

CE 331: Water Supply Engineering

Lecture 2

Overview

- Water Demand
- Hydrologic cycle
- Sources of Water
- Surface water
- Ground water
- Rain water
- Grey water

Water Demand

Quantities that are generally assessed and recorded:

- Total annual volume (V) in litres or million litres.
- Annual average rate of draft in litres per day, $(V/365)$.
- average rate of draft in litres per day per person (litres per capita day or lcpd), called per capita demand (q).
- Average rate of draft in litres per day per service. $\{ (V/365)^* 1/\text{no.of services} \}$
- Fluctuations in flows expressed in terms of % ratios of maximum or minimum yearly, monthly, daily or hourly rates to their corresponding average values.

Various Types of Water Demands

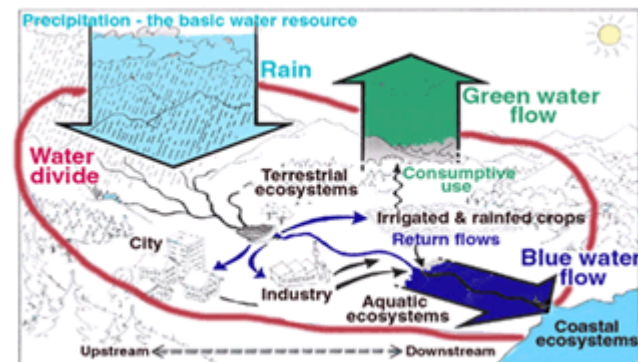
- Domestic water demand
- Industrial water demand
- Institutional and Commercial water demand
- Demand for public use
- Fire demand

World Water Distribution

Location-land areas	Volume, (10^{12} m ³)	% of total
Freshwater lakes	125	0.009
Saline lakes and inland seas	104	0.008
Rivers	1.25	0.0001
Soil moisture	67	0.005
groundwater	8350	0.61
Ice caps and glaciers	29200	2.14
Total land area	37800	2.8
Atmosphere(water vapor)	13	0.001
Oceans	1,320,000	97.3
Total all locations	1,360,000	100

Hydrologic cycle/Water Cycle

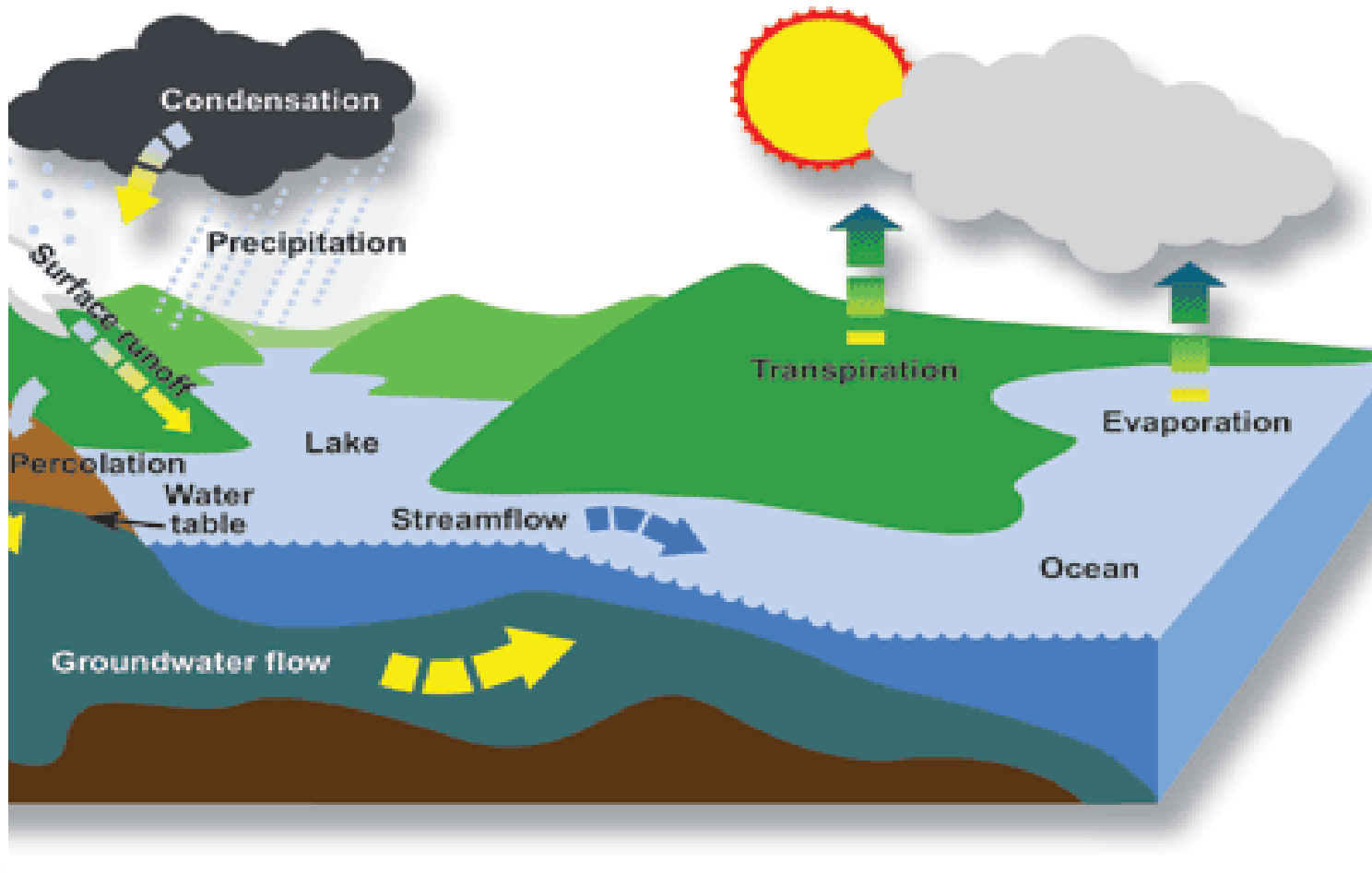
- Role of Water?
 - Terrestrial ecosystems: major factor determining distribution of organisms
 - Aquatic ecosystems: literally matrix that surrounds & serves as environment of aquatic organisms
 - Flows of water are major means for material & energy transfer
 - Water is critical for human activities: agriculture, industry, and municipal use



