SOIL CONSERVATION AND WATERSHED MANAGEMENT

ENGE 465

Lecture	**: 3**	**Year : IV**
Tutorial	**: 2**	**Part : II**
Practical	**: 1**	

Course Objectives:

The objective of this course is to provide students with an understanding of soil erosion processes and watershed degradation caused by natural and human-induced factors, along with their impacts on land productivity and downstream environments. Students will learn how soil erosion contributes to fertility loss, sedimentation, morphological changes, and water-induced hazards, as well as reduced reservoir capacity. The course also equips students with knowledge of vegetative and engineering soil conservation measures and smart approaches for sustainable watershed management.

1 Introduction (2 hours)

1.1 Need of soil conservation: Soil erosion agents, cause of soil erosion, problems of soil erosion; Mechanism of soil erosion

1.2 Necessity of water conservation: Global water balance, scarce fresh water reserve, causes of water scarcity, droughts and desertification

1.3 Concept and approaches of watershed management: Concept of management on watershed; Vegetative and engineering approaches (Water conservation and saving measures)

1.4 Watershed operations and factors affecting watershed operations (Physiography, soil and geology, land use, vegetation, precipitation and peak runoff, socio-economic factors, organization), treatment of land and soil conservation measures

2 Runoff and Sediment Yield (5 hours)

2.1 Runoff and types of runoff; Factors affecting runoff

2.2 Runoff estimations: Rational method; Water and Energy Commission Secretariate (WECS) method; Medium Irrigation Project (MIP) method

2.3 Base flow, effective rainfall and direct runoff calculation: SCS CN method

2.4 Types of soil erosion: Surface erosion; Gully erosion; Stream bank erosion

2.5 Factors affecting soil loss and soil loss computations: Universal soil loss equation (USLE)

2.6 Types of sediments; Sediment sampling methods; And relationship between soil erosion and sedimentation: Sediment Delivery Ratio (SDR)

3 Land Capability for Watershed Management (2 hours)

3.1 Land capability and purpose of land capability classification
3.2 Factors affecting land capability
3.3 Land capability classification (LCC): Land capability group/class/sub-class/units
3.4 Land use, land capability and suitability surveys: Soil survey, slope analysis and land capability and suitability classification
3.5 Land use and soil conservation practices

4 Agronomic Measures for Soil and Water Conservation (4 hours)

4.1 Cover crops: Effects and types of plant cover; mulching
4.2 Contour cultivation, crop rotation, zero-tillage and tillage farming
4.3 Strip cropping, multiple cropping, and intercropping
4.4 Grassland management
4.5 Agroforestry: Functions of agroforestry, agroforestry systems, preferred species, land reclamation
4.6 Horticulture: Soil moisture conservation and water harvesting, people's participation, agri-horti system, homestead gardens, social forestry orchards; fruit crops in wastelands

5 Engineering Measures for Conservation of Agriculture Land (8 hours)

5.1 Bunding: Contour and graded bunding; Design criteria and specification of bunding; Design of contour and graded bunding; Construction and maintenance of bunds
5.2 Terracing: Bench and broad base terraces; design of bench and broad base terraces; Construction and maintenance of terraces
5.3 Grassed waterways: Advantages/disadvantages; Site selection; Design, construction and maintenance of grassed waterways
5.4 Drainage of excessive water – surplusing structures – types of surplus drainage structures, design of surplus weir and pipe outlets

6 Engineering Measures for Conservation of Non-Agriculture Land (6 hours)

6.1 Soil conservation on wastelands
6.2 Contour and staggered trenching
6.3 Gully control structures: Types and design of temporary, semi-permanent and permanent control structures
6.4 Sediment retention structures: Design of sediment basin, calculation of surface area and basin capacity

7 Bio-Engineering for Soil and Water Conservation (5 hours)

7.1 Vegetative conservation techniques – Facines; Palisades; Wattline bamboo planting; Grass planting; Live fencing; Brush layering

