

SYLLABUS

Masters of Science in Watershed Management

2024



Tribhuvan University
Institute of Forestry
Kirtipur,
Kathmandu



FOREWORD

The Master of Science degree in Watershed Management, conferred by Tribhuvan University, stands as an advanced educational milestone designed to cultivate adept professionals in the field of watersheds. This academic journey has been shaped by a commitment to excellence, and the number of curriculum revisions ensures that the course is aligned with the changing context. The curriculum overhaul is an integral part of the Institute of Forestry's (IOF) comprehensive review process. This revision aims to fortify the students' proficiency in applying fundamental principles of watershed management to address contemporary challenges in professional practice.

At the heart of this revision process lies a collaborative spirit, with experts and stakeholders engaged at both national and international levels. Leveraging their insights, the curriculum has been crafted aiming that equip students to confront the evolving issues within watershed science. The courses introduced are strategically designed to tackle the myriad challenges associated with watershed management, environmental pollution, and climate change, particularly in the face of escalating global changes. The envisioned outcome is to empower students with analytical skills, decision-making abilities, and the capacity to address the multifaceted nature of problems inherent in the field of environment and watershed management while balancing the trade-off between ecological and societal needs.

Embarking on this new academic journey, the subjects are identified considering these multiple roles of watershed management, where the subject committees and faculty board of the IOF took a leadership role in shaping it. Moreover, many individuals and institutions have contributed directly and indirectly to bring this curriculum to this shape. This is also an outcome of the consultative processes carried out at different levels. I express my sincere thanks to internal and external experts, subject committee chairs and members, and the Faculty Board for their kind cooperation and contributions. Special appreciation is extended to the ALIGN project WWF Nepal for their financial support in the preparation of the syllabus. Further, I would like to extend my special thanks to the Academic Council of Tribhuvan University for approving this curriculum. I appreciate the contribution of curriculum revision committee members Associate Prof. Dr. Sony Baral, Prof. Dr. Krishna Raj Tiwari, Prof. Dr. Rajesh Kumar Rai, Associate Prof. Dr. Narayan Prasad Gautam and Associate Prof. Dr. Menuka Maharjan, IOF for revising the M.Sc. syllabus with leaving no stone unturned.

I am confident that our students will serve as warriors for addressing the planetary crisis, that we are now facing, such as global climate change, biodiversity losses, and environmental issues. Moreover, they will serve in the sustainable management of the global commons. As we step into this renewed academic chapter, we remain committed to upholding the highest standards of education and fostering a learning environment that prepares our students to be leaders and innovators in their respective fields.

Prof. Bir Bahadur Khanal Chhetri, PhD
Dean

TABLE OF CONTENTS

INTRODUCTION	1
SEMESTER-WISE COURSE BREAKDOWN	5
SEMESTER I.....	7
COURSE TITLE: FORESTS AND ENVIRONMENT POLICY	7
COURSE TITLE: NATURE AND SOCIETY	11
COURSE TITLE: WATER-ENERGY-FOOD-ECOSYSTEM NEXUS.....	15
COURSE TITLE: LANDSCAPE MANAGEMENT AND BIODIVERSITY CONSERVATION	20
COURSE TITLE: NATURAL RESOURCE MANAGEMENT IN CHANGING ENVIRONMENT	24
SEMESTER II	28
COURSE TITLE: GEOINFORMATICS FOR NRM.....	28
COURSE TITLE: RESEARCH DESIGN AND SCIENTIFIC WRITING.....	32
COURSE TITLE: ADVANCED STATISTICS	36
COURSE TITLE: NATURAL RESOURCE ECONOMICS	39
COURSE TITLE: LANDSCAPE RESTORATION	42
SEMESTER III	45
COURSE TITLE: INTEGRATED WATERSHED MANAGEMENT	45
COURSE TITLE: WATERSHED MODELING	50
COURSE TITLE: WATER INDUCED DISASTER AND MANAGEMENT	53
COURSE TITLE: WATERSHED ENGINEERING	57
COURSE TITLE: WATER RESOURCE MANAGEMENT	61
COURSE TITLE: NATURAL RESOURCE PROFESSIONAL ETHICS (OPTIONAL).....	66
SEMESTER IV	70

INTRODUCTION

Watershed management is currently grappling with a confluence of challenges, including climate change, biodiversity loss, and the need for sustainable production and development on a global scale. This has led to an escalating level of pressure and threats on forests, which serve as pivotal entities in addressing numerous national and international challenges. The role of the academics is pivotal in addressing these global challenges. In response to the evolving demands of the market, the Master's program in watershed management has been revised to enhance the skills of students and preparing them to navigate the diverse aspects of technical, field, and policy dimensions within the watershed management sector. The program is designed not only to equip students with the knowledge necessary to address complex national and international forest challenges but also to empower them to seek, negotiate, and implement solutions in the face of a rapidly changing world.

The Institute of Forestry (IOF) aims to provide high quality education, developing critical thinking skills, and preparing students for their future careers in forestry and natural resources sectors. This is achieved through a multifaceted approach encompassing extensive field research, a dynamic forest lab, an on-campus museum, and impactful outreach programs. Established in 1947 AD, the IOF is the pioneer institute dedicated to imparting comprehensive knowledge and technical expertise in Forestry and allied sectors. As a hub for advanced education in forestry, the Institute of Forestry continues to play a pivotal role in developing skilled professionals and the sustainable management of Nepal's rich natural resources.

The IOF has been offering academic degrees, Bachelor's in forestry, Masters and PhD programs in various fields of Forest Science, including Forestry; Community Forestry; Wildlife Management and Biodiversity Conservation; Mountain Environment and Development Studies; Watershed Management and Environmental Science; and Natural Resource Management and Rural Development. The IOF periodically revises the curriculum, engaging academicians, development practitioners, researchers, and policymakers to provide students with the current state of knowledge on forestry sciences and allied sectors and make them competent to address the emerging issues and challenges within it. The M.Sc. programs have been designed as per the increasing needs of the diverse areas and expanding context and career landscape at the national and international levels. Considering the forest is key to addressing many of these national and international challenges diverse Master programs have been introduced and revised as per the need.

The updated course streamlines the learning process by introducing a unified first-year curriculum, ensuring that students, regardless of their specialization (Forestry, Wildlife Management and Biodiversity Conservation, Natural Resources Management and Rural Development, Watershed Management and Environmental Science, Mountain Environment and Development Studies, Community Forestry), develop a foundational understanding of crucial interdisciplinary concepts against the backdrop of pressing issues such as policy, forestry, climate change, biodiversity loss, and pollution. The program is designed to produce skilled human resources with technical competency in integrated watershed management and Environmental Science. The other specific objectives of the course are:

- To provide knowledge and skills to address problems related to watershed degradation caused by soil and water issues,

- To produce competent human resources capable of planning and executing water and soil conservation strategies

For this program adopts a pragmatic, field-based teaching approach, emphasizing applied learning structures. Our graduates will be equipped with a versatile skill set that positions them to ascend in government service, attain notable success in academic pursuits, establish themselves as successful entrepreneurs, and secure high-profile green jobs. The comprehensive academic journey will prepare them to thrive in various career paths and to contribute significantly to their chosen fields.

PROGRAM DURATION AND ACADEMIC SESSION

The Watershed Management and Environmental Science program will span two academic years, comprising a total of four semesters. The First semester focuses on the theoretical aspects of forest and natural resource management. The Second semester emphasized on tools and techniques required for data collection and analysis. The Third semester focuses on integrated watershed management, watershed modeling, and watershed induced disaster and management. The Fourth semester is allocated for conducting research and sharing their findings.

COURSE CODE AND CODE NUMBERS

The course code provided in this curriculum comprises a concise representation of the Subject Matter Committee, including a number and additional information enclosed in parentheses. The initial abbreviated text within the course code signifies the specific Subject Committee category to which the course belongs. The abbreviations corresponding to the course codes are outlined below:

PWM: Park Recreation and Wildlife Management
SFB: Silviculture and Forest Biology
SFM: Social Forestry and Forest Management
WME: Watershed Management and Environmental Science
FPE: Forest Products and Engineering
BSH: Basic Science and Humanities

Students have the option to take any of the courses as extra electives in addition to the required courses for their enrolled Master's degree program

ADMISSION, EVALUATION AND AWARD OF DEGREE

The candidate must hold a Bachelor's degree of at least four years in B.Sc. Forestry, Engineering/ Agriculture and Science degree from either Tribhuvan University or any institution acknowledged by Tribhuvan University. All students must appear in the entrance examination administered by the Examination Section of the IOF and are selected for admission based on their merit score. Both academic achievements and performance in the entrance examination will play a crucial role in the admission process.

Evaluation and Examination System

Each semester, students undergo a comprehensive evaluation, encompassing both internal and external assessments. To pass the examination, students are required to secure a minimum of 50% marks in the final external (final exam) and internal (practical and assessments) examinations separately. The grading system allocates 40% of the marks to internal and 60% to the external (final) exams.

The administration of internal examination marks falls under the responsibility of the respective course coordinator, ensuring transparency and accuracy in the assessment process. However, the evaluation culminates in the final written examination, scheduled at the end of the semester. It is imperative to note that students must fulfill the prerequisite of passing the internal to be eligible to sit for the final examinations. In case of students failing to meet the passing criteria in the regular semester examination, they are provided with an opportunity to appear in a make-up examination. Nevertheless, students must adhere to the protocol of filling out the examination form for the respective semester.

The internal marks are given by the responsible course teacher based upon the assessment of attendance tracking, and various tasks such as fieldwork, laboratory exercises, term papers, class presentations, report writing, project work, and home assignments. The assessment process is undertaken by the faculty responsible for each course, who provide clear and detailed evaluation criteria to students well in advance. This proactive communication ensures students to understand and meet the expectations set forth in their courses effectively. Further, the Dean's office will form a committee to evaluate the completion of internal assessment and the marks given by the responsible course teacher. The committee will be responsible for reviewing the internal assignments and carried out while teaching the course and the evaluation criteria for the internal evaluation set by the course responsible teacher as per the nature and objective of the course. The committee will also be authorized to change or not to change the marks given by the internal evaluator if deemed necessary. Finally, the committee will submit report together with the marks of all subject of the semester to the Dean's Office stating whether or not the courses were taught and the evaluation were done in a scientific manner.

The student's thesis will undergo evaluation by the Research Assessment Committee (RAC), coordinated by the main supervisor alongside internal and external experts. The internal expert will be selected by the respective campus, while the external expert will be chosen by the exam control division, ensuring alignment with the subject area's relevance.

Attendance Requirement

A student must attend at least 80% of classes in each subject. Attendance carries 20% marks on the internal assessment. Failure to fulfill the attendance requirement by a student may result in his/her disqualification to appear in the final examination. But, in specific cases (seriously ill, out-of-control situations) students having 70% attendance are allowed to appear for the final examination. In this case, the student should submit a medical certificate for the seriously ill, and a certificate of the concerned authority in other cases.

Academic Transcript and Grading System

After the successful completion of all the requirements prescribed by the course curriculum, a student will be eligible for the award of an M.Sc. degree in the respective programs. An academic transcript is issued by the Controller of Examination of Tribhuvan University to students who have fulfilled all requirements. The academic standard of students is based on the cumulative percentage of marks secured in all examinations. The IOF adopted the grading system indicated in credit transfer, grading system, and the academic transcript study report of 2020 approved by TU Academic Council decision no 64 on 2078/1/14 [Table 1].

Table 1: Grading System for M.Sc Program

Grade	GPA	Grading Scale (in %)	Performance
A	4.0	90-100	Outstanding
A-	3.7	80- less than 90	Excellent
B+	3.3	70-less than 80	Very good
B	3.0	60- less than 70	Good
B-	2.7	50 -less than 60	Satisfactory
F	0.0	Less than 50	Fail

In this system, a student has to receive a minimum of 2.7 GPA or letter “B-” grade to pass each course.