Water is the driver of nature.

- Leonardo da Vinci

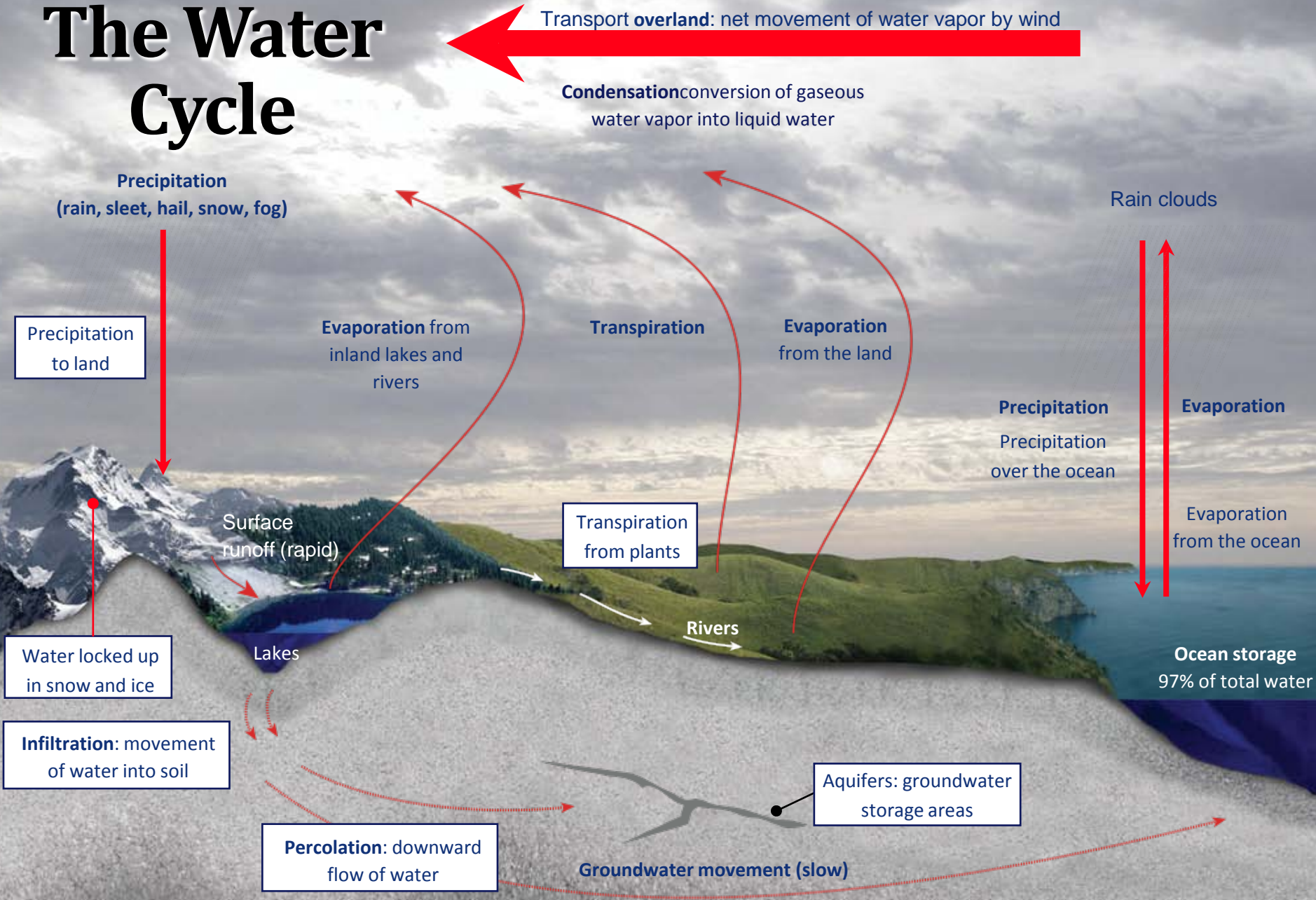
Hydrologic Cycle



Water Cycle: Main Processes

- **Evaporation:** conversion from liquid to vapor (surface to atmosphere)
- **Transpiration:** evaporation of water from leaves
- **Condensation:** conversion of vapor to liquid (ex: water droplets of water on cold soda can)
- **Precipitation:** movement as rain, sleet, hail, & snow (atmosphere to surface)
- **Infiltration:** movement into soil
- **Percolation:** downward flow through soil to aquifers
- **Runoff:** surface flow down slope to ocean, river, or lake.

The Water Cycle



Sources of Water Supply

- Surface water
 - Ponds and lakes
 - Streams and rivers
 - Storage reservoirs
 - Oceans
- Sub-surface water
 - Springs
 - Infiltration galleries
 - Infiltration wells
 - Wells and tube wells
- Groundwater

