

Class 10 Geography: Water Resources

Chapter Overview

This chapter examines water as a precious resource, its availability, distribution, utilization patterns, and conservation strategies in India. It emphasizes the need for sustainable water management practices.

1. Introduction to Water Resources

What are Water Resources?

- **Definition:** Water resources refer to sources of water that are potentially useful for human activities
- **Forms:** Surface water (rivers, lakes, reservoirs) and groundwater (aquifers, wells)
- **Renewable Resource:** Water is continuously recycled through the hydrological cycle

Importance of Water

- **Life Support:** Essential for all living organisms
- **Economic Activities:** Agriculture, industry, domestic use, transportation
- **Energy Generation:** Hydroelectric power production
- **Environmental Functions:** Climate regulation, ecosystem maintenance
- **Cultural Significance:** Rivers considered sacred in Indian culture

2. Water Availability in India

Global Water Scenario

- **Total Water on Earth:** 97.5% saltwater, 2.5% freshwater
- **Available Freshwater:** Only 1% accessible for human use
- **India's Share:** 4% of world's water resources with 18% of world's population

India's Water Resources Statistics

- **Annual Precipitation:** 4,000 cubic km (including snowfall)
- **Surface Water:** 1,869 cubic km annually
- **Replenishable Groundwater:** 432 cubic km annually
- **Total Utilizable Water:** 1,123 cubic km annually
- **Per Capita Availability:** 1,545 cubic meters per year (decreasing)

Spatial Distribution of Water

- **High Availability:** Brahmaputra basin, Western Ghats, Northeastern states

- **Medium Availability:** Ganga basin, Eastern coastal plains
- **Low Availability:** Western Rajasthan, parts of Gujarat, Haryana, Punjab

3. Sources of Water in India

Surface Water Sources

1. Rivers

- **Major River Systems:** Ganga, Brahmaputra, Indus, Godavari, Krishna, Kaveri, Narmada, Tapi
- **Contribution:** 60% of total water resources
- **Seasonal Variation:** Monsoon-dependent flow patterns

2. Lakes

- **Natural Lakes:** Wular (Kashmir), Dal Lake, Chilika Lake
- **Artificial Lakes:** Reservoirs behind dams
- **Functions:** Water storage, flood control, recreation

3. Glaciers

- **Location:** Himalayan region
- **Contribution:** Feed major north Indian rivers
- **Concern:** Glacial retreat due to climate change

Groundwater Sources

1. Aquifers

- **Types:** Confined and unconfined aquifers
- **Recharge:** Through precipitation and surface water infiltration
- **Access:** Wells, tube wells, hand pumps

2. Springs

- **Formation:** Natural groundwater discharge
- **Types:** Perennial and seasonal springs
- **Importance:** Rural water supply in hilly areas

Other Sources

1. **Rainwater:** Direct collection and storage
2. **Recycled Water:** Treated wastewater reuse
3. **Desalinated Water:** From seawater (limited use)

4. Water Utilization Pattern

Sectoral Water Use in India

1. Irrigation (83%)

- Crop production and livestock
- Highest consumer of water resources
- Inefficient traditional methods

2. Domestic Use (9%)

- Drinking, cooking, bathing, washing
- Urban vs rural consumption patterns
- Quality requirements higher

3. Industrial Use (8%)

- Manufacturing processes, cooling
- Power generation (thermal plants)
- Growing demand with industrialization

Regional Variations

- **Northern Plains:** Heavy irrigation use for wheat and rice
- **Peninsular India:** Balanced use across sectors
- **Coastal Areas:** Higher industrial and domestic use
- **Arid Regions:** Maximum groundwater exploitation

5. Water Scarcity and Its Causes

Types of Water Scarcity

1. Physical Scarcity

- Insufficient water resources to meet demand
- Common in arid and semi-arid regions
- Examples: Rajasthan, parts of Gujarat

2. Economic Scarcity

- Adequate water but lack of infrastructure
- Poor management and distribution
- Examples: Some tribal areas, remote regions

Major Causes of Water Scarcity

1. Natural Factors

- Uneven spatial and temporal distribution of rainfall
- Prolonged droughts and climate variability

- Geographic location and topography

2. Human Factors

- **Population Growth:** Increasing demand for water
- **Urbanization:** Higher per capita consumption
- **Industrialization:** Growing industrial water needs
- **Agricultural Practices:** Water-intensive crops, flood irrigation
- **Deforestation:** Reduced water retention capacity
- **Pollution:** Making available water unusable

3. Management Issues

- Inefficient water distribution systems
- Lack of proper storage facilities
- Over-exploitation of groundwater
- Poor maintenance of water infrastructure

