

# Watershed management:

## A key to sustainable soil and water conservation in Indian agriculture

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*India, with over 145 million hectares of cultivable land affected by soil erosion, faces an urgent need for sustainable natural resource management. Watershed management has emerged as a key strategy to address the twin challenges of water scarcity and land degradation, particularly in rainfed and ecologically fragile regions. Emphasising the importance of decentralised water harvesting, ridge-to-valley treatment, and stakeholder-driven resource integration, the article highlights how watershed development enhances agricultural productivity, ensures water security, mitigates climate risks, and uplifts rural livelihoods. The article also outlines various conservation measures such as agronomic, vegetative, engineering, and hill-slope specific tailored to local ecological conditions. By aligning traditional knowledge with scientific planning and community participation, watershed management offers a pathway toward resilient and sustainable Indian agriculture.*

**Keywords:** Conservation measures, Natural resource management, Resilient

INDIA faces growing water scarcity due to increasing population pressure, rapid urbanisation, and changing consumption patterns. With depleting water tables and uneven rainfall distribution, the demand for effective water resource management is critical. Traditional reliance on large-scale infrastructure such as dams and reservoirs is increasingly challenged by environmental concerns and issues related to Rehabilitation and Resettlement (R&R). In contrast, decentralised, cost-effective, and time-efficient micro water harvesting structures such as check dams, percolation tanks, and earthen bunds are emerging as sustainable solutions for rural India. With approximately 145 million hectares of India’s 180.11 million hectares of cultivable land suffering from soil erosion (Ministry of Agriculture and Farmers’ Welfare 2024), watershed management has become a vital strategy to address land degradation and ensure long-

term productivity of agricultural landscapes.

### Watershed

A watershed is a distinct hydrological unit where rainfall and surface runoff drain to a common outlet, such as a stream, river, lake, or ocean. Watersheds vary in scale, from small ponds to vast river basins, and are often classified based on their size and function.

**Table 1.** Classification of watershed

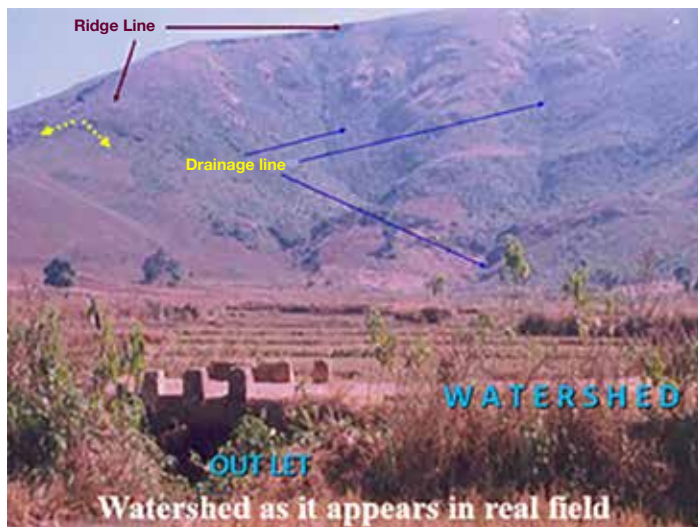
| Watershed Nomenclature | Area (ha)       |
|------------------------|-----------------|
| Region                 | 300–1,130 lakh  |
| Basin                  | 30–300 lakh     |
| Catchment              | 10–50 lakh      |
| Sub-catchment          | 2–10 lakh       |
| Watershed              | 50,000–2,00,000 |
| Sub-watershed          | 10,000–50,000   |
| Mini-watershed         | 1,000–10,000    |
| Micro-watershed        | 100–1,000       |

*Note:* India comprises 6 regions, 35 river basins, 112 catchments, 500 sub-catchments, and over 3,200 watersheds (IndiaWRIS 2024).

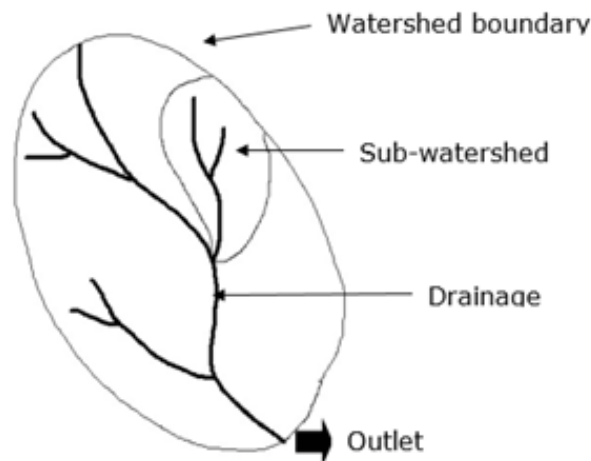
### Need for watershed-based conservation in Indian farming