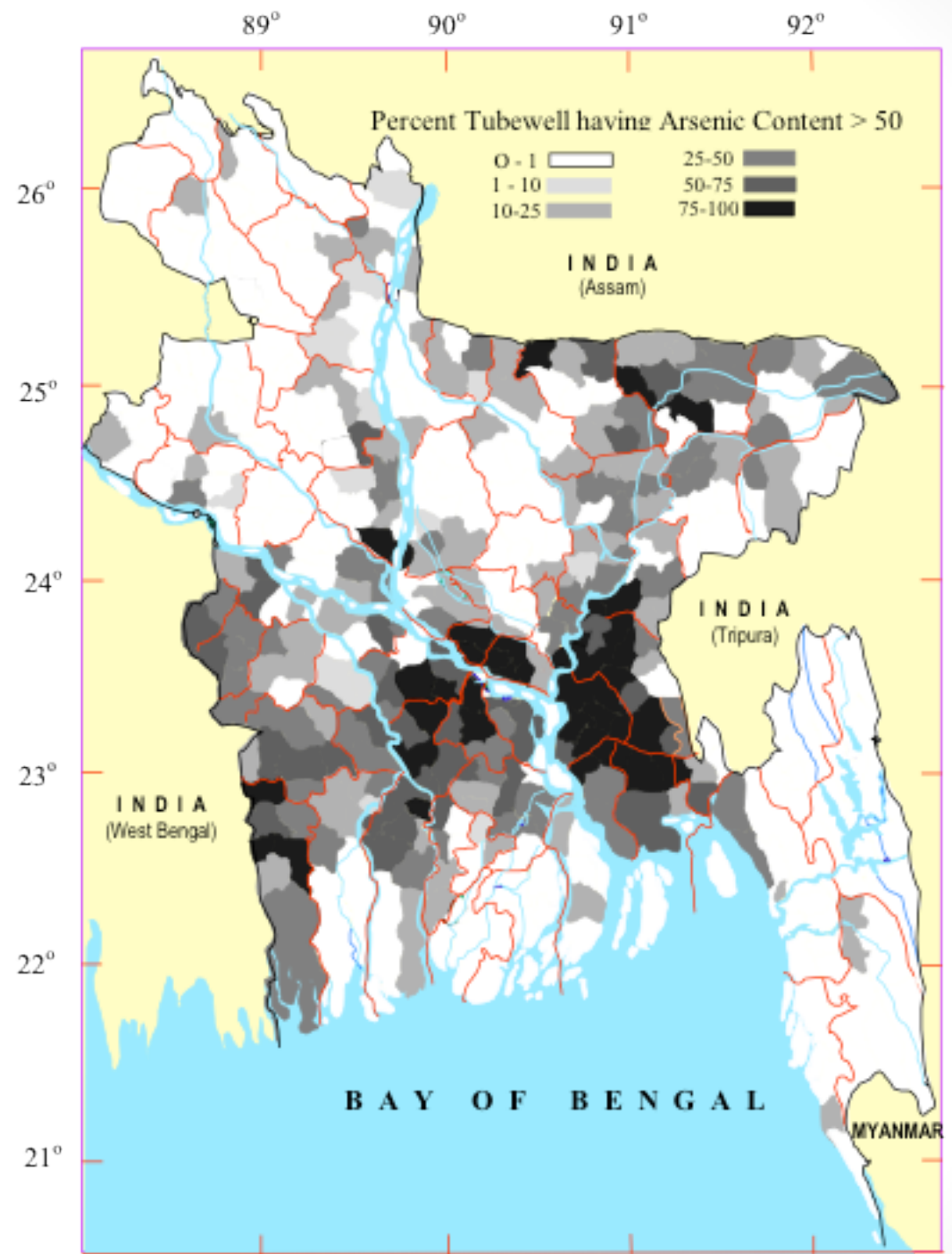
Problems in GW development

- Arsenic in groundwater
- Excessive dissolved iron
- Salinity in the coastal areas
- Lowering of groundwater level
- Rock/stony layers in hilly areas

Arsenic in groundwater

- WHO guideline for maximum desirable arsenic concentration in drinking water – 0.01 mg/L
- In Bangladesh – maximum acceptable concentration in drinking water – 0.05 mg/L