In every semester, students will be given Semester Grade Point Average (SGPA) using the following calculation

$$SGPA = \frac{\textit{Total Grade Point earned in a semester}}{\textit{Total Number of credit registered in a semester}}$$

Based on the grades earned in each semester, Cumulative Grade Point Average (CGPA) will be calculated as follows:

$$CGPA = \frac{\textit{Total Grade Point earned}}{\textit{Total Number of credits completed}}$$

SEMESTER-WISE COURSE BREAKDOWN

Semester I	Course	Credit	Page Number
SFM 501	Forest and Environment Policy	3	7
SFM 502	Nature and Society	3	11
WME 503	Water- Energy-Food- Ecosystem Nexus	3	15
PWM 504	Landscape Management and Biodiversity Conservation	3	20
SFM 505	Natural Resource Management in Changing Environment	3	24
Semester II			
WME 551	Geoinformatics for NRM	3	28
BSH 552	Research Design and Scientific Writing	3	32
BSH 553	Advanced Statistics	3	36
SFM 554	Natural Resource Economics	3	39
SFB 552	Landscape Restoration	3	42
Semester III			
WME 631	Integrated Watershed Management	3	45
WME 632	Watershed Modeling	3	50
WME 633	Water Induced Disaster and Management	3	53
WME 634	Watershed Engineering	3	57
WME 635	Water Resource Management (Optional)	3	61
SFM 606	Natural Resource Professional Ethics (Optional)	3	66
Semester IV			
WME 651	Proposal	2	70
WME 652	Pre-defense	2	70
WME 699	Dissertation	9	70
WME 653	Manuscript of Research Work	2	70

COURSE DESCRIPTIONS

SEMESTER I

COURSE TITLE: FORESTS AND ENVIRONMENT POLICY

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
SFM 501	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: Forest and other environmental policies play an important role in sustainable resource management. This course is designed to introduce students to the contextual understanding of policies that have shaped the management of renewable resources (i.e., forest, wildlife, water, etc.) in Nepal and beyond. Throughout the course, students will learn ideas behind natural resource policies and try to understand their role in broader natural resource decision-making.

OBJECTIVES: The objectives of this course are to:

- To facilitate student learning in forest and environmental policymaking and be able to apply this understanding to case studies of environmental and natural resource policy issues.
- To familiarize students with the development of key national and international policies for natural resources and environmental sustainability.
- To familiarize students with the organizational and administrative structure and policy-making processes of the major federal natural resource management agencies in Nepal.
- To facilitate students in their ability to critique and evaluate policy processes and policy outcomes in the context of emerging market issues and changing natural resource conditions.

LEARNING OUTCOMES: Upon the completion of this course, the students will be able to

- Have a clear understanding of the evolution and administrative functionalities of major forest and environmental policies in Nepal.
- Understand the public policy formulation process in national and international contexts.
- Understand the evolution of environmentalism in national and international contexts.
- Be familiar with the various policies and regulations in Nepal pertaining to environment and natural resources.

COURSE CONTENTS

UNIT 1: INTRODUCTION TO FOREST AND ENVIRONMENTAL POLICY (6)

- 1.1 Natural Resource Management and Politics
- 1.2 Importance of Public Policy
- 1.3 Evolution of Environmental Policy (forest, watershed, wildlife)
- 1.4 Global Challenges in Natural Resource Management / Planetary Crisis
- 1.5 Tragedy of the Commons
- 1.6 Externalities and Market Failure

UNIT 2: POLICY PROCESS MODELS (8)

- 2.1 Economic, Political, and Ethical Perspectives on Environmental Policy

- 2.2 Natural Resource Policy as a Process
- 2.3 Public (forest/watershed/wildlife) Policy Formulation Process in Nepal
- 2.4 Environmental Sustainability and Natural Resource Policies
- 2.5 Criteria for Policy Analysis

UNIT 3: ENVIRONMENTALISM AND ENVIRONMENTAL POLICIES (8)

- 3.1 Environmentalism and its Impact on Policies
- 3.2 Theoretical Foundation: Ecocentrism, Anthropocentrism, and Deep Ecology
- 3.3 Emergence of Environmental Impact Assessment as a Policy Tool
- 3.4 Endangered Species Conservation and International Trade

UNIT 4: INTERNATIONAL CONSERVATION POLICIES (4)

- 4.1 International Convention Joining and Withdrawal Process
- 4.2 Earth Summit 1992 and its Outcome Conventions
- 4.3 International Climate Agreements and their Effectiveness

UNIT 5: SECTORAL POLICIES IN NEPAL (6)

- 5.1 Constitutional Provisions Related to Natural Resources
- 5.2 Sectoral Policies (Other) and Natural Resource Conservation
- 5.3 Synergies in Natural Resource Related Policies (Climate, Environmental, Forests, Watershed, Wildlife)
- 5.4 Natural Resource Revenue Sharing Mechanism

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
History of policies (Sectoral) in Nepal	Literature	Literature Review and Presentation	Unit 1, 4
Policy analysis of Nepal Forest/Environment/Watershed/climate policy (Outcomes)	Policy document	Group work / Report	Unit 2
Improving EIA in Nepal	Expert Consultation	Group work / Critiques and Suggestions	Unit 3
Status and Challenges of International Treaties in Nepal	Literature, Expert Consultation	Group work/ Report	Unit 5
Policies in Nepal	Literature	Review / Class Discussion	Unit 6

KEY REFERENCES

Unit 1

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Unit 2

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Unit 3

1. Balistrieri, Carlo A. (1993). CITES: The ESA and international trade. *Natural Resources & Environment* 8, no. 1: 33-76.
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Unit 4

1. Almer, C., & Winkler, R. (2017). Analyzing the effectiveness of international environmental policies: The case of the Kyoto Protocol. *Journal of Environmental Economics and Management*, 82, 125-151.
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Unit 5

1. Constitution of Nepal 2015.
2. Nepal Kanun Kitab Byabastha Samiti (Acts – Land, Infrastructure, Mine, Industry, Hydropower).
3. National Natural Resource and Fiscal Commission Act.
4. National Natural Resource and Fiscal Commission. (2017). Recommendation on the Distribution of Royalties from Natural Resources Mobilization.

COURSE TITLE: NATURE AND SOCIETY

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
SFM 502	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: This course covers key theoretical concepts and approaches in social sciences as they relate to understanding and describing the relationship between society and nature. It is intended to help students develop contemporary knowledge and practical skills in assessing and analyzing the causes and solutions of natural resource problems by integrating concepts and foundational theories in social science disciplines.

OBJECTIVES: The objectives of this course are to:

- Foster an understanding of the evolution of human-nature relationships
- Develop a deeper understanding of the complex dynamics of coupled human and natural systems
- Enhance knowledge regarding various social science theories in explaining and predicting human behavior in the context of natural resource management
- Develop a critical foundation for further research on human-nature interactions with using the concepts and skills of conservation social science

LEARNING OUTCOMES: Upon the completion of this course, the students are expected to be able to:

- Know a range of foundational theories in social science to explain and predict the interaction between humans and nature
- Understand the evolving complexity of human and natural systems, including disturbance and adaptation
- Identify and evaluate the importance of cultural and economic institutions in the sustainability of natural resources
- Become familiar with diverse ways human values, beliefs, and norms relate to their behavior toward nature and,
- Integrate ideas and practices from contemporary social science in planning, decision-making, and policy regarding sustainable management of natural resources.

COURSE CONTENTS

UNIT 1: FOUNDATIONS OF NATURE AND SOCIETY (5)

- 1.1 Human History and Nature
- 1.2 Equilibrium and Non-Equilibrium Ecology
- 1.3 Philosophical Foundation of Nature-Human Relationship (Eco-centric, Anthropocentric)
- 1.4 The Social Construction of Nature
- 1.5 Nature and Culture

UNIT 2: CHANGES, CHALLENGES, AND PARADIGM SHIFT IN CONSERVATION

(6)

- 2.1 Anthropocene Biosphere
- 2.2 Planetary Boundaries
- 2.3 Limits to Growth
- 2.4 Ecological Modernization
- 2.5 Bright Green Environmentalism
- 2.6 Eco-centric vs Anthropocentric

UNIT 3: HUMAN NATURE INTERACTION (8)

- 3.1 Social-Ecological Systems
- 3.2 Common Property Regimes
- 3.3 The Community Capital Framework
- 3.4 Collective Actions and Impact
- 3.5 Intermediate Disturbance Hypothesis

UNIT 4: SOCIAL CONTEXT OF NATURE-BASED SERVICES (5)

- 4.1 The Worth of Nature to Humans
- 4.2 Ecosystem Marketplace as a Solution
- 4.3 Climate Change and Social Cost of Carbon
- 4.4 Opportunity Cost Approach in Conservation Priorities
- 4.5 Environmental Consumerism

UNIT 5: CULTURE AND WORLDVIEWS (8)

- 5.1 Drivers of Human Behaviors
 - 5.1.1 Theory of Behavior
 - 5.1.2 Value-Belief Norm Theory
- 5.2 Demographic Influences on Conservation Values
- 5.3 Nature-Culture/Indigenous People Relationship
- 5.4 Social Trust in Natural Resource Management

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Indigenous community (ethnic group) and nature relationship (Ethnicity/culture-wise group)	Literature review/ reading materials	Group discussion	Unit 1
Influence of human-nature Interaction on Nepal's Forest/environment/wildlife /Watershed Policy Development	Literature review	Group presentation	Unit 2
Social-ecological system	Field	A report on SES / Group	Unit 3

KEY REFERENCES

TEXT BOOK

1. Misiune, I., Depellegrin, D., & Egarter Vigl., L. (2022). *Human-Nature Interactions: Exploring Nature's Values Across Landscapes* (p. 438). Springer Nature.

Unit 1

1. Kai N. Lee., W. R. Freudenburg., and R. B. Howarth. (2013). *Humans in the Landscape: An Introduction to Environmental Studies*. Pages 258-86.
2. Meadows, D. H., Meadows, D. L., & Randers, J. (1993). Beyond the limits: An executive summary. *Bulletin of science, technology & society*, 13(1), 3-14.
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Unit 2

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Unit 4

1. Stern's review
2. Dasgupta Review
3. Westman, W. E. (1977). How Much Are Nature's Services Worth? *Science* 197: 960-964

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Unit 5

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COURSE TITLE: WATER-ENERGY-FOOD-ECOSYSTEM NEXUS

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final + Internal)
WME 503	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: Water, energy, land/food, and ecosystems (WEFE) are critical for nutrition and food security, healthy ecosystems, resilient economies, and sustainable development. Single disciplinary (or silo) approach has limitations to achieve the interconnected development goals (e.g., sustainable development goals) in inclusive manner whereas the nexus approach considers the interconnections among the sectors, quantifies synergies and trade-offs of an intervention, and also has the potential to serve as a climate change adaptation and human security solutions. However, governments, stakeholders, and investors are struggling to manage systems change in the WEFE nexus and ensure that the changes are robust under changing climate and evolving interactions among natural and human systems. In this context, this course starts with the context of natural resources under stress, introduces associated concepts, and then evolves into the system approach, nexus concept and principles, entry points for inclusion, system interactions, nexus assessment tools, nexus in practice and nexus future perspective. It includes theoretical sessions, assignments, practical/presentation sessions, and field studies. The course is divided into 5 chapters and 20 sub-chapters, with four sub-chapters in each chapter.

OBJECTIVES: This course aims for the following learning objectives

- To familiarize with the fundamentals of WEFE nexus in the context of natural resources management and climate change
- To enhance knowledge and skill in nexus assessment
- To provide exposure to practical cases and challenges for implementing WEFE nexus using context-specific and participatory approaches
- To deepen understanding of institutionalizing WEFE nexus
- To provide a future outlook of WEFE nexus as a sustainability agenda from people-centric lenses and Gender Equality, Disability and Social Inclusion (GEDSI) perspectives

LEARNING OUTCOMES: Upon the completion of this course, learners are expected to

- Internalize the nexus concept and apply as a solution in planning and designing natural resources development and management problems
- Develop interdisciplinary programs in a professional career with a focus on broader national goals rather than sector-specific goals
- Develop skills to engage with stakeholders to develop sustainable and participatory practices for WEFE nexus management
- Develop number of demonstrated cases of nexus solutions during professional practice and share in public domain

COURSE CONTENTS

UNIT 1: UNDERSTANDING OF NEXUS (6)

- 1.1 Stress in Natural Resources: Trends in Natural Resources Availability and Demand; Concept of Footprints (water, energy, and carbon footprints); Planetary Boundaries
- 1.2 System Approach: Understanding of a System and System Approach; Need of Integration Across Sectors; Evolution of the Nexus Thinking Approach (limits to growth, sustainability, and nexus)
- 1.3 WEF Nexus: Concept, Principles, and Added Benefits
- 1.4 Entry Points for Inclusion in Nexus Interventions

UNIT 2: SYSTEM INTERACTION (6)

- 2.1 Water-Energy
- 2.2 Water-Food
- 2.3 Food-Energy
- 2.4 Interdependences and Inter-Linkages Across Multiple Systems (e.g., water, energy, food, ecosystem/biodiversity): Tradeoff and Synergies

UNIT 3: ASSESSMENT TOOLS (9)

- 3.1 Assessment Process and Information Flow: Steps, Actors, Location, and Sectors
- 3.2 Various Types of Tools and Data
- 3.3 FAO Rapid Appraisal Tools and WEF Nexus Tool 2.0 (including demonstration of tool)
- 3.4 Scenario Analysis and Practical Challenges: Evaluating Impacts in the Changed Context (institutional changes, climate/environmental/socio-economic changes, policy changes, etc.)

