

DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-05): WATERSHED MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-05: WATERSHED MANAGEMENT	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Familiarize with the concepts of watershed management and its relevance in ecological balance
- Gain insights into various physico-chemical, and biological processes related to watersheds and its impact on water quality and quantity
- Empower with tools and methods widely used in watershed management, such as remote sensing and GIS
- Understand the legal and regulatory frameworks governing watershed management at different levels (local, state, and national)

Learning outcomes

After the course, the students will be able to

- Explain the concept of a watershed and its importance in maintaining ecological balance
- Describe the various physical, chemical, and biological processes occurring in watersheds and their impact on water quality and quantity
- Use remote sensing, GIS, and modeling tools to analyze and manage watersheds.
- Identify and explain the legal and regulatory frameworks governing watershed management at the local, state, and national levels
- Evaluate the effectiveness of a watershed management plan through critical analysis of case studies and practical exercises
- Critically evaluate case studies in watershed management to understand challenges and opportunities in the field

SYLLABUS OF DSE-EVS-05

Theory (02 Credits: 30 lectures)

UNIT – I Watershed Management Basics (2½ Weeks) (05 lectures)

Watershed: definition, and characteristics: Watershed Management: approaches, principles, planning, importance, institutional and legal framework, role in sustainable development, and challenges and opportunities

UNIT – II Watershed Hydrology (2 Weeks) (04 lectures)

Precipitation and its measurement, Evaporation and transpiration, Infiltration and percolation, Runoff generation and calculation, Streamflow and stream gauging, Watershed models and simulations, Hydrologic design of watershed management practices, Impacts of climate change on watershed hydrology

UNIT – III Water Quality in Watershed (1½ Weeks) (03 lectures)

Water quality parameters and standards, Sources of water pollution, Point and non-point source pollution, Water quality monitoring and sampling, Water quality modeling

Eutrophication and harmful algal blooms, Water quality management practices, Watershed management for drinking water supply

UNIT – IV Land Use in Watersheds (2½ Weeks) (05 lectures)

land use and land cover change, Land use planning and zoning, Soil erosion and sedimentation, Agricultural management practices for soil and water conservation, Forest management for watershed protection, Urbanization and watershed management, Wetland conservation and management, Mining and watershed management

UNIT – V Management Practices for Sustainable Watershed Management (2 Weeks) (04 lectures)

Best management practices (BMPs), Conservation tillage and crop rotation, Agroforestry and silvopasture, Riparian buffer management, Grassland management, Land treatment and land application, Green infrastructure and low-impact development (lid), Restoration of degraded watersheds

UNIT – VI Watershed Economics (2½ Weeks) (05 lectures)

Economic valuation of watershed services, Benefit-cost analysis of watershed management projects, Water pricing and market-based mechanisms for watershed management, Environmental economics and watershed management, Cost-effective watershed management, Watershed financing and investment, Economic instruments for watershed conservation, Watershed management and rural livelihoods

UNIT –VII Stakeholder Participation and Governance in Watershed Management

(2 Weeks) (04 lectures)

Community-based watershed management, Public participation and stakeholder engagement, Social equity and environmental justice, Governance structures and watershed management, Water user associations (WUAs), Decentralization and devolution of watershed management, Indigenous knowledge and watershed management, Gender and watershed management

UNIT – VIII Case Studies in Watershed Management (1½ Weeks) (03 lectures)

Case studies on: success and failures of watershed management, from developing countries, influence by and adaptation to climate change conflicts and resolution, and ecological restoration; Watershed management and sustainable development goals

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Delineate and categorize watershed boundary using digital elevation data and GIS software
2. Calibrate and validate the model by collecting data on climate, land use, soil properties, and topography of the watershed
3. Set up the model in the chosen software by defining the watershed boundary, hydrological processes, and inputs and outputs of the model
4. Conduct a sensitivity analysis to identify the most important model parameters that affect the model's output
5. Document prevalence of invasive species in two most significant watershed regions of India
6. Design and suggest best management practices (BMPs) of world's most notable watershed region and compare it with any watershed region of India
7. Analyze different types of satellite imagery and their use in watershed management
8. Determine the impact of changes in land use and land cover on water quality and watershed management
9. Create a hydrological model of a watershed using remote sensing and GIS, simulating runoff, soil erosion, and other hydrological processes
10. Map wetlands in a watershed using remote sensing and GIS and analyze their functions, such as water storage, nutrient cycling, and biodiversity conservation
11. Determine soil erosion rates in a watershed using remote sensing and GIS and analyze their impact on water quality, sedimentation, and flooding

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available

data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Anderson, C. W., & Miller, W. W. (2021). *Watershed management: Planning for the 21st century*. John Wiley & Sons.
- Bruijnzeel, L.A., Hamilton, L.S., and Asdak, C. (2011). *Rainforest Hydrology, Ecology and Management*. Springer.
- Dupigny-Giroux, L. A., McCabe, G. J., & Hirsch, R. M. (2017). *State of the art in watershed modeling*. John Wiley & Sons.
- King, K.W., Balogh, J.C., and Harmel, R.D. (2010). *Watershed Management for Potable Water Supply: Assessing the New York City Strategy*. American Society of Agricultural and Biological Engineers.
- National Research Council. (2008). *Urban Stormwater Management in the United States*. National Academies Press.
- Tindall, J.A., Keren, R.A., and Stone, J.J. (2016). *Watershed Management: Planning for the 21st Century*. American Society of Civil Engineers.

Suggestive readings

- Ma, J., Su, C., and Liu, W. (Eds.). (2018). *River basin management in the twenty-first century: Understanding people and place*. CRC Press.
- Miao, S. L., Zhang, C., Cai, Y., & Zhou, J. (Eds.). (2022). *Sustainable watershed management in China*. Springer.
- Water Environment Federation. (2012). *Urban Watersheds: Geology, Contamination, and Sustainable Development*. Wiley.
- Wilcock, R.J., and Iverson, R.M. (2013). *Surface Water-Quality Modeling*. Waveland Press.
- Yang, H. (2010). *Integrated Watershed Management in the Global Ecosystem*. Nova Science Publishers.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.