- Arsenic toxicity leading to cancer occurs due to excessive intake over a longer period of time.
- Presence of arsenic in Bangladesh was first detected in 1993 at Chapai Nawabganj.
- One in every three shallow tubewells was found to produce arsenic contaminated water above acceptable limits.

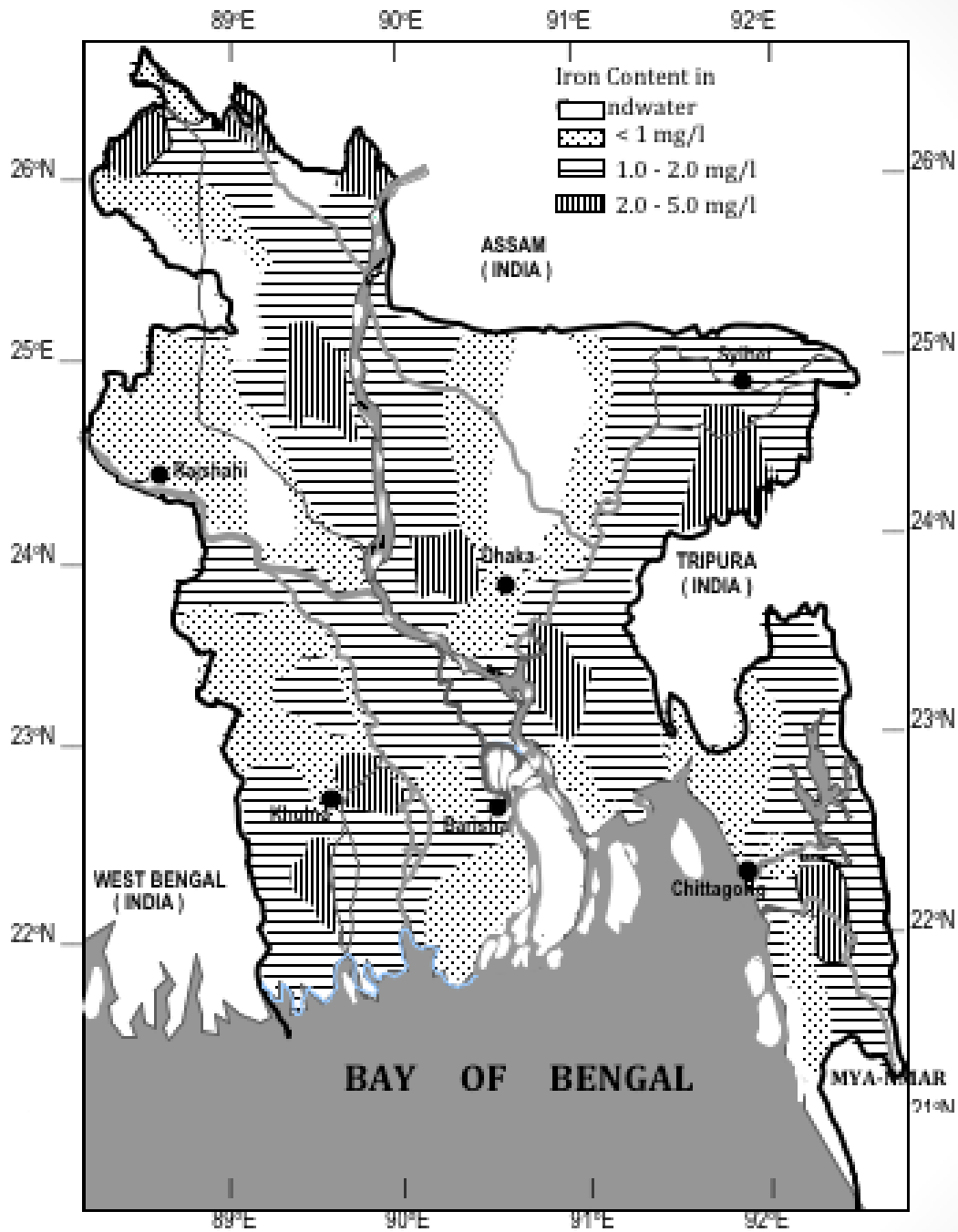
Distribution of arsenic concentration in shallow aquifers in Bangladesh