UNIT 4: NEXUS IN PRACTICE (6)

- 4.1 Dissecting Nexused Relationships on Existing Practices: Case Studies Highlighting Different Aspects of Nexus in Practice
- 4.2 Risks and Costs to Different Social Groups
- 4.3 Policy and Institutional Reforms
- 4.4 GEDSI and Indigenous Knowledge

UNIT 5: NEXUS FUTURE PERSPECTIVE (5)

- 5.1 Nexus Governance: Fundamentals of Governance and Nexus Governance; Frameworks for Governance Analysis; Improving Sectoral Governance and for Nexus Gains
- 5.2 Streamlining WEF Nexus as a Common Agenda: Promoting Dialogue (between science, policy, practice/industry, private sector); Nexus Mainstreaming
- 5.3 Addressing Bottlenecks for Implementing Inclusive Solutions for WEF Nexus Gains: Technical/Engineering Solutions; Nature-Based Solutions; Governance Solutions
- 5.4 Monitoring, Evaluation, Accountability and Learning (MEAL) Framework for Maximizing Nexus Gains

PRACTICAL (16)

- **Group assignment:** Divide the participants into different groups, each consisting of 3-5 persons. Ask the participants to identify one practical case that they are engaged with, characterize the WEFE nexus in that case, and then submit an assignment report as well as a presentation in class. There will be more discussions and inputs in the class from the instructor as well as other participants (beyond that particular group) to visualize the practical cases of the WEFE nexus. (4 hrs)
- **Assignment on application of FAO tool and WEFE nexus 2.0:** Based on data provided for a real or hypothetical case study for simulating WEFE nexus 2.0, and demonstration made in Chapter 3, students will prepare and submit a report on analysis of trade-offs and synergies and recommend potential solutions for minimizing tradeoffs and maximizing the synergies. (4 hrs)
- **Field study:** Students will join to 1-2 days field study in nearby areas to select 1-2 cases of different orientations (e.g., water, energy, food, ecosystem) but have nexuses relationships and dissect nexuses relationships in those cases, prepare a report and present in the class as post-field study report. (8 hrs)

Contents	Equipment/ tools	Methodology/methods	Link to Unit(s)
Dip dive nexuses relationship in existing approaches	Reference materials, Analytical thinking	Literature review to understand nexuses relationship Selected a couple of cases of different orientation Think critically to visualize interlinkages (trade-offs and synergies) Identify challenges and opportunities	Unit 1, 2, 4
Visualize nexus governance and explore the potential of WEFE nexus as a future security agenda	Field logistics, Reference materials, Analytical thinking	Field visits, Interaction with related stakeholders, Critical thinking to visualize interlinkages (trade-offs and synergies), and governance Identify the challenges faced and ways they are managed	Unit 5
Perspectives, cross-fertilization, and synthesis	Field data, Critical thinking	Analyses of field visit/data, Perspectives from different cases explored (e.g., management, policy, governance), Synthesis	Unit 1,2,3,4,5

KEY REFERENCES

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**COURSE TITLE: LANDSCAPE MANAGEMENT AND BIODIVERSITY
CONSERVATION**

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final +Internal)
PWM 504	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: This course is designed to develop an understanding of issues on conservation landscape (hereafter referred to as landscape), landscape ecology, and biodiversity conservation. To prepare for careers in landscape and biodiversity conservation, students must attain academic skills and knowledge (both theoretical and technical) related to landscape management and biodiversity conservation. This course will help enrich student's understanding of biodiversity conservation at the landscape level. It enhances students' capacity to identify the prospects and challenges of biodiversity conservation and management in multiple-use landscapes.

OBJECTIVES: The objective of this course are to:

- Familiarize students with key technical terms related to landscape ecology, and biodiversity conservation.
- Enrich students' knowledge on landscape principles, and best conservation practices at landscape levels.
- Increase students' understanding on the causes and consequences of biodiversity loss in human-dominated landscapes.
- Enrich student's knowledge and skill in landscape planning, management, and biodiversity conservation.

LEARNING OUTCOMES: At the end of the course, students will be able

- To understand the basic landscape and biodiversity-related key terminologies
- To explore and understand landscape-level conservation values and challenges
- To learn the theories and principles related to landscape ecology
- In planning and implementation of landscape-level conservation initiatives
- To gain knowledge on biodiversity conservation and management in a human-dominated landscape

COURSE CONTENTS

UNIT 1: INTRODUCTION (6)

1.1 Landscape

1.1.1 Concept of Landscape and Landscape Ecology

1.1.2 Review of the Key Terms: Habitat, Eco-region, Biomes, Biodiversity Hotspots, Biodiversity Cold Spots, Habitat Fragmentation, Edge Effect, Corridors and Connectivity, Upstream-downstream Linkages, Landscape Integrity and Functions

1.1.3 Epistemology of the Landscape

1.1.3.1 The Nature of Landscape (material and conceptual)

1.1.3.2 Role of Landscape (domain, system, Unit)

1.1.3.3 Description of Landscape (ecological and cognitive)

- 1.1.4 Landscape Functions and Dynamics: Linkages with Species and Human Culture (IT/TK)
- 1.2 Biodiversity
 - 1.2.1 Components of Biodiversity (genetic diversity, species diversity, ecosystem diversity, functional diversity)
 - 1.2.2 Species Richness Over Geological Time Scale (rates of species formation, rates of species extinction, current pattern of species richness)
 - 1.2.3 Values and Importance of Biodiversity (consumptive and non-consumptive use values, productive use values)
 - 1.2.4 Patterns of Diversity (variation along climate and environment, variation in topography, geological age, and habitat)
 - 1.2.5 Concept of Climate Change Refugia

UNIT 2: THEORIES AND MODELS IN LANDSCAPE ECOLOGY (6)

- 2.1 Driving Forces for Landscape Approach (international dialogue, conservation debate, innovations)
- 2.2 Landscape Stability Principle and CBD Malawi Principle 1995
- 2.3 Theories Incorporated in Landscape Ecology: Complexity Theory, Information Theory, Cognition and Autopoiesis Theory, Hierarchy Theory, Percolation Theory, Resource Theory
- 2.4 Landscape Ecology Models
 - 2.4.1 Metapopulation Model
 - 2.4.2 Source-sink Model
 - 2.4.3 Island Biogeography Equilibrium

UNIT 3: PRINCIPLES FOR LANDSCAPE CONSERVATION, MANAGEMENT AND DESIGN (10)

- 3.1 Landscape Evaluation (creating and quantifying landscape patterns)
- 3.2 The Cultural (human-dominated) Landscape (interaction between natural and cultural landscapes, fragility of the cultural landscapes, cultural keystone species, landscape indicators, predictive landscape models)
- 3.3 Principles for Landscape Management
- 3.4 Landscape Ecology (landscape principles for natural reserves, disturbance regime, and reserve design indications, inter-refuge corridor design)
- 3.5 Principles of Landscape Classification (structural patch, functional patch, resource patch, habitat patch, corridor patch)
- 3.6 Landscape Level Conservation
- 3.7 Ecosystem Processes on Landscapes
- 3.8 Hierarchical Structure of the System and Biodiversity Conservation
- 3.9 The Landscape-level Species Conservation Approach
- 3.10 Transborder Landscape Conservation Approaches

UNIT 4: BIODIVERSITY CONSERVATION IN HUMAN-DOMINATED LANDSCAPE (4)

- 4.1 Biodiversity Conservation (with examples: in-situ and ex-situ)
- 4.2 Issues of Biodiversity Conservation
- 4.3 Urban Biodiversity Conservation Challenges

- 4.4 Green Infrastructure: Linking Landscape and Community
- 4.5 Roles of Ecosystem Management in Landscape Integrity: Protected Area: Core and Buffer Zone, Habitats Outside PAs, MAB (Man and Biosphere Reserve), Other Effective Area-Based Conservation Measure (OECM)
- 4.6 Importance of Landscape-level Biodiversity for Promoting Ecosystem Services and Local Livelihood in Developing Countries

UNIT 5: LANDSCAPE MANAGEMENT FOR BIODIVERSITY CONSERVATION (6)

- 5.1 Evolution and Practices of Landscape Management Models (global to national)
- 5.2 Conservation Landscapes of Nepal (TAL, CHAL, Kanchenjunga, SHL, and Kailash)
- 5.3 Prospects and Challenges of Landscape Management and Biodiversity Conservation
- 5.4 Land Use Planning and Conservation
- 5.5 Landscape Effects: in Individuals, Populations, and Organisms
- 5.6 Landscape Management Approaches and Strategies
 - 5.6.1 River Basin Approach
 - 5.6.2 North-South and East-West Landscape Approach
- 5.7 Case Studies
 - 5.7.1 Nepalese Model: Landscape (e.g., TAL, CHAL) and Corridor (e.g., Khata Corridor, Barandabhar Corridor)
 - 5.7.2 North American Model: (e.g., Yukon to Yellow stone)
 - 5.7.3 South African Model: (e.g., Great Limpopo Transfrontier Park)

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Measuring biodiversity	Silva compass, measuring tape, crown-densiometer, Abney level	3 days Field Diversity index (Simpson, Shannon Wiener) Observation, FGD,	Unit 1
Designing biodiversity conservation activities in the urban landscape	Reports, related literature	meetings with nearby community, KIS, Literature review, Report writing	Unit 1, 3
Study linkages with species and human culture	Checklist		Unit 1
Review of CBD Malawi Principle 1995	Related literature	Group presentation, report	Unit 2
Study on urban biodiversity challenges and threats ranking	Related literature	Excursion, Observation, Review of literature, Assessment by pairwise ranking, Report writing	Unit 4

KEY REFERENCES

Unit 1, 2, 3

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Unit 5

1. Acharya, K. P., Tripathi, D. M., Joshi, J., & Gurung, U. M. (2011). Leveraging the Landscapes: Conservation beyond the Boundaries. *Kathmandu: Nepal Foresters Association*. (Unit 3, 4 too)

COURSE TITLE: NATURAL RESOURCE MANAGEMENT IN CHANGING ENVIRONMENT

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final + Internal)
SFM 505	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: Changing the environment has jeopardized human-nature interaction, which has created a lose-lose scenario. This course focuses on understanding the changing context, its impacts on natural resources, and their mitigation, adaptation, and management strategies.

OBJECTIVES: The objectives of the course are to:

- To understand the changing context
- To understand key environmental issues and their effects on nature and society
- To assess appropriate strategies for natural resource management in the changing contexts
- To understand the issues in changing contexts in NRM in Nepal

LEARNING OUTCOMES: On completion of this course, students should be able to:

- Understand the changing contexts and its effects on natural resources
- Analyze the natural resource management related issues in the changing contexts,
- Develop a conceptual and practical understanding of strategies for natural resource use and management in the changing environmental conditions
- Apply the learned concepts to a natural resource management problem of particular interest to them.

COURSE CONTENTS

UNIT 1: UNDERSTANDING THE CHANGING CONTEXT (5)

- 1.1 Theoretical context – Change Theory
- 1.2 Global Environmental Changes: Climate Change, Land use and land cover change, Invasive Species
- 1.3 Social Changes- Demographic Shifts, Cultural Transformations, Technological Advancement, Urbanization, Gender Roles and Equality, Environmental Movement
- 1.4 Economic Changes – Technological Transformations, Globalization, Labor Market Change, Financial System, Environmental and Sustainable Practices, Income equality, Global Economic Shift

UNIT 2: EFFECTS OF CHANGING ENVIRONMENT ON NATURAL RESOURCES (7)

- 2.1 Effects on:
 - 2.1.1 Water Resources – Glacier’s Retreat, Precipitation Pattern, Sea Level, Spring, Rivers, Groundwater, Wetlands
 - 2.1.2 Agricultural Resources– Agro-Biodiversity, Cropping Pattern, Pest and Diseases

- 2.1.3 Forest and Biodiversity– Shift in Habitat Ranges, Increased Wildfire, Invasive Alien Species
- 2.1.4 Wildlife
- 2.1.5 Rangelands
- 2.1.6 Landscape
- 2.2 Alteration of Human-Nature Interactions Due to Changing Context

UNIT 3: MITIGATION AND ADAPTATION STRATEGIES (5)

- 3.1 Sustainable Land and Water Management
- 3.2 Biodiversity Conservation and Restoration
- 3.3 Climate Resilient Infrastructure
- 3.4 Traditional Knowledge, Practices, and Technologies
- 3.5 Renewable Energy Transition

UNIT 4: ISSUES IN NRM IN CHANGING CONTEXT IN NEPAL (5)

- 4.1 Shift in Demand for Natural Resources
- 4.2 Land Abandonment
- 4.3 Human-Wildlife Conflict
- 4.4 Governance Conflict
- 4.5 Level of Participation in Natural Resource Management

UNIT 5: MANAGING NATURAL RESOURCES IN CHANGING ENVIRONMENT (10)

