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Concept of Watershed Resource Management, Problems, Approach and Components

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Soil, water, and vegetation are critical natural resources essential for sustaining life and ecosystems. These resources are highly interdependent, necessitating an integrated approach to their management for optimal use and conservation. A watershed, which is a defined land area where precipitation collects and drains to a common outlet, provides an effective unit for managing these resources.

Concept of Watershed Management

A watershed, also known as a drainage basin or catchment area, is a geographical unit that collects and channels precipitation runoff to a single point. This hydrological unit is ideal for implementing agricultural development and conservation programs, particularly in drylands. Watershed management aims to optimize the use of land, water, and vegetation to alleviate drought, moderate floods, prevent soil erosion, improve water availability, and increase sustainable agricultural production.

Watershed Management in India

In India, watershed management has been incorporated into various government programs. Notable initiatives include:

- ❖ Drought Prone Area Development Programme (DPAP)
- ❖ Desert Development Programme (DDP)
- ❖ Integrated Watershed Development Project (IWDP)
- ❖ National Watershed Development Programme for Rainfed Areas (NWDPRA)

These programs utilize the watershed approach to manage and conserve natural resources effectively.

Classification of Watersheds

Watersheds are categorized based on their size:

- ❖ **Micro Watersheds**: Ranging from a few hectares to hundreds of hectares, often within crop fields.

- **Small Watersheds**: Covering a few thousand hectares.
- **Large Watersheds**: Encompassing entire river basins.

Principles of Watershed Management

Effective watershed management is guided by several principles:

- Utilize land according to its capability.
- Protect fertile topsoil.
- Minimize silting in reservoirs and fertile lands.
- Maintain vegetative cover year-round.
- Conserve rainwater in situ.
- Divert surface runoff safely to storage structures.
- Stabilize gullies and construct check dams to recharge groundwater.
- Increase cropping intensity through intercropping and sequence cropping.
- Employ alternate land use systems for marginal lands.
- Harvest water for supplemental irrigation.
- Ensure ecosystem sustainability.
- Maximize farm income through diversified agricultural activities.
- Develop small-scale agro-industries.
- Improve infrastructure for storage, transport, and marketing.
- Enhance the socio-economic status of farmers.

Objectives of Watershed Management

Watershed management aims to integrate soil and water conservation with broader objectives such as flood protection, sediment control, and maximizing agricultural productivity. The ultimate goal is to improve the living standards of people within the watershed by increasing their income and providing essential facilities like electricity, drinking water, and irrigation.

Key objectives include

- Recognizing the watershed as a development unit.
- Controlling floods through multipurpose reservoirs.
- Ensuring adequate water supply for various needs.
- Reducing organic, inorganic, and soil pollution.
- Efficiently utilizing natural resources to enhance agriculture and allied occupations.
- Expanding recreational facilities.

The objectives can be encapsulated using the acronym POWER

P: Production of food, fodder, fuel, fruit, fiber, fish, and milk sustainably; Pollution control; Flood prevention.

O: Minimize over-exploitation of resources; Ensure operational practicability and accessibility.

W: Water storage for diverse purposes; Conservation of wildlife and indigenous plants.

E: Erosion control; Ecosystem safety; Economic stability; Employment generation.

R: Groundwater recharge; Drought hazard reduction; Reduction of reservoir siltation; Recreation enhancement.

Components of Watershed Management Programme

Watershed management involves integrated and sustainable use of resources within a watershed, balancing ecological, economic, and social factors. The main components of a watershed management programme are:

- Soil and Water Conservation
- Water Harvesting
- Crop Management

- Alternate Land Use Systems
- Agroforestry
- Ley Farming
- Land Use Classification (Land Capability Classification

1. Soil and Water Conservation Measures

Soil and water conservation measures are essential for improving moisture availability and reducing soil erosion. They can be classified into permanent, semi-permanent, and temporary treatments:

a. Permanent Measures

Waterways: Used for safe disposal of runoff water. Can be grassed or ungrassed.