Excessive dissolved iron

- In Bangladesh, the permissible limit of iron in groundwater is 1 mg/L
- Iron content upto 5 mg/L is acceptable for rural water supply
- Dissolved iron in shallow tubewell water in about 67% areas of Bangladesh is in excess of 2 mg/L.
- Iron content in deep tubewell water is comparatively lower.

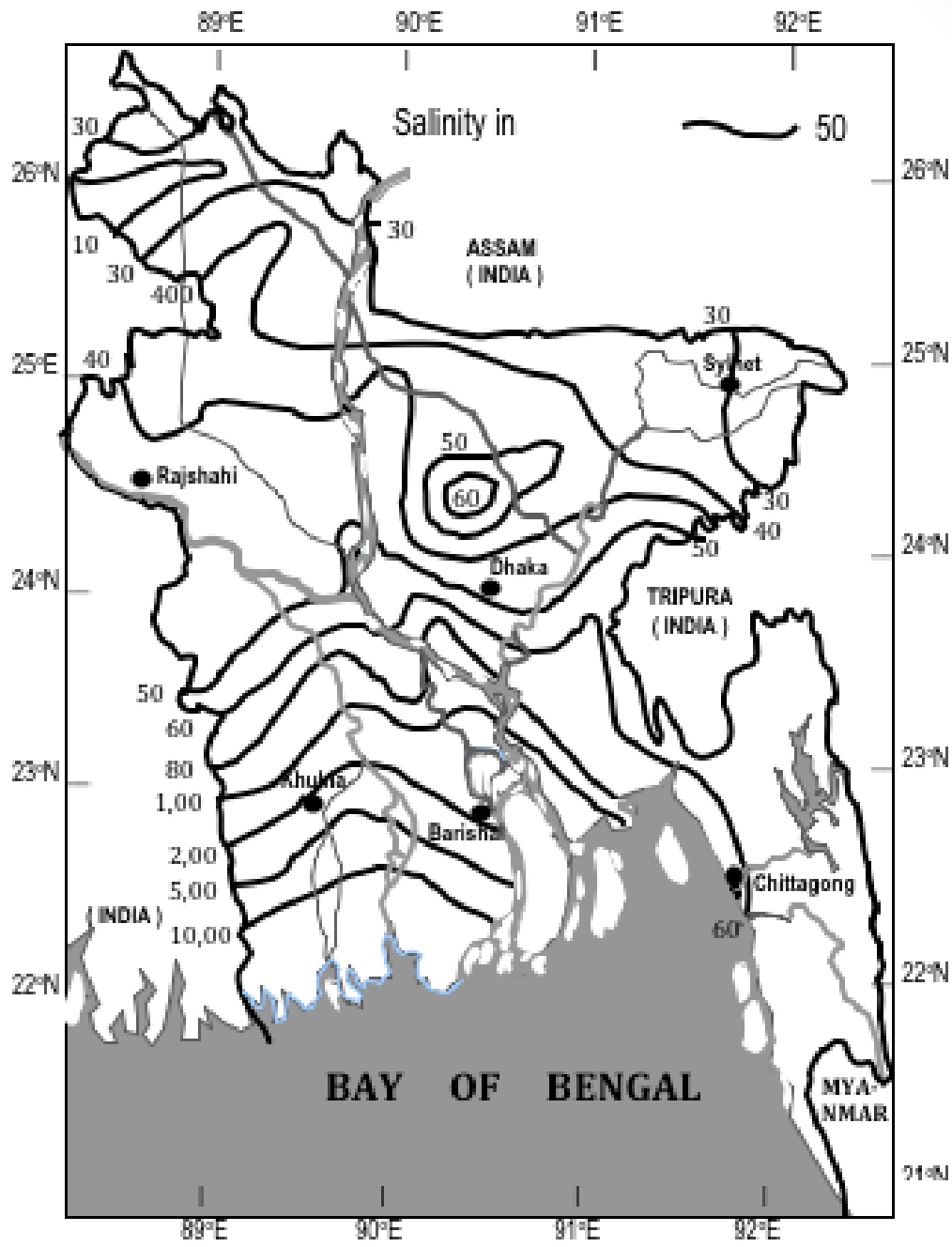
Dissolved iron in shallow tubewell water in Bangladesh