- 5.1 Ecological Principles and their Application to Natural Resource Management
- 5.2 Adaptive Management
- 5.3 Forest-Landscape Restoration
- 5.4 Invasive Species Management
- 5.5 Nature Based Solutions
- 5.6 Disturbance-based Ecosystem Management

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Drivers of changing context	Field /Checklist	Prepare a list of drivers and strategies to address them (Group work)	Unit 1, 2
Issues of NRM in Nepal and potential solutions	Literature review	Group / Class presentation	Unit 4
Enlisting mitigation/adaptation/management interventions in own locality	Interview (Telephone), Field observation	Individual - list of interventions	Unit 3, 4, 5

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Unit 2

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Unit 3

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Unit 4

1. Laudari, H. K., Sapkota, L. M., Maraseni, T., Subedi, P., Pariyar, S., Kaini, T. R. & Volkova, L. (2024). Community forestry in a changing context: A perspective from Nepal's mid-hill. *Land Use Policy*, 138, 107018.
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Unit 5

1. Bolte, A., Ammer, C., Löf, M., Nabuurs, G. J., Schall, P., & Spathelf, P. (2009). Adaptive forest management: a prerequisite for sustainable forestry in the face of climate change. *Sustainable forest management in a changing world: a European perspective*, 115-139.
2. von Gadow, K. (2008). *Managing forest ecosystems: the challenge of climate change* (p. 338). F. Bravo, V. LeMay, & R. Jandl (Eds.). New York: Springer.
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4. Thurman, L. L., Gross, J. E., Mengelt, C., Beaver, E. A., Thompson, L. M., Schuurman, G. W. & Olden, J. D. (2022). Applying assessments of adaptive capacity to inform natural-resource management in a changing climate. *Conservation Biology*, 36(2), e13838.
5. Kuuluvainen, T., Angelstam, P., Frelich, L., Jõgiste, K., Koivula, M., Kubota, Y., ... & Macdonald, E. (2021). Natural disturbance-based forest management: Moving beyond retention and continuous-cover forestry. *Frontiers in Forests and Global Change*, 4, 629020.
6. Seddon, N., Chausson, A., Berry, P., Girardin, C. A., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions of the Royal Society B*, 375(1794), 20190120.

SEMESTER II
COURSE TITLE: GEOINFORMATICS FOR NRM

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final + Internal)
WME 551	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course is designed for students having background on the foundation of GIS and Remote Sensing (RS). As the name says “Geoinformatics”, the course contents aim to provide broader understanding on the application of GIS and Remote Sensing in NRM, with particular focus on developing skills on geospatial data extraction, analysis, modelling, management and effective communication for sharing the research widely. The course is based on both the theoretical and lab-based teaching/learning approaches.

OBJECTIVES: The course aims to provide advanced knowledge on applying geospatial technologies and remote sensing in natural resources management with the particular focus on emerging technologies for data analysis and cloud computing. The specific objectives of this course are to make students:

- Understand recent advancements/trends in Geoinformatics including theoretical and practical knowledge on the advanced concepts of RS & GIS in NRM.
- Enhance knowledge and practical skills on geo computation including exploratory data analysis and advanced concepts on spatial statistics.
- Develop a theoretical foundation on geomodelling and practical hands-on modelling related to NRM used cases.
- Provide overview and hands-on on emerging geospatial technologies for NRM like Machine Learning (ML) cloud computing with Google Earth Engine (GEE).

LEARNING OUTCOMES: After the completion of the course, the learners are expected to be able to:

- Develop a project and use advanced GIS/RS techniques for data collection to address specific problems in NRM
- Use geo-computational and statistical knowledge for data cleaning, analysis and management
- Use geospatial techniques for predictive modelling - NRM used cases.
- Use Cloud computing platform for efficient data analysis and visualization

COURSE CONTENTS

UNIT 1: OVERVIEW OF GEOINFORMATICS (6)

- 1.1 Fundamentals of Remote Sensing and GIS
- 1.2 Data to Geoinformation in NRM (data sources and availability, acquisition, interpretation and data quality issues)
- 1.3 RS and GIS Software (open source and commercial)
- 1.4 Recent Advancements/Trends in Geoinformatics

- 1.4.1 Mobile GIS, Drone-Based GIS, Citizen Science in GIS
- 1.4.2 Overview of Google Earth Engine, AI, and ML in NRM

UNIT 2: REMOTE SENSING SATELLITE AND SENSORS (8)

- 2.1 Sensors and Satellites (including orbits)
- 2.2 Scanning Systems
- 2.3 Optical Remote Sensing
- 2.4 Hyperspectral Remote Sensing
- 2.5 Radio Detection and Ranging (RADAR) Remote Sensing
- 2.6 Light Detection and Ranging (LIDAR) Remote Sensing

UNIT 3: GEOCOMPUTATION (6)

- 3.1 Digital Image Processing and Classification
- 3.2 Review Geospatial Interpolation (Kriging, / IDW, etc.)
- 3.3 Geospatial Statistics
- 3.4 Map Algebra and Raster Models Analysis
- 3.5 Terrain and Visibility Analysis

UNIT 4. GEOMODELLING (6)

- 4.1 Database Queries and Geo-Processing
- 4.2 Model Building for Geo-Processing
- 4.3 AHP Modelling
- 4.4 Geo-Visualization (cartographic representation)

UNIT 5. APPLICATION OF GEOSPATIAL TECHNOLOGIES (6)

- 5.1 Resource Assessment and Management.
- 5.2 Risk Assessment (forest fire, landslide)
- 5.3 Suitability Analysis
- 5.4 Analyzing Multi-Temporal Earth Observation Data

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Image acquisition and processing	QGIS, /ArcGIS	Practical: 4hrs Demo and case presentation Student Engagement: 10hrs	Unit 1
Data cleaning and/map algebra and raster models/ surface and visibility analysis	QGIS/ ArcGIS	Practical: 4hrs One demo and other can be case presentation Student Engagement: 6hrs	Unit 3
Data queries/ Analysis and geo-visualization.	QGIS/ArcGIS	Practical: 3hrs one demo and other case presentation Student Engagement: 12hrs	Unit 4
Forest resource inventory and mapping/ indices (e.g., NDVI, NDSI, NDWI calculation)/Suitability/Time-series analysis	Cloud computing/GEE/ QGIS/ ArcGIS	Practical: 5hrs one demo and other case presentation Student Engagement: 20hrs	Unit 5
Project report and presentation		Review and report	

KEY REFERENCES

Unit 1

1. Duckham, M., Goodchild, M. F., & Worboys, M. (2003). Foundations of geographic information science. CRC Press.
2. Liu, J. G., & Mason, P. J. (2016). Image processing and GIS for remote sensing: techniques and applications. John Wiley & Sons.
3. McInerney, D., & Kempeneers, P. (2014). Open source geospatial tools: applications in earth observations. Earth Systems Data and Models, Springer.
4. Ma, X., Mookerjee, M., Hsu, L., & Hills, D. (Eds.). (2023). *Recent Advancement in Geoinformatics and Data Science* (Vol. 558). Geological Society of America.
5. Chuvieco, E. (2020). *Fundamentals of satellite remote sensing: An environmental approach*. CRC press.
6. Bajracharya, B., Thapa, R. B., & Matin, M. A. (2021), Earth observation science and applications for risk reduction and enhanced resilience in Hindu Kush Himalayan Region, Springer Nature, free access

Unit 2

1. Verbyla, D. L. (2022). *Satellite remote sensing of natural resources*. CRC Press.
2. Varshney, P. K., & Arora, M. K. (2004). *Advanced image processing techniques for remotely sensed hyperspectral data*. Springer Science & Business Media.
3. Richards, J. A. (2009). *Remote sensing with imaging radar* (Vol. 1, pp. 172-173). Berlin/Heidelberg, Germany: Springer.
4. Liang, S., & Wang, J. (Eds.). (2019). *Advanced remote sensing: terrestrial information*

extraction and applications. Academic Press.

5. Lu, B., Dao, P. D., Liu, J., He, Y., & Shang, J. (2020). Recent advances of hyperspectral imaging technology and applications in agriculture. *Remote Sensing*, 12(16), 2659.
6. Wang, G., & Weng, Q. (2013). *Remote sensing of natural resources*. CRC Press.
7. Flores-Anderson, A. I., Herndon, K. E., Thapa, R. B., & Cherrington, E. (2019). The SAR handbook: comprehensive methodologies for forest monitoring and biomass estimation (No. MSFC-E-DAA-TN67454).

Unit 3

1. Chun, Y., & Griffith, D. A. (2013). Spatial statistics and geostatistics: theory and applications for geographic information science and technology.
2. Getis, A., Anselin, L., Lea, A., Ferguson, M., & Miller, H. (2004). Spatial analysis and modeling in a GIS environment. In *A research agenda for geographic information science* (pp. 157-196). CRC Press. (Unit 4 too).

Unit 4 and 5

1. McClain, B. P. (2022). Python for Geospatial Data Analysis. " O'Reilly Media, Inc."
2. Crooks, A., Malleon, N., Manley, E., & Heppenstall, A. (2015). Agent-based modeling and geographical information systems. *Geocomputation: A Practical Primer*. SAGE Publications Ltd, Thousand Oaks, CA, 63-77.
3. Pourghasemi, H. R., & Gokceoglu, C. (2019). Spatial modeling in GIS and R for earth and environmental sciences. Elsevier.
4. Wani, A. A., Bali, B. S., Ahmad, S., Nazir, U., & Meraj, G. (2022). Geospatial Modeling in Landslide Hazard Assessment: A Case Study along Bandipora-Srinagar Highway, NW Himalaya, J&K, India. In *Geospatial Modeling for Environmental Management* (pp. 113-125). CRC Press.
5. Wang, L., Yin, D. Z., & Caers, J. (2023). Data science for the geosciences. Cambridge University Press. (Unit 5 too).
6. Moseley, B., & Krischer, L. (2020). Machine learning and artificial intelligence in geosciences. Academic Press. (Unit 5 too).

COURSE TITLE: RESEARCH DESIGN AND SCIENTIFIC WRITING

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final + Internal)
BSH 552	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: The scope of this course is designed to imbue M.Sc. students with a scientific perspective, bridging the gap between overarching methodological principles and the intricacies of systematic inquiry into literature. It equips students with the skills needed to adeptly select and employ a range of research methods and tools for data collection. Through this course, students are equipped with the proficiency to thoughtfully select and deploy a diverse array of research methods and tools, ensuring a holistic approach to data collection. Moreover, the course offers a guided journey through the entire research process. From the initial stages of data collection to the in-depth analysis, students receive hands-on guidance that facilitates a comprehensive comprehension of each step. Furthermore, the course guides them through the entire process, from analysis to effectively articulating and presenting their research findings in their M.Sc. thesis.

OBJECTIVES: The objectives of this course are to:

- Acquire a profound understanding of diverse research types, encompassing their distinctive characteristics and ethical considerations.
- Comprehend both quantitative and qualitative research designs, mastering the art of employing various data collection methods to ensure the generation of high-quality data.
- Cultivate the ability to conduct thorough literature reviews, organizing information systematically to build a solid foundation for research endeavors.
- Hone skills in crafting meticulous and comprehensive research proposals, coupled with the proficiency to eloquently defend them during presentations, showcasing a mastery of the subject matter.
- Develop the capacity to articulate research findings effectively through the composition of clear and concise research reports, thesis documents, and scientific articles.

LEARNING OUTCOMES: Upon course completion, students will adeptly handle the intricacies of research methodology, understanding the critical connection between research questions and theoretical frameworks.

- Gain the capability to independently formulate and develop robust research proposals aligned with overarching research objectives.
- Acquire practical skills in data generation and analysis, utilizing diverse research methods and analytical tools to produce high-quality data and insightful interpretations.
- Navigate the complexities of an M.Sc. thesis, demonstrating proficiency in structuring and integrating research findings within theoretical frameworks.
- Demonstrate adeptness in manuscript composition and effectively communicating research findings with clarity and impact.