7.2 Natural hazard prevention – Gully treatment; Landslide treatment; Stream bank protection; Degraded land rehabilitation

7.3 Protection of developed infrastructure – Irrigation channel stabilization; Trail improvements; Road slope stabilization; Water source protection

8 Water Conservation and Harvesting (7 hours)

8.1 Water conservation principles – reducing evaporation, transpiration/evapotranspiration, seepage, quality degradation; Cloud seeding, increasing groundwater recharge or other storage; Treating and reusing drainage, sewage, or other waste water; Using super absorbents

8.2 Water conservation methods for cropland - Broad bed and furrow (BBF) system; conservation bench terraces (CBT); Tied ridging or furrow damming; Contour furrows; Inundation methods

8.3 Small storage structures – Conservation ponds; Small earthen dams; Small weirs; Sand dams

8.4 Recharge and use of ground water

9 Watershed Management (6 hours)

9.1 Causes and consequences of watershed deterioration

9.2 Objectives and steps of watershed management

9.3 People's participation in watershed management

9.4 Watershed management plan (WMP)

9.5 Formulation of project proposal

Tutorial (30 hours)

1. Estimation of soil loss by USLE
2. Design of contour and graded bunding
3. Design of bench terraces
4. Design of broad base graded terrace
5. Design of surplus weir and pipe outlets
6. Design of grassed waterways
7. Design of straight drop and chute spillway
8. Design of water retaining structure
9. Design of small earthen dam

Practical (15 hours)

1. Individual assignment on delineation of watershed boundary, compute runoff volume, estimate soil erosion and sediment deposition and preparation of Watershed Management Plan (WMP)
2. Identify potentially degraded land in your surroundings and suggest appropriate agronomic and engineering measures to coup with the problem
3. Students are instructed to submit a report comprising of answers to the questions furnished alongside the instructions.

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	Marks distribution*
1	2	4
2	5	6
3	2	4
4	4	6
5	8	12
6	6	10
7	5	6
8	7	8
9	6	4
Total	**43**	**60**

* There may be minor deviation in marks distribution.

References

1. NARMSAP Nepal, Department of Soil Conservation and Watershed Management. (2004). Soil conservation and watershed management measures and low-cost techniques.
2. Tideman, E. M. (2000). Watershed management: Guidelines for Indian conditions. Omega Scientific Publishers.
3. Suresh, R. (2012). Soil and water conservation engineering. Standard Publishers Distributors.
4. Blanco, H., Lal, R. (2008). Principles of soil conservation and management. Springer.
5. Morgan, R. P. C. (2005). Soil erosion and conservation. Blackwell Publishing.

VOLUNTEERED GEOGRAPHIC INFORMATION AND PARTICIPATORY GIS

ENGE 466

Lecture	**: 3**	**Year : IV**
Tutorial	**: 2**	**Part : I**
Practical	**: 1**	

Course Objectives:

This course provides a comprehensive exploration of volunteered geographic information (VGI) and participatory GIS (PGIS). Students will critically evaluate crowdsourced data frameworks, master free and open source software (FOSS), and design community-centric mapping projects. The course emphasizes ethical data acquisition, mobile GIS integration and the application of spatial tools for inclusive governance and disaster resilience.

1 Fundamentals of Volunteered GI (7 hours)

1.1 Introduction to V-GI: Concepts, history and significance
1.2 Crowdsourcing in GIS: Definition, examples and tools
1.3 Community mapping through V-GI: How volunteer data contributes to mapping projects
1.4 Data acquisition techniques
1.5 Ethical Issues in V-GI: Data quality, consent and privacy concerns

2 Basics of Participatory GIS (PGIS) (7 hours)

2.1 Introduction to participatory GIS: Key concepts, principles and importance.
2.2 Traditional GIS challenges and PGIS
2.3 Engagement in PGIS: Techniques for community involvement.
2.4 Participatory GIS for inclusive decision-making processes
2.5 Tools for PGIS
2.6 Challenges in PGIS: Social, technical and practical barriers