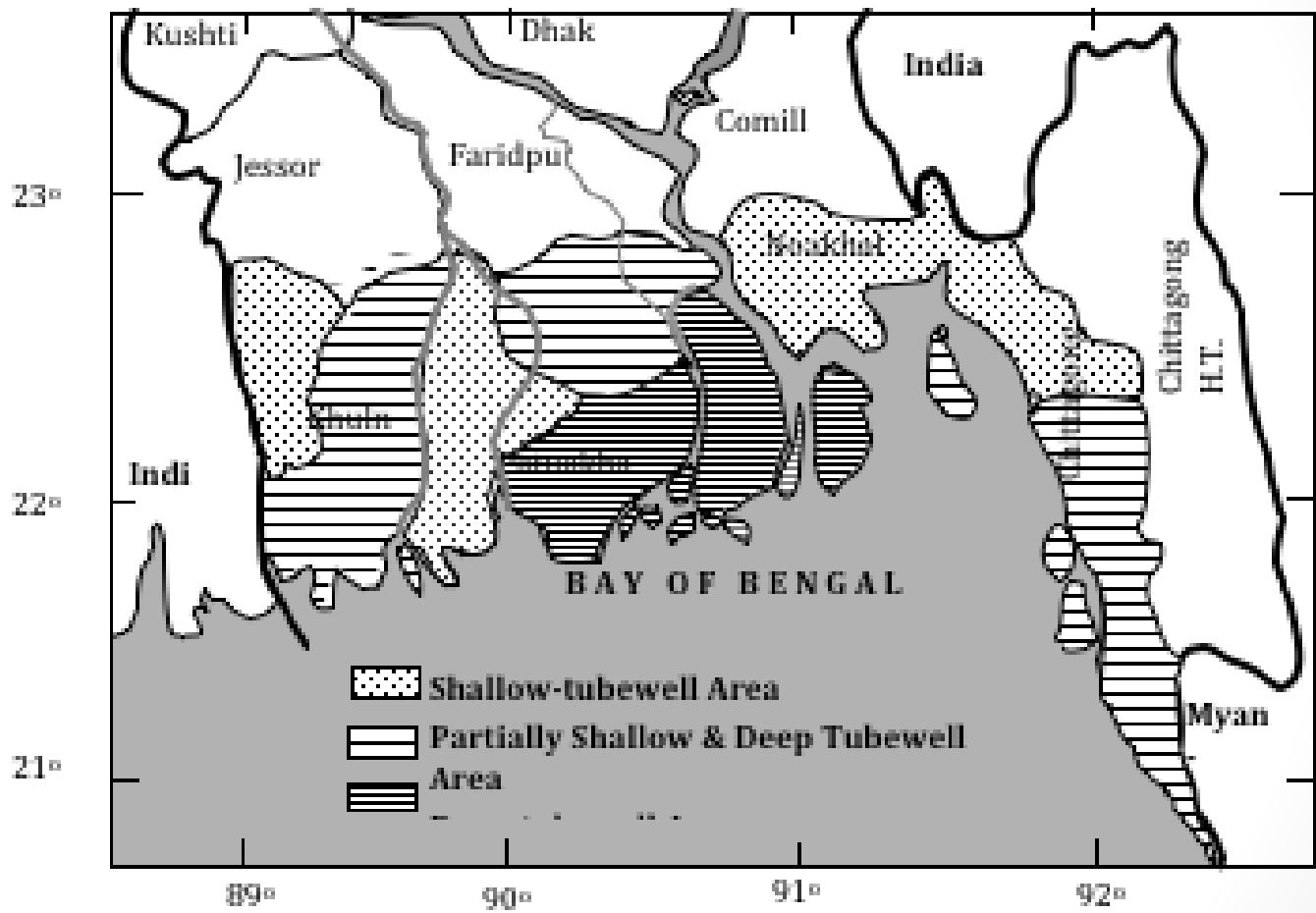
Salinity in coastal areas

- Concentration of dissolved minerals in groundwater is higher than that in surface water
- The coastal belt of Bangladesh is identified as a problem area
- Scarcity of groundwater of acceptable quality at coastal area from shallow depth.
- Low salinity groundwater is not available in many areas at coastal belts within a depth of 1100 ft.