COURSE CONTENTS

UNIT 1: RESEARCH CONCEPTS (6)

- 1.1 Definition and Purpose
- 1.2 Research Paradigm (Normative, Explorative, Critical)
- 1.3 Research Types (Qualitative, Quantitative and Mixed)
- 1.4 Conceptual Framework of Research
- 1.5 Research Ethics: Informed Consent, Data Use & Confidentiality, Research Interpretation, Authorship and Publication, Plagiarism)

UNIT 2: RESEARCH DESIGN (10)

- 2.1 Meaning, Concept, Importance
- 2.2 Research Design: Components and Features
- 2.3 Characteristics
- 2.4 Types of Designs
 - 2.4.1 Descriptive
 - 2.4.2 Diagnostic
 - 2.4.3 Experimental and Quasi-experimental
 - 2.4.4 Exploratory Formulative
 - 2.4.5 Case Study
- 2.5 Quantitative Research Design
 - 2.5.1 Definition
 - 2.5.2 Purpose
 - 2.5.3 Analytical Framework
 - 2.5.4 Data Collection Methods (sampling design and methods, survey)
 - 2.5.5 Data Reliability and Validity
 - 2.5.6 Data Analysis Methods (descriptive, inferential and casual analysis)
- 2.6 Qualitative Research Design
 - 2.6.1 Definition
 - 2.6.2 Purpose
 - 2.6.3 Analytical Framework (use of theories)
 - 2.6.4 Data Reliability and Validity
 - 2.6.5 Data Collection Methods (observation, focus group discussion, semi-structured interview, content analysis)

UNIT 3: LITERATURE REVIEW AND ORGANIZATION (4)

- 3.1 Purpose and Types of Review
- 3.2 Review Organization
- 3.3 Citation and Reference Management

UNIT 4: RESEARCH PROPOSAL WRITING (4)

- 4.1 Research Proposal (purpose, components, and format)
- 4.2 Research Subject and Object
- 4.3 Formulating of Research Problem
- 4.4 Defining Research Objectives
- 4.5 Setting Research Hypothesis/Questions (meaning, definitions, nature, functions, importance, kinds, characteristics, formulation and testing)
- 4.6 Research Matrix
- 4.7 Research Site Selection

- 4.8 Respondent Selection
- 4.9 Data Collection Methods
- 4.10 Data Analysis
- 4.11 Work Plan
- 4.12 Budget Estimation

UNIT 5: THESIS WRITING AND PRESENTATION (4)

- 5.1 Purpose and Characteristics of the Good Thesis
- 5.2 Outline of the Thesis /Major Chapters or Sections
- 5.3 Data Analysis and Interpretation
- 5.4 Discussion on Findings (convergence and divergence Analysis)
- 5.5 Establishing a Causal Link Between Objective, Findings, Conclusion and Recommendations
- 5.6 Thesis Presentation: Slide Preparation, Table Graph, etc.

UNIT 6: SCIENTIFIC PAPER WRITING (4)

- 6.1 Step-wise Procedure
- 6.2 Selecting a Journal for Publication/Predatory
- 6.3 Communicating with the Journal Editor/Editorial Board
- 6.4 Peer Review Processes and Responding to Reviewer

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Research Design	Classwork	Group discussion and panel discussion	Unit 1 & 2
Scientific paper writing	4-5 person in a team review and write paper	Review paper/research paper on the contemporary subjects related to their field of study (able to identify knowledge gap, analyses and interpreted study findings).	Unit 3, 6
Research proposal	Literature review	Each student will write, submit and present a research proposal in their area of interest.	Unit 4
Presentation	4-5 person in a team) will prepare and present their research findings	Prepare and present among students on their research findings and solicit comments and suggestions from students and faculties	Unit 3, 5, 6

KEY REFERENCES

Unit 1

1. Kumar, R. (2018). Research methodology: A step-by-step guide for beginners. *Research methodology*, 1-528.
2. Kerlinger, F. N. (1966). Foundations of behavioral research.

3. Mligo, E. S. (2016). *Introduction to research methods and report writing: A practical guide for students and researchers in social sciences and the humanities*. Wipf and Stock Publishers.

Unit 2

1. Bryman, A. (2012). *Social Research Methods*. Oxford University Press, New Delhi.
2. Cohen, L., Lawrence, M., & Morrison, K. (2005). *Research Methods in Education*, 5th edition. Oxford University Press, Oxford.
3. Denscombes, M. (2010). *The Good Research Guide, For Small-Scale Social Research Projects*. Open University Press, Maidenhead, Berkshire, UK.
4. Gregory, J., Miller, S., & Miller S. (2000). *Science in Public: Communication, Culture and Credibility*, Reprint edition. Perseus Book Group, New York.

Unit 3

1. Field, A. (2003). *How to Design and Report Experiments*. Sage Publications, Newbury Park, California.
2. Glass, D. (2006). *Experimental Design for Biologists*. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
3. Holliman, R., Whitelegg, L., Scanlon, E., Smidt, S., & Thomas, J. (2009). *Investigating science communication in the information age: Implications for public engagement and popular media*. Oxford University Press.
4. Singh, Y.K. (2006). *Fundamental of Research Methodology and Statistics*. New International (P) Limited, Publishers, New Delhi.

Unit 4

1. Soraya, M.C. & Cynthia, A.S. (2001). *Proposal Writing*. Sage Publications, Newbury Park, California.
2. Wallinman, N. (2006). *Your Research Project: A Step-by-Step Guide for the First Time Researcher*. Sage Publications, London.

Unit 5

1. Adu, P & Miles D. A. (2024). *Dissertation Research Methods: A Step-by-Step Guide to Writing Up Your Research in the Social Sciences*. Routledge, New York.

Unit 6

1. Thomas, C.G. (2021). *Research Methodology and Scientific Writing* (2nd eds). Springer. <https://link.springer.com/book/10.1007/978-3-030-64865-7>
2. Hoffmann, A.H. (2009). *Scientific Writing and Communication: Papers, Proposals, and Presentations*. Oxford, UK.
3. Mligo, E.S. (2016). *Introduction to Research Methods and Report Writing. A Practical Guide for Students and Researchers in Social Sciences and the Humanities*. Resource Publications, Eugene, Oregon.
4. Day, R. A., & Gastel, B. (2024). *How to write and publish a scientific paper*. Cambridge University Press.

COURSE TITLE: ADVANCED STATISTICS

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
BSH 553	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: The course will increase understanding on general concepts, meaning & use of statistics, and develop basic skills for computing & interpreting social and bio-physical data, and their applications using computer software in applied research. More importantly, the course aims to help M.Sc. students in selecting and use of different regression models in forestry research.

OBJECTIVES: The objectives of this course are to:

- Demonstrate the concepts of descriptive statistical measures, probability distribution and their uses in forestry research.
- Demonstrate basic concepts of hypothesis testing and experimental designs.
- Learn different types of parametric and non-parametric tests and use them in forestry research.
- Understand correlation and regression analysis and apply different types of regression models in forestry research and interpretation of results.
- Understand the concept of factor and discriminant analysis and develop skills for computation.

LEARNING OUTCOMES: Upon the completion of this course students will be able to

- Demonstrate the ability to understand the different types of variables and data
- Understand the appropriate use of statistical analysis
- Develop basic skills for computing & interpreting the data and their applications using computer software in applied forestry research.

COURSE CONTENTS

UNIT 1: INTRODUCTION (4)

Review: Data, Variables and Scale of Measurement, Population and Sample, Central Tendency and Dispersion, Sampling Techniques

UNIT 2: PROBABILITY DISTRIBUTIONS (4)

Review of Binomial, Poisson and Normal Probability Distribution, and their Applications

UNIT 3: ESTIMATION AND TESTING OF HYPOTHESIS (4)

Point estimation, Interval Estimation; t-test, z-test, Non-Parametric Tests: Chi-square Test, Median Test, Mann Whitney u-test, Kruskal Wallis test, Friedman ANOVA, Wilcoxon Sign Rank Tests

UNIT 4: ANALYSIS OF VARIANCE AND EXPERIMENTAL DESIGNS (6)

One-way and two-way ANOVA, Simple and Factorial Designs

UNIT 5: CORRELATION AND REGRESSION ANALYSIS (10)

Correlation Analysis, Ordinary Least Square Regression Models, Regression with Dummy Variables, Probit, Logit, Ordered Logit and Probit, MNL

UNIT 6: MULTIVARIATE ANALYSIS (4)

Principal Component Analysis (PCA), Factor Analysis, Cluster and Discriminant Function Analysis

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Data entry, coding, and editing in statistical software	Computer	Use of the questionnaire/ data	Unit 1
Computation of frequency distribution, diagram, and graphs, descriptive measures and their interpretations	With appropriate software	Using student's own or the given data	Unit 1
Testing of different types of hypotheses: T-tests. F-test etc.	With appropriate software	Using student's own or the given data	Unit 2, 3
Use of different non-parametric tests and their interpretations	With appropriate software	Using student's own or the given data	Unit 3, 4
Linear regression models and testing assumptions: Normality, Multicollinearity	With appropriate software	Using student's own or the given data	Unit 5
heteroscedasticity and auto-correlation; analysis of residuals	With appropriate software	Using student's own or the given data	Unit 5
Fitting of the logit, Probit, ordered logit, multinomial logit regression models and their interpretations	With appropriate software	Using student's own or the given data	Unit 5
Principal component analysis	With appropriate software	Using student's own or the given data	Unit 6

KEY REFERENCES

Unit 1

1. Shrestha, S. & Silwal D.P. (2003). Statistical Methods in Management. Taleju Prakashan, Bhotahity Kathmandu.

Unit 2

1. Gupta, S. C., & Kapoor, V.K. (1994). Fundamentals of Mathematical Statistics, 4th edition. Sultan Chand & Sons; 23, Daryagunj, Delhi.

Unit 3

1. Levine, D. M., & Stephan, D. F. (2009). *Even you can learn statistics: A guide for everyone who has ever been afraid of statistics*. FT Press.
2. Shrestha, S. & Silwal, D.P. (2003). Statistical Methods in Management. Taleju Prakashan, Bhotahity Kathmandu.
3. Triola, M. F., Goodman, W. M., Law, R., & Labute, G. (2004). *Elementary statistics* (p. 794). Boston: Pearson/Addison-Wesley.

Unit 4

1. FAO (1999). A Statistical Manual for Forestry Research. Forestry research support program, for Asia and the Pacific, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok.
2. Nargundkar, R. (2008). Marketing Research: Text and Cases- Third edition. Tata McGraw-Hill Publishing Company Limited, NEW DELHI

Unit 5

1. FAO (1999). A Statistical Manual for Forestry Research. Forestry research support program, for Asia and the Pacific, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok.
2. Levine, D. M., & Stephan, D. F. (2009). *Even you can learn statistics: A guide for everyone who has ever been afraid of statistics*. FT Press
3. Snedecor, G.W., & Cochran, W.G. (1994). Statistical Methods, eighth edition. Iowa State University Press, Ames Iowa.

Unit 6

1. FAO (1999). A Statistical Manual For Forestry Research. Forestry research support program, for Asia and the Pacific, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok.
2. Levine, D. M., & Stephan, D. F. (2009). *Even you can learn statistics: A guide for everyone who has ever been afraid of statistics*. FT Press
3. Nargundkar, R. (2008). Marketing Research: Text and Cases- Third edition. Tata McGraw-Hill Publishing Company Limited, NEW DELHI

COURSE TITLE: NATURAL RESOURCE ECONOMICS

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
SFM 554	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course focuses on the concept of both theoretical and empirical evaluation of natural resources (forests, biodiversity, and water) pertaining to management. It includes subjects related to the time value of money, evaluation of a natural resource management project from an economic perspective, application of different valuation techniques to estimate the non-market benefits obtained from an ecosystem, practice of ecosystem service market, and green economy promotion for strong sustainability. Basically, it aims to capacitate students to analyze the problems and practices prevailing in the natural resource management sector from an economic perspective.