3 Free and Open Source Software (7 hours)

3.1 Definitions and concepts: Understanding FOSS, free software versus open-source software, copyleft
3.2 History and evolution: The origin of the FOSS movement, key milestones, and influential projects (GNU, Linux)
3.3 Licensing and legal issues: Overview of licenses (GPL, MIT, Apache, Creative commons), intellectual property rights and software freedom
3.4 FOSS versus proprietary software: Comparisons in terms of cost, flexibility, security and community support

4 Project Design and Data Collection in PGIS (7 hours)

4.1 Designing PGIS projects: Setting goals, identifying stakeholders and resource planning
4.2 Data collection techniques: Participatory mapping, surveys and fieldwork
4.3 Tools and technologies for participatory mapping
4.4 Mobile GIS in PGIS: Using smartphones and tablets for data collection
4.5 Data validation and quality assurance: Ensuring accuracy and reliability

5 Community Cartography and PGIS (7 hours)

5.1 Concepts and approaches
5.2 Participatory mapping techniques
5.3 Empowering communities through PGIS
5.4 PGIS for engaging local knowledge, community development and planning
5.5 Challenges, innovations and future directions

6 Policy and Governance in PGIS (5 hours)

6.1 Understanding participatory approval: Processes and frameworks
6.2 Legal and governance aspects: Role of government and policy in supporting PGIS
6.3 Ethics and best practices: Guidelines for responsible use of VGI and PGIS
6.4 Future trends: Emerging technologies and the future of participatory GIS

7 Applications of VGI and PGIS (5 hours)

7.1 Application in disaster response: Using VGI for emergency mapping (E.g., OpenStreetMap)
7.2 Environmental monitoring: Community-led initiatives using PGIS
7.3 Urban planning: Incorporating public input into urban development
7.4 Case study: Indigenous mapping: Role of PGIS in preserving cultural heritage

Tutorial (30 hours)

1. Participatory mapping workshop
2. Developing a VGI project proposal
3. Strategic stakeholder mapping and power dynamics
4. Implementing a small-scale VGI/PGIS initiative
5. Analyzing remote sensing data using open-source software
6. Implementing a FOSS-based solution for a real-world problem
7. Semantic interoperability: "Tagging" the world
8. Deployment strategies: Offline mobile GIS for remote areas

Practical (15 hours)

1. Data collection using mobile GIS applications
2. Customizing OpenStreetMap data

3. Visualization of participatory GIS data
4. Developing a custom tool or plugin in QGIS.
5. Accuracy and reliability assessment of a PGIS product

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	Marks distribution*
1	7	9
2	7	9
3	7	9
4	7	9
5	7	9
6	5	8
7	5	7
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Goodchild, M. F. (2007). Citizens as sensors: The world of volunteered geography. GeoJournal, 69(4), 211–221.
2. Elwood, S. (2006). Critical issues in participatory GIS: Deconstructions, reconstructions, and new research directions. Transactions in GIS, 10(5), 693–708.
3. McCall, M. K., Dunn, C. E. (2012). Geo-information tools for participatory spatial planning: Fulfilling the criteria for “good” governance? Geoforum, 43(1), 81–94.
4. Perkins, C., Dodge, M. (2008). The potential of user-generated cartography: A case study of the OpenStreetMap project and map mashups. Environment and Planning B: Planning and Design, 35(3), 475–490.

CADD AND BUILDING INFORMATION MODELING
ENGE 467

Lecture	**: 3**	**Year : IV**
Tutorial	**: 2**	**Part : II**
Practical	**: 1**	

Course Objectives:

The objective of this course is to provide students with fundamental knowledge and practical skills in Computer-Aided Design and Drafting (CADD), CADD–GIS integration, and Building Information Modeling (BIM). Upon completion, students will be able to apply these technologies in geomatics engineering for spatial data management, infrastructure planning, design visualization, and the efficient planning, design, construction, operation, and management of built environments.