Bunds:

- **Contour Bunds:** Suitable for low rainfall areas (<600 mm) with slopes up to 6%.
- **Graded Bunds:** Suitable for high rainfall areas (>600 mm) with 2-6% slopes.

Terraces:

- **Bench Terracing:** Reduces slope length and degree, suitable for slopes of 16-33%.

b. Semi-permanent Measures

- **Small Section/Key Line Bunds:** Installed across slopes to reduce velocity of overland flow.
- **Strip Levelling:** Reduces velocity of surface flow by levelling strips of land above the bund.
- **Live Beds:** Vegetative beds that reduce flow velocity and filter runoff.
- **Vegetative Barriers:** Grass or legume barriers along bunds to filter runoff.

c. Temporary Measures

Techniques such as contour farming, compartmental bunding, broad bed and furrows, dead furrows, tillage, and mulching for in situ moisture conservation.

2. Water Harvesting

Water harvesting involves collecting and storing runoff for agricultural or drinking purposes. This is critical in regions with variable rainfall to ensure water availability during dry periods.

- Catchment Area: Part of the land that contributes rainwater.
- Storage Facility: Ponds, tanks, or in situ moisture storage.
- Command Area: Area where harvested water is used.

Methods

Arid Regions: Water spreading, microcatchments, traditional systems like Tanka, Nadi, Khadin.

Semiarid Regions: Dug wells, tanks, percolation tanks, farm ponds.

3. Crop Management

Crop management includes selecting suitable crops and cropping systems, optimizing sowing times, balanced nutrient use, weed management, and contingency planning for aberrant weather.

4. Alternate Land Use Systems

Alternate land use systems optimize resource use, integrate crops and livestock, conserve resources, and reduce dependency on off-farm inputs. Examples include agroforestry, tree farming, and ley farming.

5. Agroforestry

Agroforestry integrates woody perennials with agricultural crops and/or livestock on the same land management unit. This system provides ecological and economic benefits.

Types

- Agri-silviculture: Combines crops with trees.
- Silvi-pastoral: Integrates pasture with trees.

- ❖ Agri-silvi-pastoral: Combines crops, pasture, and trees.
- ❖ Agri-horticultural: Integrates fruit trees with crops.
- ❖ Hortipastoral: Combines fruit trees with pasture.
- ❖ Alley Cropping: Growing crops in alleys formed by hedgerows.

6. Ley Farming

Ley farming involves rotating legume forages with cereals, improving soil fertility and providing fodder.

7. Land Use Classification (Land Capability Classification)

Land capability classification groups soils based on their suitability for different uses and the treatments required for sustainable use. The USDA system classifies land into eight classes (I to VIII), indicating increasing limitations and fewer choices for crop use.

- ❖ Class I-IV: Suitable for arable crops.
- ❖ Class V-VIII: Suitable for alternate uses like forestry or wildlife.

Sub-classes

- ❖ Climate-related limitations.
- ❖ Erosion-related limitations.
- ❖ Soil character limitations.
- ❖ Wetness-related limitations.

Key Problems and Challenges in Watershed Management

Watershed management faces numerous complex and long-term challenges. Watersheds are vital for the livelihoods of their inhabitants but are frequently under pressure due to finite natural resources and the risk of degradation from unsustainable exploitation. These challenges can be categorized into ecological, socio-economic, technical, and institutional dimensions.

Ecological Challenges

1. Water Resources Decline: Decreased quantity and quality of water resources due to overuse and pollution.
2. Natural Disasters: Increased frequency and severity of heavy storms, landslides, and wildfires causing damage to ecosystems.
3. Deforestation and Degradation: Rapid deforestation, both legal and illegal, reduces groundwater replenishment and increases sediment in surface water. Conversion of forests into agricultural land leads to loss of biodiversity and ecosystem services.
4. Increased Run-off and Erosion: Unsustainable land use practices increase surface runoff and soil erosion, leading to siltation in water bodies.
5. Biodiversity Loss: Reduction in species diversity affects ecological integrity and food production capabilities.
6. Soil and Water Contamination: Inappropriate use of chemicals in agriculture increases soil and water contamination, affecting health and productivity.
7. Nutrient Pollution: Elevated nutrient levels from fertilizers cause algae blooms, which negatively impact aquatic ecosystems.