Salinity in groundwater in Bangladesh



Zoning of coastal area of Bangladesh by tubewell type



Lowering of groundwater level

- A considerable area of the country faces scarcity of groundwater within suction limit in the dry season
- Water level declines due to the over-exploitation of groundwater for irrigation purposes

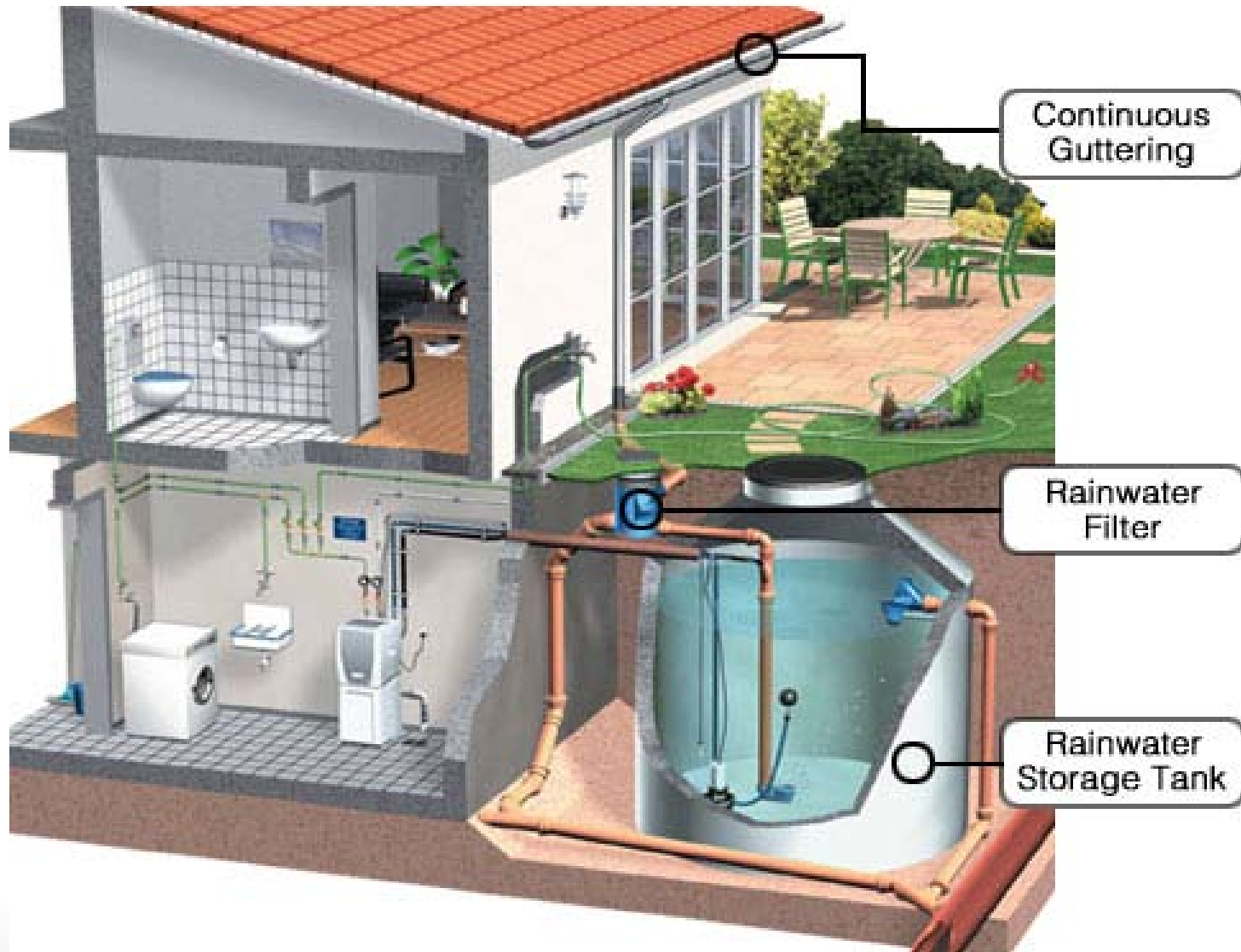
Rock/stony layers in hilly areas

- Presence of hard formations in the subsurface of hill tracts districts make it difficult to drill tubewells for rural water supply
- Areas – Chittagong, Cox's bazar, Sylhet, north of Mymensingh, Netrokona, Panchagar districts
- Mechanical drilling rigs used to overcome the problem and provide potable water
- Installation cost increases as a result