6. Water Pollution

Sources of Water Pollution

1. Industrial Pollution

- Chemical discharge from factories
- Thermal pollution from power plants
- Heavy metals and toxic substances
- Examples: Textile, leather, pharmaceutical industries

2. Domestic Sewage

- Untreated household wastewater
- Urban sewerage systems overload
- Rural sanitation problems

3. Agricultural Pollution

- Pesticide and fertilizer runoff
- Animal waste from livestock
- Soil erosion and sedimentation

4. Religious and Cultural Activities

- Ritual offerings in rivers
- Mass bathing during festivals
- Immersion of idols and ashes

Polluted Rivers in India

- **Ganga:** Most polluted despite being sacred
- **Yamuna:** Severely polluted in Delhi stretch
- **Godavari:** Industrial pollution in Maharashtra
- **Krishna:** Agricultural and industrial pollution

Effects of Water Pollution

1. Health Impacts

- Waterborne diseases (cholera, typhoid, dysentery)
- Heavy metal poisoning
- Cancer risks from toxic chemicals

2. Environmental Impacts

- Aquatic ecosystem destruction
- Loss of biodiversity
- Eutrophication of water bodies

3. Economic Impacts

- Treatment costs increase
- Agricultural productivity decline
- Tourism revenue loss

7. Multi-Purpose River Valley Projects

Concept and Objectives

- **Definition:** Large-scale projects combining multiple water uses
- **Objectives:** Irrigation, power generation, flood control, navigation, recreation
- **Nehru's Vision:** "Temples of modern India"

Major River Valley Projects

1. Bhakra Nangal Project

- **River:** Sutlej River
- **States:** Punjab, Haryana, Rajasthan
- **Features:**
 - Bhakra Dam (226m high)
 - Nangal Dam (29m high)
 - 1,325 MW power generation

- Irrigation in 1.6 million hectares

2. Damodar Valley Corporation (DVC)

- **River:** Damodar River
- **States:** Jharkhand and West Bengal
- **Features:**
 - Multiple dams (Tilaiya, Konar, Maithon, Panchet)
 - Flood control in "Sorrow of Bengal"
 - Thermal and hydel power generation

3. Hirakud Project

- **River:** Mahanadi River
- **State:** Odisha
- **Features:**
 - World's longest earthen dam (25.8 km)
 - Controls floods in delta region
 - 347.5 MW power generation

4. Nagarjuna Sagar Project

- **River:** Krishna River
- **States:** Telangana and Andhra Pradesh
- **Features:**
 - Large masonry dam
 - Extensive irrigation network
 - 815 MW power generation

5. Sardar Sarovar Project

- **River:** Narmada River
- **States:** Gujarat, Maharashtra, Madhya Pradesh
- **Features:**
 - Controversial large dam
 - Irrigation in Gujarat and Rajasthan
 - 1,450 MW power generation

Benefits of Multi-Purpose Projects

1. **Irrigation:** Increased agricultural production and food security
2. **Power Generation:** Renewable hydroelectric energy
3. **Flood Control:** Reduced flood damage and loss of life
4. **Navigation:** Improved inland water transport
5. **Recreation:** Tourism and recreational activities
6. **Employment:** Job creation during construction and operation

Problems and Criticisms

1. Environmental Issues

- Large-scale deforestation
- Loss of biodiversity
- Soil erosion and sedimentation
- Microclimate changes

2. Social Problems

- Displacement of local communities
- Loss of cultural heritage sites
- Inadequate rehabilitation measures
- Conflicts over water sharing

3. Economic Concerns

- High construction and maintenance costs
- Unequal benefit distribution
- Debt burden on states

4. Technical Issues

- Siltation reducing reservoir capacity
- Seismic activity risks
- Structural safety concerns

8. Rainwater Harvesting

Definition and Concept

- **Definition:** Collection and storage of rainwater for future use
- **Principle:** Capture runoff from rooftops, land surfaces
- **Benefits:** Groundwater recharge, reduced dependence on other sources

Traditional Systems

1. **Bawris/Baolis:** Stepwells in Rajasthan and Gujarat
2. **Tanks:** Artificial reservoirs in South India
3. **Kuls:** Diversion channels in Himachal Pradesh
4. **Bamboo Drip Irrigation:** Meghalaya's bamboo pipes system
5. **Johads:** Check dams in Rajasthan

Modern Rainwater Harvesting

1. **Rooftop Harvesting**
 - Collection from building rooftops
 - Storage in tanks or ground recharge
 - Urban applications
2. **Surface Runoff Harvesting**
 - Catchment area development
 - Check dams and percolation tanks
 - Rural applications

