

SOIL AND WATER CONSERVATION ENGINEERING

ENAE 351

Lecture : 3
Tutorial : 1
Practical : 2

Year : III
Part : II

Course Objectives:

The objective of this course is to provide fundamental principle, processes and mechanism of soil erosion, analyze their impacts on land productivity and apply appropriate soil and water conservation measures. After completion of course, students will be able to design suitable soil and water conservation structures for protection and restoration, particularly considering the physiographic and climatic conditions of Nepal.

1 Introduction (2 hours)

- 1.1 Soil erosion, conservation and its importance
- 1.2 Water sources, types, water source protection and its importance
- 1.3 On-site and off-site consequences of soil erosion
- 1.4 Socio-economic effects of soil erosion in Nepal
- 1.5 Role of agricultural engineering in soil conservation and watershed management

2 Soil Erosion by Water and Wind (7 hours)

- 2.1 Water erosion: Forms and factors
- 2.2 Characteristics of raindrop and rainfall erosivity
- 2.3 Mechanism and assessment of raindrop splash
- 2.4 Mechanism of sheet and rill erosion
- 2.5 Gully erosion mechanism, types and stages
- 2.6 Stream-bank erosion
- 2.7 Wind erosion: Forms and factors
- 2.8 Mechanism of soil movement due to wind
- 2.9 Estimation and prediction of wind erosion rates
- 2.10 Wind erosion control

3 Soil Loss Estimation and Monitoring (3 hours)

- 3.1 Simple visual methods for identifying signs of erosion
- 3.2 Universal Soil Loss Equation (USLE)
 - 3.2.1 Parameters of USLE
 - 3.2.2 Applicability and limitations of USLE
 - 3.2.3 Revised USLE

- 3.3 Soil erosion monitoring
 - 3.3.1 Sedimentation survey
 - 3.3.2 Paired catchment studies
 - 3.3.3 Run-off and erosion plots

4 Landslide, Landslip and Mass Wasting (2 hours)

- 4.1 Definition and differences: Landslide, landslip and mass wasting
- 4.2 Causes of landslides and landslips
- 4.3 Effects on soil and water conservation
- 4.4 Preventive and control measures
- 4.5 Relevance in hilly regions in Nepalese context

5 Erosion Control: Non-Structural Measures (12 hours)

- 5.1 Principle of soil erosion control
 - 5.1.1 Land classification and evaluation of erosion sensitivity
 - 5.1.2 Appropriate soil erosion control measures selection criteria
- 5.2 Biological and cultural measures
 - 5.2.1 Tillage and crop rotation
 - 5.2.2 Contouring
 - 5.2.3 Strip cropping
 - 5.2.4 Mulching
 - 5.2.5 Plantation and seeding: Wattling, bolsters, jute netting
 - 5.2.6 Controlled grazing
 - 5.2.7 Manuring and fertilization
 - 5.2.8 Sloping land agricultural technology
- 5.3 Mechanical measures
 - 5.3.1 Terracing: Types of terraces; Design of broad base and bench terraces; Maintenance of terrace system
 - 5.3.2 Bunding: Types of bunds for soil conservation; Design of contour bunds
 - 5.3.3 Waterways: Purpose of waterways; Design of vegetated waterways

6 Erosion Control: Structural Control Measures (10 hour)

- 6.1 Check dams: Purpose and types of check dams; Design and construction of check dams; Stability analysis of check dams
- 6.2 Gully control structures: Processes, stages and growth of gully; Gully plugging; Design and construction of drop spillway; Design and construction of chute spillway; Design and construction of drop-inlet spillway
 - 6.2.1 Stream-bank erosion control structures: Types of embankments; Design and construction of embankments; Types of spurs, jetties and groyens; Design of spurs and groyens
 - 6.2.2 Roadside erosion control structures
- 6.3 Soil conservation in hilly areas

7 Water Conservation and Management: Arid and Semi-Arid Areas (3 hours)

- 7.1 Soil and water management problems
- 7.2 Tolls and techniques for water sources protection: Hill, Mountain and Terai
- 7.3 Methods of soil moisture management
- 7.4 Systems of water harvesting and recycling
- 7.5 Design of farm ponds and conservation ponds

8 Watershed Management and Institutional Arrangement (4 hours)

- 8.1 Concept of watershed management
- 8.2 Watershed management planning
- 8.3 Objectives of integrated watershed management
- 8.4 Sub-watershed and micro-watershed prioritization
- 8.5 Organizational structure watershed management in Nepal
- 8.6 Legislation and legal provisions
 - 8.6.1 Land tenure
 - 8.6.2 Water laws in Nepal
 - 8.6.3 Soil and watershed conservation act, 1982
 - 8.6.4 Soil and watershed conservation regulation, 1985
 - 8.6.5 Regulations related to protected areas
 - 8.6.6 Soil and watershed management activities in NDC and NAP
- 8.7 Programs and strategies

9 Remote Sensing, GIS and Erosion Model (2 hours)

- 9.1 Introduction to satellite imagery, digital elevation models (DEM), soil data, and vegetation indices
- 9.2 Introduction to computer-based model: Soil and water assessment tool (SWAT), HEC-HMS for hydrological and erosion modeling
- 9.3 Water erosion prediction project (WEPP)
- 9.4 Applications: Estimation of sediment yield and runoff for conservation planning

Tutorial (15 hours)

1. Compute rainfall erosivity factor (R) and understand its role in soil erosion
2. Estimate soil detachment caused by raindrop impact using given rainfall intensity and soil properties
3. Estimation soil loss due to wind erosion
4. Design a shelterbelt considering height, spacing, and orientation for a given field
5. Analyze differences in soil loss estimation using USLE and Revised USLE for a given watershed
6. Estimate sedimentation rate using given reservoir capacity data over time
7. Interpret experimental data obtained from erosion plots and calculate soil loss
8. Plan contour farming, strip cropping, and mulching practices for a sloping agricultural land

9. Design of gully control structures
10. Develop a soil and water conservation plan for a hilly farm in Nepal

Practical

(30 hours)

1. Calculation of rainfall erosivity index
2. Use of Weismair's Nomograph for soil erodibility estimation
3. Use of USLE for calculation of soil loss
4. Design of vegetated waterways
5. Design problem solving on bench and broad base terraces
6. Design problem solving on contour and graded bunds
7. Design problem solving on check dams
8. Design of farm ponds
9. Field observation of check dams and other soil conservation structures
10. Field observation on bio-engineering practices of soil conservation

Field visit to a nearby watershed management site.

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	2	2
2	7	9
3	2	3
4	3	4
5	12	15
6	10	14
7	3	4
8	2	3
9	4	6
Total	45	60

* There may be minor deviation in marks distribution.

References

1. Schwab, G. O., Fangmeier, D. D., Elliot, W. J., Frevert, R. K. (1993). Soil and water conservation engineering (Latest Edition). John Wiley & Sons.
2. Suresh, R. (2017). Soil and water conservation engineering. Standard Publishers Distributors.
3. Murty, V. V. N., Jha, M. K. (2011). Land and water management engineering. Kalyani Publishers.
4. Morgan, R. P. C. (2005). Soil erosion and conservation . Blackwell Publishing.
5. Food and Agriculture Organization (FAO). (1986). Guidelines for watershed management (FAO Conservation Guide No. 1). FAO.