Socio-economic Challenges

1. Rural Poverty and Migration: Upland rural poverty drives migration to urban areas, exacerbating urban crowding and resource strain.
2. Food Insecurity: Land degradation and unsustainable farming reduce agricultural productivity, leading to food insecurity.
3. Population Pressure: Rapid population growth increases pressure on natural resources and leads to land scarcity.

4. Resource Conflicts: Increasing competition for land, forest, and water resources leads to conflicts among different user groups.
5. Gender Inequality: Limited access to knowledge and decision-making power for women restricts their ability to contribute to resource management.
6. Infrastructure Deficits: Poor infrastructure limits access to markets, healthcare, and education, affecting overall socio-economic development.
7. Water Demand and Irrigation: Expanding irrigation systems increase water demand, often leading to overuse and conflict over water resources.

Technical Challenges

1. Development Activities: Poorly planned and executed development projects (e.g., roads, housing, mining) degrade streams and pollute the environment.
2. Agricultural Pollution: Excessive use of pesticides and fertilizers leads to increased pollution and ecosystem disruption.
3. Hydrological Changes: Dams for hydropower and irrigation alter river flow regimes, impacting aquatic habitats and downstream water availability.
4. Water Abstraction: Over-extraction of surface and groundwater for irrigation reduces water availability for other uses and ecosystems.

Institutional Challenges

1. Property Rights and Access: Unclear and inadequate property rights hinder effective resource management and access for users.
2. Fragmented Legal Framework: Weak law enforcement and fragmented regulations complicate watershed management efforts.
3. Administrative Capacity: Insufficient capacity within administrative systems and service providers limits effective management and enforcement.
4. Planning and Participation: National planning procedures often overlook watershed perspectives, and local stakeholders are inadequately involved in planning processes.
5. Personnel and Decision-making: Lack of well-trained personnel and effective decision-making mechanisms at the watershed level impedes efficient management.
6. Top-down Approach: The prevalent top-down approach, combined with limited understanding of participatory methods among government officials, hampers community engagement.
7. Jurisdiction and Coordination: Overlapping jurisdictions and conflicting regulations, along with insufficient coordination, create challenges in national and cross-boundary collaboration.
8. Awareness and Education: There is a general lack of awareness about the importance of watersheds and their functions at both local and national levels.

Conclusion

In conclusion, watershed management is a crucial approach for ensuring the sustainable use of land, water, and vegetation resources. By recognizing a watershed as a management unit, we can implement practices that improve water availability, reduce soil erosion, and enhance agricultural productivity. Various government programs in India actively promote watershed management, recognizing its importance for the well-being of communities. However, numerous challenges hinder effective watershed management. Ecological issues like declining water quality, deforestation, and biodiversity loss threaten the health of watersheds. Socio-economic challenges such as rural poverty, food insecurity, and population pressure add further strain. Technical shortcomings in development projects, agricultural practices, and water management contribute to environmental degradation. On the institutional front, unclear property rights, fragmented legal frameworks, and inadequate stakeholder participation create roadblocks. To overcome these challenges, a multi-pronged approach is needed. Strengthening legal frameworks, promoting community involvement, and fostering collaboration across various stakeholders are essential. Investing in capacity building, research, and education can equip communities with the knowledge and skills necessary for sustainable resource management. By adopting a holistic approach that integrates ecological, social, and economic considerations, watershed management can ensure the long-term health of our watersheds and the well-being of the communities that depend on them.

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