Components of RWH System

1. **Catchment Area:** Roof or land surface
2. **Conveyance System:** Gutters and downpipes
3. **First Flush Diverter:** Removes initial dirty water
4. **Storage System:** Tanks or recharge structures
5. **Treatment:** Basic filtration if needed

Benefits of Rainwater Harvesting

1. **Water Security:** Reduces dependence on external sources
2. **Groundwater Recharge:** Increases water table levels
3. **Flood Mitigation:** Reduces surface runoff
4. **Cost Effective:** Lower long-term costs
5. **Quality:** Generally good quality water
6. **Self-sufficiency:** Community-level water management

Government Initiatives

1. **Legal Provisions:** Mandatory in many states
2. **Financial Incentives:** Subsidies and tax benefits

3. **Awareness Campaigns:** Promotion through various media
4. **Technical Support:** Training and guidance programs

9. Water Conservation Strategies

Need for Water Conservation

- **Increasing Demand:** Population and economic growth
- **Limited Supply:** Finite freshwater resources
- **Climate Change:** Altered precipitation patterns
- **Pollution:** Reducing available quality water
- **Over-exploitation:** Declining groundwater levels

Water Conservation Methods

1. Agricultural Sector

1. Drip Irrigation

- Water-efficient delivery system
- 90-95% water use efficiency
- Suitable for all crops

2. Sprinkler Irrigation

- Overhead water distribution
- 70-80% efficiency
- Good for field crops

3. Crop Selection

- Drought-resistant varieties
- Less water-intensive crops
- Crop rotation practices

4. Mulching

- Soil moisture conservation
- Reduced evaporation losses
- Organic and plastic mulches

2. Industrial Sector

1. **Water Recycling:** Treating and reusing industrial water
2. **Process Optimization:** Reducing water use in manufacturing
3. **Cooling Tower Management:** Efficient water use in cooling

4. **Rainwater Harvesting:** Industrial roof harvesting

3. Domestic Sector

1. **Water-efficient Appliances:** Low-flow fixtures and devices
2. **Behavioral Changes:** Conscious water use practices
3. **Greywater Reuse:** Using treated household wastewater
4. **Leak Detection:** Regular maintenance and repair

4. Urban Planning

1. **Green Infrastructure:** Permeable surfaces, green roofs
2. **Stormwater Management:** Collection and treatment systems
3. **Water-sensitive Design:** Buildings with water conservation
4. **Urban Forestry:** Trees for water retention

Watershed Management

1. **Definition:** Holistic approach to water and land management
2. **Components:** Soil conservation, afforestation, water harvesting
3. **Benefits:** Flood control, groundwater recharge, ecosystem restoration
4. **Examples:** Successful programs in Maharashtra, Rajasthan

10. Government Policies and Programs

National Water Policy

1. **Objectives:** Equitable and sustainable water management
2. **Priorities:** Drinking water, irrigation, hydropower, ecology
3. **Strategies:** Integrated planning, stakeholder participation
4. **Revisions:** Updated in 1987, 2002, and 2012

Major Programs and Schemes

1. Jal Jeevan Mission (2019)

- **Objective:** Tap water connection to every rural household
- **Target:** 'Har Ghar Jal' by 2024
- **Features:** Community-based water management
- **Budget:** ₹3.6 lakh crore investment

2. National River Conservation Plan

- **Objective:** Pollution abatement in rivers
- **Coverage:** Major rivers across India
- **Activities:** Sewage treatment, industrial pollution control
- **Results:** Mixed success with ongoing challenges

3. Pradhan Mantri Krishi Sinchayee Yojana

- **Objective:** Irrigation coverage expansion
- **Motto:** "Har Khet Ko Pani"
- **Components:** Surface irrigation, groundwater, watershed development
- **Target:** Achieve 'More Crop Per Drop'

4. Atal Bhujal Yojana

- **Objective:** Sustainable groundwater management
- **Coverage:** Seven states with declining water tables
- **Approach:** Community participation in water management
- **Duration:** 2020-2025

Inter-State Water Disputes

1. **Cauvery Dispute:** Karnataka vs Tamil Nadu
2. **Krishna Dispute:** Andhra Pradesh, Karnataka, Maharashtra
3. **Narmada Dispute:** Gujarat, Madhya Pradesh, Maharashtra
4. **Ravi-Beas Dispute:** Punjab vs Haryana
5. **Resolution Mechanism:** Inter-State Water Disputes Tribunal