OBJECTIVES: The general objective of this course is to train students to promote economically viable natural resource management. Specific objectives are to:

- Enable students to understand and practice economic evaluation of natural resource management projects
- Enable students to estimate non-market benefits received from ecosystems
- Understand the importance of the ecosystem service market
- Prepare strategies for green economy promotion towards sustainable development

LEARNING OUTCOMES: After the completion of this course, students will be able to

- Understand and analyze the existing problems associated to natural resource management from the economic perspective
- Apply different economic evaluation tools in natural resource management
- Estimate non market benefits of ecosystem services and provide policy feedback for its proper management
- Practice activities for green financing promotion and support for green accounting of natural resource

COURSE CONTENTS

UNIT 1: INCORPORATING ENVIRONMENT INTO THE ECONOMIC SYSTEM (4)

- 1.1 Ecological Economics vs Environmental Economics
- 1.2 Economy-Environment Systems
- 1.3 Modelling Economy-Environment Interactions

UNIT 2: VALUATION OF ECOSYSTEM SERVICES (12)

- 2.1 Concept of Valuing the Ecosystem Services
- 2.2 Valuation Techniques
 - 2.2.1 Direct Market Approach
 - 2.2.1.1 Market Price Method
 - 2.2.1.2 Production Function Approach
 - 2.2.1.3 Cost-based Approach
 - 2.2.2 Non-Market Based Valuation Techniques

- 2.2.2.1 Contingent Valuation
- 2.2.2.2 Travel Cost Method
- 2.2.2.3 Hedonic Price Method

UNIT 3: BENEFIT-COST ANALYSIS (8)

- 3.1 The Foundations of Benefit-Cost Analysis
- 3.2 Steps of Benefit-Cost Analysis
- 3.3 Time Value of Money (Discounting and Compounding, One-time payment, Annual Payment and Perpetual, Periodic Payment and Perpetuity)
- 3.4 Decision Criteria (Net Present Value, Benefit-Cost Ratio, Internal Rate of Return)
- 3.5 Sensitivity Analysis

UNIT 4: ECOSYSTEM SERVICES MARKET (4)

- 4.1 Financing Green and Greening Financing
- 4.2 Payment for Ecosystem Services
- 4.3 Forest Carbon Offset and Market
- 4.4 Biodiversity Offsets

UNIT 5: ENVIRONMENT AND SUSTAINABLE DEVELOPMENT (4)

- 5.1 Concept of Weak and Strong Sustainability
- 5.2 Sustainable accounting (Green accounting): System of National Accounting (SNA) and System of Environmental Economics Accounting (SEEA)

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Natural Resources	Questionnaire, Excel, Data	Contingent Valuation Method	Unit 1, 2
Recreation areas such as protected areas/wetlands	Questionnaire, Excel, Data	Travel Cost Method	Unit 1,2
Evaluation of an environmental project/ Opportunity cost of carbon	Excel, Data	Benefit-cost analysis	Unit 3
Financing solutions	Peer-reviewed papers	Group presentation	Unit 4
SEEA of protected area/ CF	Peer-reviewed papers	Class Room discussion	Unit 5
Nature as an Input	Data, Excel	Production Function Approach	Unit 2

KEY REFERENCES

Unit 1

1. Adger, W. N. (2014). Environmental and ecological economics. In *Environmental science for environmental management* (pp. 93-118). Routledge.
2. Asafu-Adjaye, J. (2005). *Environmental economics for non-economists: techniques and policies for sustainable development*. World Scientific Publishing Company. (Chapter 2)
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Unit 4

1. Brears, R. C. (2022). Financing Nature-Based Solutions. In *Financing Nature-Based Solutions: Exploring Public, Private, and Blended Finance Models and Case Studies* (pp. 29-50). Cham: Springer International Publishing.
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2. Pelenc, J., Ballet, J., & Dedeurwaerdere, T. (2015). Weak sustainability versus strong sustainability. Brief for GSDR United Nations, 1-4.
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4. Dietz, S., & Neumayer, E. (2007). Weak and strong sustainability in the SEEA: Concepts and measurement. *Ecological economics*, 61(4), 617-626.
5. United Nations (2021). *System of Environmental-Economic Accounting— Ecosystem Accounting (SEEA EA)*. White cover publication, pre-edited text subject to official editing. Available at: <https://seea.un.org/ecosystem-accounting>.

COURSE TITLE: LANDSCAPE RESTORATION

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
SFB 552	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course aims to provide the skills and knowledge that would be needed to restore any landscape that has been degraded, damaged or destroyed. The course emphasizes the conservation and rehabilitation of degraded land, encompassing subjects such as landscape degradation, strategies for restoring degraded landscapes, planning and designing restoration projects, relevant policies and commitments concerning landscape restoration, and global and national initiatives in landscape restoration. The course integrates classroom lectures with practical exercises to equip students with the essential knowledge and skills required to apply the fundamental principles and methodologies employed in landscape restoration.

OBJECTIVES: Upon completing the course, students will be able to:

- To understand the historical development of restoration concepts and the role that restoration can serve in the future stewardship of natural resources,
- To learn about land degradation from global and national level
- To describe the causes, impacts, and assessment of land degradation
- To use appropriate methods and tools for designing and conducting ecosystem restoration projects

LEARNING OUTCOMES: Upon completion of this course, the students will be able to

- Explain the concept and role of restoration in conservation of natural resources
- Identify the landscape restoration initiatives at global and national level
- Identify the causes and impacts of land degradation
- Apply the appropriate methods and tools for designing and conducting ecosystem

COURSE CONTENTS

UNIT 1: LANDSCAPE DEGRADATION (8)

- 1.1 Concept of Landscape Degradation
 - 1.1.1 Physical Degradation
 - 1.1.2 Chemical Degradation
 - 1.1.3 Biological Degradation
- 1.2 Causes of Landscape Degradation
 - 1.2.1 Natural Causes (Natural calamities, succession)
 - 1.2.2 Human Induced Causes (Demographic shift, Urbanization, Agriculture intensification, Resource exploitation, War and conflicts, Industrialization/Pollution, Climate change, Lack of management/mis-management)

- 1.3 Impact of Landscape Degradation
 - 1.3.1 Impact on Biodiversity
 - 1.3.2 Impact on Water Resources
 - 1.3.3 Impact on Soil Fertility and Productivity

UNIT 2: RESTORATION OF DEGRADED LANDSCAPE (5)

- 2.1 Concept and Principles of Landscape Restoration
- 2.2 Significance of Landscape Restoration
- 2.3 Approaches of Landscape Restoration
 - 2.3.1 Functional Restoration
 - 2.3.2 Area-based Restoration

UNIT 3: LANDSCAPE RESTORATION PLANNING AND DESIGN (8)

- 3.1 Set Goal and Geographic Focus
- 3.2 Identify and Prioritize Site
- 3.3 Assessment of Landscape Degradation
 - 3.3.1 Direct Field Observation
 - 3.3.2 Landscape Unit Assessment
 - 3.3.3 Parametric Semi-Quantitative Method (computation of indices)
 - 3.3.4 Rating System and Decision Trees
 - 3.3.5 Simulation Modelling
- 3.4 Identify and Prioritize Interventions
- 3.5 Develop Restoration Action Plan
- 3.6 Implement Restoration
- 3.7 Monitor and Evaluate Progress
- 3.8 Incorporating Climate Change Considerations into Restoration Planning
- 3.9 Community Involvement and Social Aspects of Restoration
 - 3.9.1 Local Communities in Restoration
 - 3.9.2 Indigenous Knowledge and Traditional Ecological Practices in Restoration

UNIT 4: POLICIES AND COMMITMENTS SUPPORTING LANDSCAPE RESTORATION (6)

- 4.1 Global Policies and Commitments
- 4.2 National Policies and Frameworks

UNIT 5: LANDSCAPE RESTORATION INITIATIVES AT GLOBAL AND NATIONAL LEVEL (5)

- 5.1 Global Landscape Restoration Initiatives and their Outcomes
- 5.2 National Landscape Restoration Initiatives and their Outcomes
- 5.3 Prospects and Challenges of Landscape Restoration
 - 5.3.1 Landscape Restoration and Sustainable Development Goals
 - 5.3.2 Landscape Restoration and Climate Change Mitigation

PRACTICAL (16)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Causes and process of landscape degradation	Literature review	Review, 300-word synopsis	Unit 2
Assessment of landscape degradation	Field exercise	500-word report	Unit 3, 4
Students will visit nearby appropriate sites for fieldwork to perform a survey and study about the indigenous and traditional ecological practices for ecological/landscape restoration and the challenges faced during restoration.	Excursion	Excursion, 500-word report	Unit 5
National and local policy-level restoration initiatives review	Review	Literature review, 500-word synopsis	Unit 6
Case study of good practices e.g., Wetland restoration (photo evidence-based comparison, relocation of settlements)			

KEY REFERENCES

Unit 1

1. Imeson, A. (2012). *Desertification, land degradation and sustainability*. John Wiley & Sons. (Unit 1)
2. Olsson, L., H. Barbosa, S. Bhadwal, A. Cowie, K. Delusca, D. Flores-Renteria, K. Hermans, E. Jobbagy, W. Kurz, D. Li, D.J. Sonwa, L. Stringer, 2019: Land Degradation. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. <https://doi.org/10.1017/9781009157988.006>

Unit 2

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1. Stocking, M., & Murnaghan, N. (2000). Land degradation–Guidelines for field assessment. *Overseas Development Group, University of East Anglia, Norwich, UK, 120*.

Unit 4

1. IUCN, FAO & UNEP. (2021). The Restoration Initiative: 2020 Year in Review. Rome. <https://doi.org/10.4060/cb6675en>

Unit 5

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SEMESTER III
COURSE TITLE: INTEGRATED WATERSHED MANAGEMENT

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
WME 631	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course describes watersheds in terms of land, water, vegetation, and interaction with humans and reflections in the ecosystem. The course describes watersheds (watershed morphometric characteristics) as natur

al as well as socio-economic settings. It familiarizes the international, regional, national, and local dimensions in areas such as land degradation, climate change, watershed health, national efforts in land resource planning, watershed management, wetland management, water management and policy and plan formulation, and integrated and sustainable land management. Furthermore, it also describes upstream and downstream linkage in watershed management. The multiple benefits of watershed management therefore accrue not only to the agriculture, energy, and water sectors, but also have implications for disaster risk reduction, transportation, and climate change mitigation. It also provides opportunities for students to learn theoretical and practical exercises in watershed analysis, and planning.

OBJECTIVES: The course provides concepts, principles, and approaches, linkages and interactions, and conservation and planning of watershed resources as integrated watershed management. In addition, the course will provide the following specific skills and knowledge to the student

- To delineate watersheds, and analyse and interpret watershed characteristics through practical exercises.
- To analyze watershed degradation and determine watershed conditions regarding emerging issues of climate change and watershed attributes.
- To be familiar with watershed planning and analyse the cause and effect of watershed degradation, and develop integrated watershed management plans
- To determine morphometric parameters (linear and shape) and interpret watershed characteristics with respect to the hydrograph
- To identify problems, causes, and effects, and familiar with Logical framework analysis (LFA) and prepare a project planning matrix

LEARNING OUTCOMES: After the completion of the course the students will be able to

- Identify the cause of effects of watershed degradation and analyze watershed resources.
- Able to prepare integrated watershed management plans to address the watershed management issues in the changing context.

COURSE CONTENTS

UNIT 1: FUNDAMENTALS OF WATERSHED MANAGEMENT (6)

- 1.1 Concepts of Watershed- Watershed as a Hydrological Unit, Watershed as a Natural Resource Management Planning Unit
- 1.2 Water and Watershed – (water tower) Blue Water (water in wetland including groundwater and ice packs), Brown Water (wastewater including treated water), Green Water (soil moisture and water in the plants)
- 1.3 Watershed Characteristics: Climate, Geology, Geomorphology, Soil, Land Use and Land Capability
- 1.4 Concepts of Ethics, Socio-Cultural Aspects, Socio-Economic Aspects and Issues, Gender and Equity
- 1.5 Different Approaches in Watershed Management: Participatory Integrated Approach, Nexus Approach, Ecosystem Perspective, Basin approach and Springshed Management
- 1.6 Upstream-Downstream Linkages and Resource Use

UNIT 2: WATERSHED ASSESSMENT TOOL (6)

- 2.1 Watershed Health and Indicator
-Water, Biodiversity and Habitat, Sustainable Agriculture, Sustainable Infrastructure and Mining, Climate Resilience and Disaster Risk Reduction, Governance and Equity, and Indicators.
- 2.2 DPSIR (Driver-Pressure-State-Impact-Response) Framework
- 2.3 Morphometric Analysis

UNIT 3: LAND USE DYNAMIC AND INTEGRATED LAND MANAGEMENT (4)

- 3.1 Land Use Dynamic and Drivers for Degradation of Watershed Area
- 3.2 Land degradation definitions and processes: Soil degradation, Vegetation and Biodiversity Degradation, and Water Resource Degradation
- 3.3 Churia Conservation Activities and Programme
- 3.4 Wetlands and Lakes in Nepal
- 3.5 Integrated Landscape Management and Sustainable Land Management
- 3.6 Upstream and Downstream Linkages: PES Payment for Watershed services, Equitable Benefits Sharing

UNIT 4: POLICY AND INSTITUTIONAL CONTEXT (6)

- 4.1 Watershed Management Policy Plans Master Plan for the Forestry Sector-Soil Conservation and Watershed Management Sub-Plan, Churia Area Programme Strategy, Chure Terai Madhesh Conservation and Management Master Plan
- 4.2 Watershed Management Policy and Legislations, SCWM Act (1982) and SCWM Regulation (1986) and Provincial Policies
- 4.3 Land Use Policies and Practices in Nepal
- 4.4 Institutional Arrangement and Role and Responsibilities of Federal, Provincial, and Local Government in Watershed Management
- 4.5 United Nations Convention to Combat Desertification (UNCCD) and Land Degradation Neutrality (LDN) Principles and Indicators of Nepal Target Setting Programme

UNIT 5: WATERSHED, AND SUB WATERSHED PLANNING (6)

- 5.1 Integrated Sub-Watershed Planning and Watershed Project Planning
- 5.2 Logical Framework Analysis Approach in Watershed Management Planning, Cause and Effect Analysis and Project Planning Matrix
- 5.3 Watershed Management Planning Tools and Planning Process Based on Land Capability, Land Suitability, and Degree of Degradation
- 5.4 River System Integrated Resource Management Plan

UNIT 6: CHALLENGES IN WATERSHED MANAGEMENT (4)

