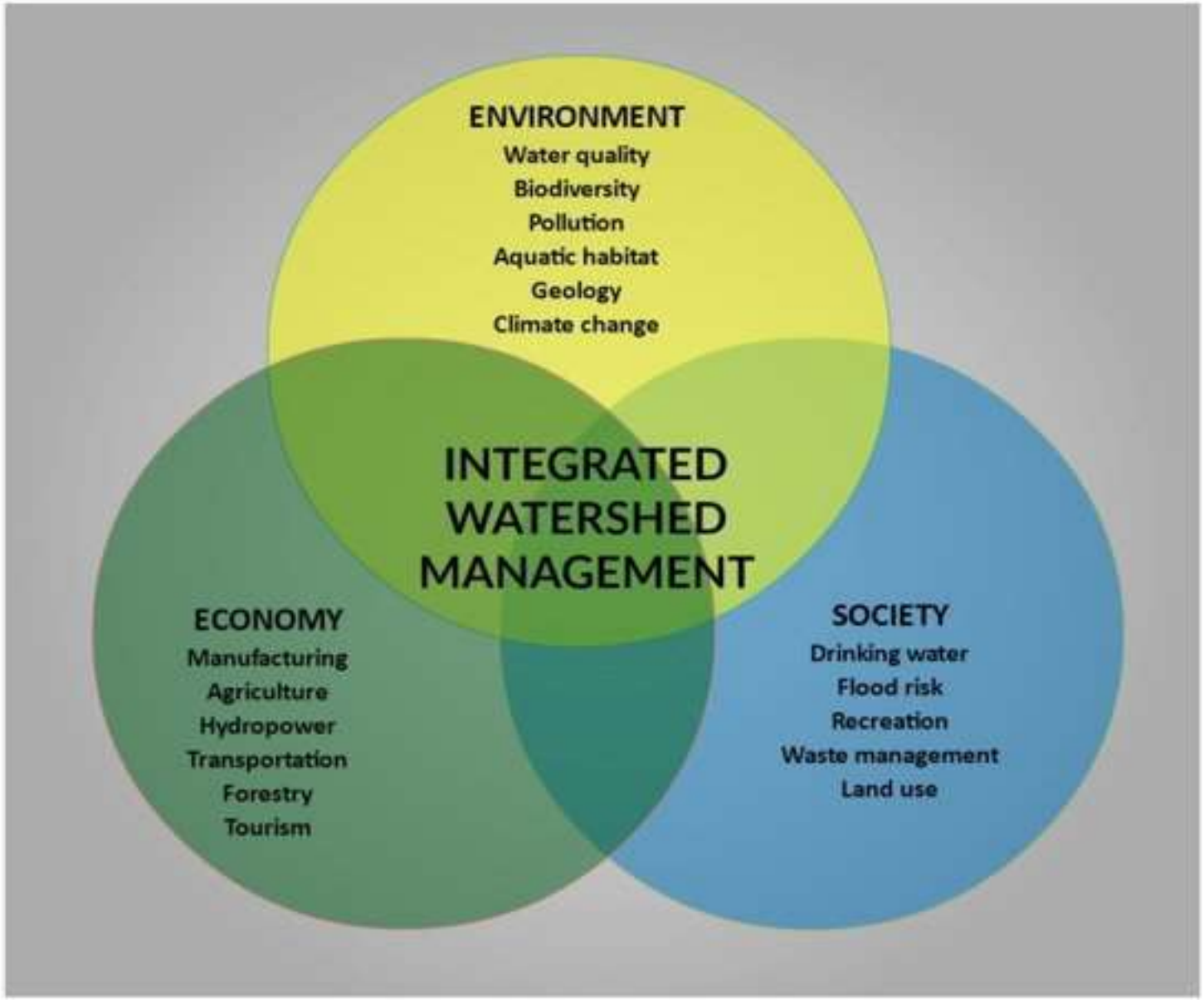
- Vegetative cover
- Density

Benefits of Watershed Management

- Controls floods, erosion and sedimentation
- Enhances productivity per unit area, per unit time and per unit of water
- Increases cropping intensity
- Leads to proper utilization of waste lands through alternate land use systems

Benefits of Watershed Management

- Ensures ecological balance
- Maximizes income through integrated farming system and
- Stabilizes income even under unfavorable weather conditions.


ENVIRONMENT
Water quality
Biodiversity
Pollution
Aquatic habitat
Geology
Climate change
INTEGRATED WATERSHED MANAGEMENT
ECONOMY
Manufacturing
Agriculture
Hydropower
Transportation
Forestry
Tourism
SOCIETY
Drinking water
Flood risk
Recreation
Waste management
Land use

Thank You