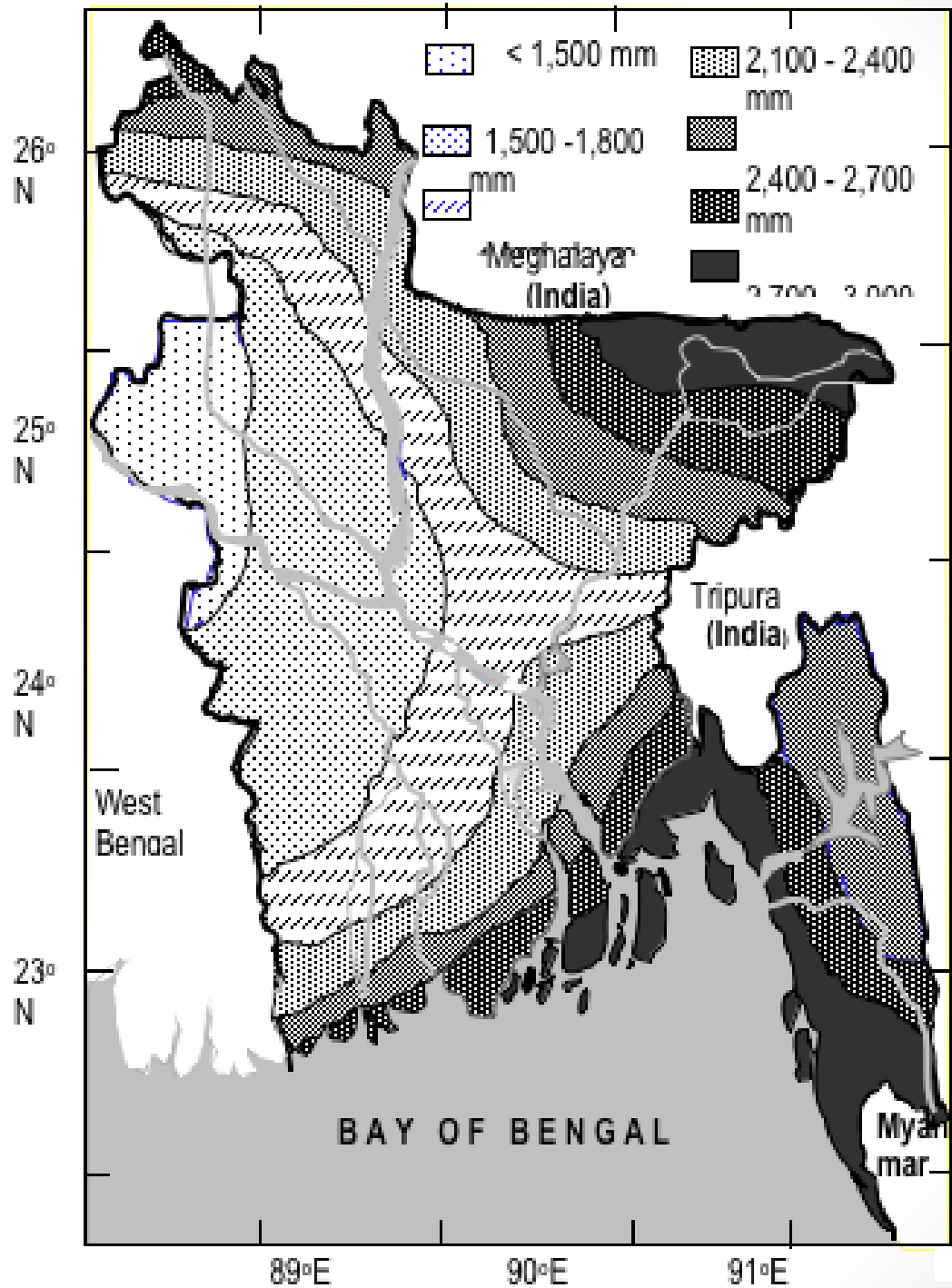
Rainwater

- Being a tropical country, Bangladesh receives heavy rainfall
- Rainwater can be a potential source of water supply
- Areas with high salinity problems harvest rain water (as high as 36% of households) although collection, storage and use are not organized
- The coastal and hilly areas with high source problem intensity lie in the high rainfall areas
- Rainwater harvesting could be a good opportunity for these areas.
- Large rainwater storage reservoirs will be needed due to unequal monthly rainfall distribution

Rainwater Harvesting



Normal annual distribution of rainfall in Bangladesh



Grey Water

- **Greywater** or **sullage** is defined as wastewater generated from wash hand basins, showers and baths, which can be recycled on-site for uses such as toilet flushing, landscape irrigation and constructed wetlands. Greywater often includes discharge from laundry, dishwashers and kitchen sinks. It differs from the discharge of toilets which is designated sewage or blackwater to indicate it contains human waste.