- 6.1 Emerging Issues and Challenges in Urban Watershed Management
- 6.2 Hydropower Watershed Management
- 6.3 GEDSI (Gender Equality, Disability and Social Inclusion)
- 6.4 Climate Change Impact and Adaptation Measures
- 6.5 Transboundary River

PRACTICAL (16)

Learning objectives

- To understand watershed and interpret characteristics
- To familiarize problem-solving techniques (Vulnerability Assessment) and prepare a planning matrix
- To be able to prepare the IWM plan

Fieldwork: Field study nearby watershed area (Field report and plan)

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Determination of morphometric parameters and interpretation of watershed	WS area map, tape, DEM/contour-field	Manual, GIS	Unit 2
Watershed Core issue identification, analysis of causes and effects, and linkages (LFA) and DPSIR	Meta cards, flip chart, pen	Brainstorming in group	Unit 5, 6
Prepare IWM Plan	WS area map, tape, DEM/contour-field	Manual, GIS	Unit 6

KEY REFERENCES

Unit 1

1. Brooks, K.N., Folliott, P.F. & Magner, J.A. (2012). Hydrology and the Management of Watersheds. John Wiley and Sons, New York.
2. Upadhya, M. (2009). Ponds & Landslides: Water culture, food systems and the political economy of soil conservation in mid-hill Nepal, Nepal Water Conservation Foundation (NWCF), Kathmandu (Section 3).
3. Sthapit K. M. (2022). Land Degradation Mapping Guideline for Nepal (Revised), handout prepared for the training on Sub-watershed Management Planning 22-28 September 2019 Pokhara for Hariyo Ban Program,

4. Singh, W.R., Barman, S., & Tirkey, G. (2021). Morphometric analysis and watershed prioritization in relation to soil erosion in Dudhnai Watershed. *Applied Water Science*, 11:151
5. Dixon, J.A., & Easter, K.W. (1991). Integrated watershed management: an approach to resource management. *Watershed resource management: Studies from Asia and the Pacific*: 3-15 (Chapter 1).
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1. Brooks, K.N., Ffolliott, P.F. & Magner, J.A. (2012). *Hydrology and the Management of Watersheds*. John Wiley and Sons, New York.
2. Department of Forests and Soil Conservation (2020). A report on Preparation of Criteria and Indicators of Critical Watershed, Critical Watershed Management Section
3. Government of Nepal and USAID (2016-2021). USAID PAANI PROGRAM, MIDDLE KARNALI WATERSHED HEALTH REPORT
4. Upadhya, M. (2009). Ponds & Landslides: Water culture, food systems and the political economy of soil conservation in mid-hill Nepal, Nepal Water Conservation Foundation (NWCF), Kathmandu (Section 3).
5. International Water Management Institute (2012). *Climate Change and Vulnerability Mapping in Watersheds in Middle and High Mountains of Nepal*, ADB/DSCWM

Unit 3

1. Government of Nepal, Land Resource Mapping Project (1986). *Land use, Land Systems, Land capability Reports and Maps*.
2. MOFE (2013). National wetland policy. <https://www.mofe.gov.np/uploads/documents/wetland-policy-2069-final1526466553pdf-9358-745-1658747595.pdf>
3. MoFE (2018). *National Ramsar Strategy and Action Plan, Nepal (2018-2024)*. Ministry of Forests and Environment, Singha Durbar, Kathmandu, Nepal
4. NLCDC (2021). *Inventory of Lakes in Nepal (Main Report)*. National Lake Conservation Development Committee (NLCDC)/Ministry of Forests and Environment/Government of Nepal. Kathmandu. Nepal. pp 145.

Unit 4

1. Government of Nepal, Ministry of Forests and Soil Conservation (2016) *Forestry sector Strategy (2016-2025)* <https://www.mofe.gov.np/uploads/documents/forestry-sector-strategy-2016-20251526466721pdf-7869-771-1658747252.pdf>
2. Government of Nepal, Ministry of Forests and Soil Conservation (2008). *Churia Area Programme Strategy*. Kathmandu: In collaboration with CARE-Nepal, IUCN-Nepal and WWF-Nepal, <https://www.archnet.org/publications/8828>

Unit 5

1. Brooks, K.N., Folliott, P.F. & Magner, J.A. (2012). Hydrology and the Management of Watersheds. John Wiley and Sons, New York.
2. Department of Forests and Soil Conservation (2020). A report on Preparation of Criteria and Indicators of Critical Watershed, Critical Watershed Management Section
3. Dixon, J.A. & Easter, K.W. (1991). Integrated watershed management: an approach to resource management. *Watershed resource management: Studies from Asia and the Pacific*: 3-15 (Chapter 1).
4. FAO (2006). The new generation of watershed management programmes and projects, Forestry Paper 150, ISBN 92-5-105551-3, <https://www.fao.org/3/a0644e/a0644e.pdf>
5. Government of Nepal, Department of Soil Conservation and Watershed Management, (2017). Inventory of Rivers by Local Units of Nepal
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8. DSCWM (2016). Sub-watershed Management Planning Guideline. Department of Soil Conservation and Watershed Management, Kathmandu, Nepal
9. PCTMCD. (2015). *President Chure Terai Madesh Conservation Development Board Bakaiya River system Integrated Resource Management Plan*

Unit 6

1. MoFE. (2021). Vulnerability and Risk Assessment and Identifying Adaptation Options in the Forest, Biodiversity and Watershed Management in Nepal. Ministry of Forests and Environment, Government of Nepal. Kathmandu, Nepal. <https://www.mofe.gov.np/uploads/documents/forest-biodiv-watshed-mgmtvra-20211633697969pdf-0572-555-1658827523.pdf>
2. Herman, B. (2000). Integrated water management: emerging issues and challenges, *Agricultural Water Management*, Volume 45, Issue 3, Pages 217-228, ISSN 0378-3774, [https://doi.org/10.1016/S0378-3774\(00\)00092-5](https://doi.org/10.1016/S0378-3774(00)00092-5).
3. Kumar, M. D. (2014). The Challenge of Sustainable Urban Water Management in Developing Economies, *Thirsty Cities: How Indian Cities Can Meet their Water Needs* (Delhi, 2014; online edn, Oxford Academic, 20 Nov. 2014), <https://doi.org/10.1093/acprof:oso/9780198099550.003.0003>

COURSE TITLE: WATERSHED MODELING

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
WME 632	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: The course starts with an introductory chapter dealing with the hydrological cycle and watershed balance components. The reliable prediction of the various hydrological parameters becomes tedious and time-consuming with conventional methods. So, this course mainly focuses on hydrological modeling and its developments. Five units are devoted to basic knowledge of modeling components in watersheds. The first two units are devoted to understanding the atmospheric and basic components of water balance. The third unit describes how surface runoff measures and statistical distribution are fitted to the environment. And the last three units designate different types of watershed models to determine and analyze the effect of land use, climatic conditions, and soil characteristics on hydrology. However, all these models vary significantly in their analysis of parameters, input and output flexibility, scale accountability, processing ability, computational efficiency, and capability of modeling the changes in catchments.

OBJECTIVES: This course aims for the following learning objectives:

- To enhance the knowledge and skills of learners in quantifying components of the water cycle and integrate them into their profession.
- Provide exposure to practical cases and challenges for implementing watershed models.
- Become used to the fundamentals and latest thinking on modelling various aspects of the hydrological cycle in watersheds.

LEARNING OUTCOMES: Upon the completion of this course, learners are expected to:

- Recognize the necessity of need and uses of hydrological components in natural resources management.
- Apply watershed models to solve related issues in natural resource management.

COURSE CONTENTS

UNIT 1: INTRODUCTION (4)

- 1.1 Role of Watershed on Hydrological Cycle
- 1.2 Cryosphere and its Components
- 1.3 River System of Nepal
- 1.4 Climate Change and Hydrology

UNIT 2: WATER BALANCE COMPONENT (6)

- 1.1 Water Budget Equations
- 1.2 Average Precipitations Measurements
- 1.3 Estimation of Missing Rainfall
- 1.4 Canopy/Forest Floor Interception and Measurements
- 1.5 Evaporation Measurement in Field
- 1.6 Transpiration and its Measurement
- 1.7 Groundwater Flow and its Recharge

- 1.7.1 Occurrence and Movement of Groundwater (arid and semi-arid regions)
- 1.7.2 Infiltration, Percolation, and Capillary Action at Wetting Front

UNIT 3: RUNOFF AND HYDROGRAPH (8)

- 3.1 Stream Flow Measurement Methods
 - 3.1.1 Area Velocity
 - 3.1.2 Spring Shed Measurement
- 3.2 Hydrograph
 - 3.2.1 Unit Hydrograph
 - 3.2.2 Base Flow Separation
 - 3.2.3 Flood Hydrograph
- 3.3 Prediction in Ungauged Basins
 - 3.3.1 Empirical Formulas (MIP, HYDEST, and WECS/DHM)
- 3.4 Stochastic Hydrology
 - 3.4.1 Frequency Analysis, Return Period
 - 3.4.2 Gumbel Distribution,
 - 3.4.3 Log Normal Distribution,
 - 3.4.4 Log Pearson Distribution

UNIT 4: WATERSHED MODEL (4)

- 4.1 Physical and Systems Approaches in Modelling Components of Water Cycle
- 4.2 The Basic Principle of Model Selection
- 4.3 Classification of Mathematical Catchment Model
 - 4.3.1 Linear Versus Nonlinear Models
 - 4.3.2 Time-Invariant Versus Time-Variant Models
 - 4.3.3 Lumped Versus Distributed Models
 - 4.3.4 Continuous Versus Discrete Models
 - 4.3.5 Analytical Versus Numerical Model
 - 4.3.6 Event Driven Versus Continuous-Process Models
- 4.4 Calibration, Validation and Sensitivity of Models

UNIT 5: SEMI DISTRIBUTED CATCHMENT MODEL (HEC-HMS) (5)

- 5.1 Description of Model
- 5.2 Stream Network Model Development
- 5.3 Rainfall Runoff Simulation
 - 5.3.1 Precipitation
 - 5.3.2 Interception/Infiltration
 - 5.3.3 Unit Hydrograph
 - 5.3.4 Baseflow
 - 5.3.5 Flood Routing
 - 5.3.6 Parameter Calibration

UNIT 6: INTRODUCTION TO DISTRIBUTED MODEL (SWAT MODEL) (5)

- 2.1 Description of Model
- 2.2 Watershed Configurations
- 2.3 Model Preparation and Input
 - 2.3.1 DEM, LULC, Soil, Precipitation, Humidity, Temperature, Wind Speed, Solar Radiation

2.4 Model Simulation

PRACTICAL (16)

Based on the theoretical part and current context of watershed modelling in Nepal, the following three hands-on real-life applications need to be carried out as practical exercises as part of the course.

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Application of SWAT Model to various watersheds of Nepal (6 hr)	Monthly and daily climatic data of related stations. Observed daily/ monthly discharge of the corresponding date.	Perform calibration, validation, and sensitivity analysis of the parameters of the models and prepare a report.	Unit 3
Application of the HEC-HMS model to various watersheds of Nepal (6 hr)	Daily climatic data of related stations. Observed daily discharge of the corresponding date. LULC data of watershed	Perform calibration, validation, and sensitivity analysis of the parameters of the models and ‘what if?’ analysis. Prepare a report.	Unit 5
Springshed And River flow measurement (4 hr)	Stopwatch container, Spring box method, Weir Method (rectangular/V-notch), Area Velocity method OR Dilution method	Field Practical	

KEY REFERENCES

Unit 1, 2, 3

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2. Ven Te Chow, David Maidment and Larry Mays. Applied Hydrology. McGraw Hill.

Unit 4

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Unit 5

2. V. Klemes 1986. Operational testing of hydrological simulation models. Hydrological Sciences Journal, 31,1,3/1986.

Unit 6, 7

1. Hydrologic Engineering Centre, US Army Corps. HEC-HMS User and Reference Manuals
2. S.L. Neitsch et al. 2002. Soil and Water Assessment Tools User’s Manual. Grassland, Soil & Water Research Laboratory, Temple, Texas GSWRL Report 02-02.

COURSE TITLE: WATER INDUCED DISASTER AND MANAGEMENT

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
WME 633	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: The course provides a comprehensive understanding of water-induced disasters, their causes, impacts and management strategies. With the completion of this course, the students will be able to explore various types of water-induced disasters and examine the different options of disaster management.

OBJECTIVES: The overall objective of this course is to give a comprehensive understanding of water-induced disasters and equip them with the knowledge and skills necessary to effectively manage and mitigate water-induced disasters. The specific objectives are as follows:

- Understand the different types of water-induced disasters, their causes, and the environmental and societal impacts
- Analyze the interaction of hydrological, geological, and environmental factors in water-induced disasters
- Examine the role of community preparedness, response, and recovery in disaster management.
- Develop a holistic perspective on water-induced disasters and their management, considering environmental sustainability, social justice, and global interconnectedness.