1 CADD and GIS Integration (3 hours)

1.1 Overview of CADD – 2D, 3D drafting, modeling and design
1.2 GIS and CADD integration – importing and exporting GIS and CADD data, data conversion
1.3 Link GIS attribute data to CADD drawing
1.4 CADD plugins and extensions for GIS
1.5 Spatial accuracy and consistency

2 Building Information Modeling (BIM) (10 hours)

2.1 Understanding BIM
2.2 History of BIM
2.3 BIM Concepts – different levels of BIM
2.4 4 Pillars of BIM – technology, process, people and policy
2.5 BIM dimensions – 3D to 7D
2.6 Working procedure of BIM: Design to pre-construction, construction to operation
2.7 Applications of BIM – digital modeling of buildings, archeological artifacts, 3D city planning, construction management, facility management, energy analysis, disaster management

3 Data Acquisition and Model Development (6 hours)

3.1 3D measurement techniques
3.2 Approaches to 3D data production
3.3 Point cloud-based approach
3.4 Image-based approach
3.5 Hybrid approach

3.6 Selection criteria
3.7 Integration of multi-source data

4 BIM Implementation and Challenges (8 hours)

4.1 Pre-contract – planning and designing, digital model, information model
4.2 Post-contract – construction supervision and progress monitoring
4.3 Operation and management
4.4 BIM execution plan
4.5 Technological barriers, human resources, collaborative issues
4.6 Implementation difficulties
4.7 Financial and legal hurdles

5 BIM Expansion in Urban Planning (6 hours)

5.1 City information modeling (CIM)
5.2 Public infrastructure management
5.3 City planning and zoning
5.4 Urban renewal approaches
5.5 Renewable processes: Diagnostic, planning, execution and management phase
5.6 Lifecycle management

6 Current Trends and Future Perspectives of BIM (8 hours)

6.1 Sustainability management
6.2 Design for manufacture and assembly (DfMA)
6.3 Digital twins and internet of things (IoT)
6.4 Virtual and augmented reality (VR/AR)
6.5 Artificial intelligence (AI) and machine learning (ML)
6.6 Virtual and augmented reality (VR/AR)
6.7 Generative design

7 Data Standards (4 hours)

7.1 Standardization bodies: OGC, ISO and buildingSMART
7.2 OGC standards: Geography Markup Language (GML) and CityGML; GeoScience Markup Language (GeoSciML); Geospatial User Feedback (GUF)
7.3 ISO standards: TC211
7.4 buildingSMART standards: Information Dissemination Manual (IDM), Model View Definition (MVD), Digital Dictionary Registry (DDR), BIM Collaboration Format and IFC (Industry Foundation Class) Data Storage and Structuring Model

Tutorial **(30 hours)**

1. CAD to GIS conversion and correct messy output into GIS
2. CAD to GIS translation – validate data, manipulate the geometry, represent CAD into GIS attributes and georeferencing
3. GIS to CAD conversion with file manipulation engine (FME)
4. Connect 3D digital data and attributes to building layers

Practical **(15 hours)**

1. Drafting a building drawing and prepare and 3D information model for computing the cost of building with different options
2. Use of as build drawing for the management and operation of an academic (School/college) building

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	3	4
2	10	14
3	6	8
4	8	10
5	6	8
6	8	10
7	4	6
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Hajji, R., Oulidi, H. J. (Eds.). (2021). Building information modeling for a smart and sustainable urban space. John Wiley & Sons.
2. Hardin, B., McCool, D. (2015). BIM and construction management: Proven tools, methods, and workflows. John Wiley & Sons.
3. Teicholz, P. (Ed.). (2015). BIM for facility managers. John Wiley & Sons.
4. Farrer, N., Philp, D. (2016). BIM for landscape. Routledge.
5. Whyte, J., Nikolić, J. (2018). Virtual reality and the built environment. Routledge.