11. International Cooperation

Shared River Systems

1. Indus Waters Treaty (1960)

- Between India and Pakistan
- Distribution of Indus river waters
- World Bank mediation

2. Ganges Water Treaty (1996)

- Between India and Bangladesh
- Farakka Barrage water sharing
- Dry season allocation formula

3. Mahakali Treaty (1996)

- Between India and Nepal
- Sarada Barrage and future projects
- Mutual benefits approach

Regional Cooperation

1. **SAARC Water Resources:** Regional water management initiatives
2. **Brahmaputra Cooperation:** With China and Bangladesh
3. **Technical Cooperation:** Sharing expertise and technology

12. Climate Change and Water Resources

Impact of Climate Change

1. **Precipitation Changes:** Altered monsoon patterns
2. **Temperature Rise:** Increased evaporation rates
3. **Glacier Melting:** Threat to river systems
4. **Sea Level Rise:** Coastal aquifer salinization
5. **Extreme Events:** More frequent floods and droughts

Adaptation Strategies

1. **Water Storage:** Enhanced storage capacity
2. **Efficient Use:** Technology-driven conservation
3. **Alternative Sources:** Desalination, recycling
4. **Early Warning:** Weather monitoring systems
5. **Crop Patterns:** Climate-resilient agriculture

13. Emerging Technologies

Water Treatment Technologies

1. **Membrane Technology:** Reverse osmosis, ultrafiltration
2. **Biological Treatment:** Advanced sewage treatment
3. **Desalination:** Solar-powered desalination plants
4. **Nanotechnology:** Advanced water purification

Smart Water Management

1. **IoT Sensors:** Real-time monitoring systems
2. **Satellite Technology:** Water resource mapping
3. **AI and ML:** Predictive water management

4. **Mobile Apps:** Consumer awareness and management

Key Terms and Definitions

- **Water Scarcity:** Lack of sufficient available water resources
- **Water Stress:** Demand exceeds available supply
- **Aquifer:** Underground layer of permeable rock containing water
- **Watershed:** Land area that drains into a common water body
- **Eutrophication:** Excessive nutrients causing algal blooms
- **Water Table:** Upper level of groundwater saturation
- **Runoff:** Surface water flow after precipitation
- **Groundwater Recharge:** Process of water moving from surface to aquifer
- **Virtual Water:** Hidden water in products and services
- **Water Footprint:** Total water used in production process

Important Facts and Figures

- India receives 4% of global precipitation but has 18% of world population
- Only 8% of annual rainfall is currently harvested
- Groundwater contributes 40% of India's water supply
- 21 major cities may run out of groundwater by 2020 (NITI Aayog report)
- 70% of India's surface water is contaminated
- Agriculture uses 83% of available water but contributes only 15% to GDP
- India ranks 120th among 122 countries in Water Quality Index
- Annual per capita water availability has declined from 1,816 cubic meters (2001) to 1,545 cubic meters (2011)

Regional Case Studies

1. Chennai Water Crisis (2019)

- **Cause:** Failed monsoons, rapid urbanization
- **Impact:** Day Zero scenario, water trains from other states
- **Lessons:** Need for sustainable urban water management

2. Cape Town Day Zero (2018)

- **Global Example:** Severe water crisis averted
- **Strategies:** Strict rationing, public awareness

- **Relevance:** Model for Indian cities

3. Israel's Water Management

- **Success Story:** Desert country achieving water security
- **Technologies:** Desalination, drip irrigation, recycling
- **Lessons:** Technology and policy integration

Questions for Practice

Short Answer Questions

1. What is water scarcity? Explain its types.
2. List the major sources of water pollution in India.
3. What are the objectives of multipurpose river valley projects?
4. Describe the traditional rainwater harvesting systems of India.

Long Answer Questions

1. Analyze the spatial and temporal distribution of water resources in India.
2. Discuss the problems associated with multipurpose river valley projects and suggest solutions.
3. Evaluate the role of rainwater harvesting in water conservation with examples.
4. Examine the causes and consequences of water scarcity in India.

Map-based Questions

1. Mark the major river valley projects on India's map.
2. Identify water-scarce regions in India.
3. Show the distribution of groundwater availability.

Conclusion

Water resources are fundamental to India's development and environmental sustainability. The country faces significant challenges including uneven distribution, increasing demand, pollution, and climate change impacts. Effective water management requires integrated approaches combining traditional knowledge with modern technology, strong governance, community participation, and inter-state cooperation. Conservation and efficient use of water resources are essential for ensuring water security for current and future generations. The success of water management initiatives depends on coordinated efforts across all sectors of society, from individual conservation practices to national policy implementation.