Watershed management is particularly crucial in rainfed, arid, semi-arid, hilly, and tribal regions of India, which often suffer from poverty, ecological degradation, and food insecurity. According to NITI Aayog, focused interventions at the watershed level can enhance livelihoods, prevent degradation, and build resilience to climate change. Key issues necessitating watershed-based approaches are:

- Uneven and erratic rainfall
- Seasonal water scarcity and declining groundwater
- Soil erosion and shallow soil profiles
- Deforestation and degraded grazing lands
- Increased slope-driven runoff and sedimentation
- Low crop productivity and food insecurity
- Poor land and water resource management



Schematic showing of a physical watershed



Schematic showing watershed boundary and drainage

- Climate change impacts on agro-ecosystems
- Rural unemployment and out-migration

#### Watershed management: An integrated solution

Watershed management is a holistic and integrated approach aimed at optimal utilisation and conservation of land, water, and vegetation resources. It blends engineering, ecological, and community-based practices for sustainable agriculture and natural resource enhancement.

#### Objectives of watershed management

- Reduce runoff and maximise *in situ* water conservation
- Prevent soil erosion and sedimentation
- Enhance groundwater recharge and aquifer storage
- Ensure drought and flood mitigation
- Promote afforestation and vegetative cover
- Improve agricultural productivity and food security
- Facilitate employment and rural livelihood opportunities
- Build capacity of local communities and stakeholders

#### Guiding principles of watershed development

- Ridge-to-valley planning and treatment
- 100% land use based on capability classification

- Rainwater conservation at the point of fall
- Vegetative cover during monsoons to minimise erosion
- Safe disposal of excess water with controlled velocity
- Contour-based barriers and soil moisture conservation techniques
- Alternative land use systems for marginal lands
- Convergence of mechanical and biological measures

#### Key parameters for planning watershed projects

- Watershed size, shape, and topography
- Rainfall pattern and drainage density
- Land use/land cover status
- Soil type, depth, and texture
- Livestock pressure and fodder availability
- Demography and socio-economic profiles
- Resource and institutional availability

#### Stakeholders in watershed management: The 5J framework

Successful watershed development requires multi-stakeholder engagement, including community participation and convergence of local and institutional resources. This is captured in the 5J model:

- **जल (Water):** Water resource management
- **जंगल (Forest):** Vegetative and forestry cover

- **जमीन (Land):** Soil health and land productivity
- **जानवर (Livestock):** Grazing and fodder integration
- **जन (People):** Community-led governance and action

The synergy among these components is vital for a resilient and productive watershed. Neglecting any one may lead to ecological imbalance and livelihood instability.

#### Benefits of watershed management in Indian agriculture

- Enhanced soil and water conservation
- Groundwater recharge and aquifer replenishment
- Reduction in drought vulnerability
- Flood moderation and sediment control
- Increased crop yield and food security
- Employment generation through NRM activities
- Strengthened rural livelihoods
- Biodiversity conservation and eco-restoration
- Long-term climate resilience and sustainability

#### Watershed conservation measures

Watershed interventions fall under the following categories based on terrain, slope, soil condition, and rainfall intensity:

##### Agronomic measures:

- Contour cultivation
- Strip cropping
- Mixed/intercropping

**Vegetative measures:**

- Live fencing
- Shelterbelts and windbreaks
- Graminology, agroforestry, and afforestation

**Engineering measures:**

- Check dams, earthen dams, and farm ponds
- Loose boulder structures (LBCD)
- Terracing (bench, inward/outward sloping)
- Percolation tanks, weirs, spillways

- Waterways and safe drainage channels

**Hill slope management:**

- Staggered/continuous contour trenches
- Graded bunds and vegetative hedges

Measures must be selected based on local agro-ecological conditions, budget constraints, and community priorities.

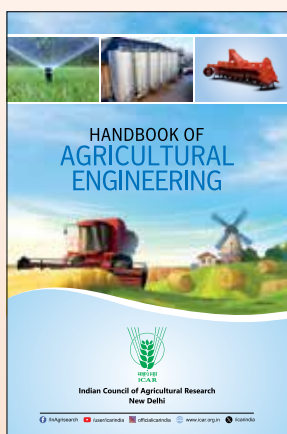
longer an optional practice but a strategic necessity for ensuring soil health, water security, and sustainable agriculture in India. By integrating scientific planning, community participation, and natural resource conservation, watershed projects can transform degraded rural landscapes into productive, climate-resilient, and self-reliant ecosystems.

**SUMMARY**

Watershed management is no

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