LEARNING OUTCOMES: Upon the completion of this course, the students will be able to:

- Understand the different types of water-induced disasters
- Analyze the cause and mechanisms of water-induced disasters to evaluate risk and vulnerability
- Develop risk reduction strategies using scientific principles as well as community engagement.
- In-depth knowledge about disaster management through case study

UNIT 1: INTRODUCTION (4)

- 1.1 Introduction of Disaster and Water-Induced Disaster
- 1.2 Types of Water-Induced Disasters (Flood, Landslide/debris flow, Glacial Lake Outburst Flood, Drought)
- 1.3 Multi-Hazard and Cascading Effects
- 1.4 Climate Change Impact on Water-Induced Disasters
- 1.5 Future Climate Projections and Water-Induced Disaster Scenarios
- 1.6 Understanding of Hydrological Cycles and Distribution of Water-Induced Disasters in the Nepal Himalaya

UNIT 2: WATER-INDUCED DISASTER (8)

- 2.1 Glacial Lake Outburst Flood (GLOF)

- 2.1.1 Glacial Features and Process for the Formation of Glacial-Dammed Lakes
- 2.1.2 Good Practices in GLOF, Decreasing the Water Level of Glacier, Installation of Automatic Weather Station
- 2.2 Landslide/Debris Flow
 - 2.2.1 Definition of Mass Movement, Description of Landslide Features, and Classification of Landslide
 - 2.2.2 Landslide/Debris Flow Occurrences in the Different Geological and Geomorphological Sub-Divisions of the Nepal Himalayas
- 2.3 Flood
 - 2.3.1 Types of Floods and its Mechanism
 - 2.3.2 Causes and Impacts of Flood
- 2.4 Drought
 - 2.4.1 Types of Droughts and its Mechanism
 - 2.4.2 Causes and Impacts of Flood

UNIT 3: RISK ASSESSMENT (10)

- 3.1 Methods of Vulnerability and Social Risk Assessment of Water Induced Disaster
- 3.2 GLOF Assessment
- 3.3 Landslide/Debris Flow Assessment
- 3.4 Flood Assessment
- 3.5 Drought Assessment

UNIT 4: DISASTER MITIGATION, MANAGEMENT, AND ECOSYSTEM RESILIENCE (6)

- 4.1 Multiple Principles of Community-Based Disaster Management and its Practice in Nepal
- 4.2 Early Warning Systems: GLOF, Landslide, Flood, Drought
- 4.3 Mitigation and Management: GLOF, Landslide, Flood, Drought
- 4.4 Nature-Based Disaster Management Practices i.e., Wetland, Mangrove, Riparian Vegetation, Low Impact Development Disaster, Sponge City Program
- 4.5 Good Practices for Building the Climate Resilience of Watersheds in the Mountain Region
- 4.6 Building Ex-Ante Resilience of Disaster-Affected Region
- 4.7 Trans-Boundary Water-Related Disaster Management, Institutions and Practices
- 4.8 Regional and Global Agreements on Disaster Risk Reduction

UNIT 5. POLICY AND GOVERNANCE (4)

- 5.1 International Policies and Risk Governance Frameworks for Water-Induced Disaster Management e.g., Sendai framework
- 5.2 Local Governance in Disaster Risk Reduction

PRACTICAL (16)

Learning Objectives: The objective of the practical is to provide practical tools and techniques to understand the causes, mechanisms and mitigative measures of water-induced disaster and management.

Fieldwork: Field study of typical water-induced disaster in the Nepal Himalaya

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Risk assessment: GLOF/Landslide/flood/ drought (any of these disaster)	GIS and Remote sensing, Field	Analysis	Unit 3
Case study: GLOF/Landslide/flood/drought	Literature	Analysis	Unit 4

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Unit 4

1. Shrestha, M. S., Gurung, D. R., Bajracharya, A., & Parajuli, B. (2022). Landslide dam outburst in Myagdi, Nepal: early warning and preparedness key to minimizing disaster. *Impact of Climate Change, Land Use and Land Cover, and Socio-economic Dynamics on Landslides*, 65-81 https://doi.org/10.1007/978-981-16-7314-6_3
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Unit 5

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2. United Nations. Economic Commission for Europe. (2018). Words into action guidelines implementation guide for addressing water-related disasters and transboundary cooperation: integrating disaster risk management with water management and climate change adaptation: in support of the Sendai framework for disaster risk reduction 2015-2030.
3. Gencer, E. A. (2017). Local government powers for disaster risk reduction: A study on local-level authority and capacity for resilience. UN Office for Dis. Risk Red., Center for Urban Dis. Risk Red. & Resilience.

COURSE TITLE: WATERSHED ENGINEERING

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
WME 634	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: Watershed Engineering describes and covers the causes and processes of various form of water induced erosion including slope failures. Fluvial processes such as channel flow, sediment discharge and river channel behavior are also covered in this course. Watershed assessment, themes, and methods are also part of the course. Various structures and techniques (Civil Engineering and Bioengineering) are integral part of the course.

OBJECTIVES: The main objectives of the course are to:

- Understand the concept about the process and mechanism of erosion.
- Able to measure runoff, fluid, and sediment discharge.
- Understand the application of models to estimate the amount of soil erosion using models.
- Insight of various erosion/ sediment management techniques.

LEARNING OUTCOMES: After the completion of the course, the students will be able to:

- Explain erosion and slope failure processes.
- Describe the fluvial process including flooding and sedimentation.
- Compute velocity and discharge of open channel.
- Elaborate watershed assessment process and results.
- Illustrate various methods of erosion control and sediment management structures.

UNIT 1: EROSION AND SLOPE FAILURE (6)

- 1.1 Cause and mechanism of soil erosion
 - 1.1.1 Splash, Sheet, and Rill Erosion and Gullies (raindrop, rainfall intensity, rainfall duration, antecedent moisture condition, soil characteristics, etc.)
 - 1.1.2 Infiltration, Infiltration Capacity (measurement and estimation infiltration capacity)
 - 1.1.3 Prediction of Soil Erosion- Universal Soil Loss Equation with Modifications
- 1.2 Cause and Mechanism of Slope Failure
 - 1.2.1 Causes- Surface water, Ground Water, Weathering, Undercutting, Addition of Weight
 - 1.2.2 Mechanism- Slides, Liquefaction, Plane Failure, Disintegration, Differential Weathering
 - 1.2.3 Forms of Slides- Planner Sliding or Transitional Landslide, Shear Failure or Rotational Landslide, Debris Flow

UNIT 2: FLUVIAL PROCESS- FLOOD AND SEDIMENTATION (5)

- 2.1 Fluid Flow in Channel
- 2.2 Discharge and Velocity of Flow in Open Channel- Manning Formula
- 2.3 Variations of Velocity and Turbulence Across a Channel

- 2.4 Sediment Transport
- 2.5 Sediment Discharge (estimation of sediment discharge)
- 2.6 Sediment Deposition
- 2.7 Forms of Alluvial Channel- Straight, Meandering, Anastomosing, Braided

UNIT 3: EOLIAN PROCESSES (2)

- 3.1 Eolian Erosion (deflation, transportation, and deposition)
- 3.2 Ripples and Dunes

UNIT 4: WATERSHED ASSESSMENT (5)

- 4.1 Bio-Physical Assessment
 - 4.1.1 Geology and Geomorphology
 - 4.1.2 Slope Instability Susceptibility
 - 4.1.3 Flood Susceptibility
 - 4.1.4 Drainage System
 - 4.1.5 Biodiversity
 - 4.1.6 Climate and Climate Change
 - 4.1.7 Degraded Land
- 4.2 Climate- Precipitation and Temperature
- 4.3 Land Use and Land Cover
- 4.4 Socioeconomic Assessment
 - 4.4.1 Human Settlement and Population
 - 4.4.2 Livestock Population and Livestock Farming Practices
- 4.5 Human Settlement and Population
- 4.6 Livestock Population and Livestock Farming Practices
- 4.7 Water use Infrastructures- Existing, Planned, Potential

UNIT 5: EROSION CONTROL AND SEDIMENT MANAGEMENT STRUCTURES (6)

- 5.1 Determination of Runoff and Channel Capacity
 - 5.1.1 Designed Runoff Rates – Rational method
- 5.2 Components and Functions of Structures
 - 5.2.1 Check Dam – Live check dam, Earthen Dam, Loose Stone Check Dam, Gabion Check Dam, Masonry Check Dam
 - 5.2.2 Spurs
 - 5.2.3 Embankment
 - 5.2.4 Waterways/drainage
 - 5.2.5 Contour Trench, Contour Bunds
 - 5.2.6 Weirs
 - 5.2.7 Terraces
 - 5.2.8 Ponds- Cascaded Pond
 - 5.2.9 Settling Basin
 - 5.2.10 Dredging
 - 5.2.11 Shelterbelt

UNIT 6: BIOENGINEERING (8)

- 6.1 Introduction to Bioengineering- Scope and Limitations
- 6.2 Engineering Functions and Hydrological Effects of Vegetation
- 6.3 Site Investigation for Bioengineering Works

- 6.4 Compatibility of Civil Engineering and Bioengineering Structures
- 6.5 Combining Civil Engineering and Bioengineering Structures
- 6.6 Species Selection for Bioengineering
- 6.7 Maintenance of Bioengineering Structures

PRACTICAL (16)

Learning objectives: The excursion provides exposure for assessing various soil and water conservation structures. Similarly, field exercise provides hands-on experience in computing velocity and discharge of open channels.

Excursion (4): Students will be taken to a nearby site to show soil/water conservation measures. Information sheet about the site focusing on types of measures will be prepared and distributed before heading to the field. Students are required to prepare and submit field reports in a prescribed format by the instructor.

Exercise (12): Exercises on field measurement and drawing cross sections of natural channel, watershed area estimation. Calculation of velocity and discharge of the channel.

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Velocity and discharge of open channel	Notebook, tape, level (slope measurement),	Field measurement, calculation, and report writing	Unit 2.2
Observation of Soil and water conservation measures	Notebook, measuring tape, camera	Field Excursion and report writing	Unit 4.2
Monitoring/Estimation of soil erosion	ArcGIS	RUSLE	

KEY REFERENCES

Unit 1

1. Selby, M. J. (1985). *Earth's changing surface: an introduction to geomorphology. (No Title).*
2. Schwab, G. O., Richard, K. F., Edminster, T. K., & Barnes, K. K. (1981). *Soil and Water Engineering*, John Wiley & Sons, New York, Third Edition, ISBN 0-471-03078-3.

Unit 2

1. Selby, M. J. (1985). *Earth's changing surface: an introduction to geomorphology. (No Title).*
2. Schwab, G. O., Richard, K. F., Edminster, T. K., & Barnes, K. K. (1981). *Soil and Water Engineering*, John Wiley & Sons, New York, Third Edition, ISBN 0-471-03078-3.
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Unit 3

1. Selby, M. J. (1985). *Earth's changing surface: an introduction to geomorphology. (No Title).*

Unit 4

1. Mahnot, S.C. (2014). *Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi*
2. DeBarry, P. A. (2004). *Watersheds: processes, assessment, and management. (No Title).*

Unit 5

1. Department of Soil Conservation and Watershed Management, the Natural Resource Management Sector Assistance Programme (NARMSAP), Soil Conservation and Watershed Management Component (2005). *Training Hands out on Bioengineering and Survey, Design and Estimation of Soil Conservation Activities. First Edition.*
2. Sthapit, K. M. (2017). *Teaching Material On Soil and Water Conservation Engineering Bachelor in Science Institute of Forestry, Pokhara*
3. PCTMCD. (2018). *President Chure-Tarai Madhesh Conservation and Management Master Plan; President Chure-Tarai Madhesh ConservationDevelopment Board: Lalitpur, Nepal.*

Unit 6

1. Howell, J. (1999). *Roadside bio-engineering.* His Majesty's Government of Nepal, Department of Roads.
2. Department of Soil Conservation and Watershed Management, the Natural Resource Management Sector Assistance Programme (NARMSAP), Soil Conservation and Watershed Management Component (2005). *Training Hands out on Bioengineering and Survey, Design and Estimation of Soil Conservation Activities. First Edition.*
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COURSE TITLE: WATER RESOURCE MANAGEMENT

Course Code	Credit	Lecture Hours (Theory + Practical)	Total Marks (External/final + Internal)
WME 635	3	48 (32+16)	75 (45+30)

Note: 1 credit= 16 lecture hours

SCOPE: This course covers the overall management aspects of water resources – starting from the global scenario of water availability, potential conflicts from mismanagement of water resources (local, provincial, national, and international), policies related to water management, tools of national and international cooperation in transboundary water management, productive uses of water resources (hydropower, irrigation), and sustainable uses of water in the context of global climate change. Without going into the depths of technical design aspects, this course deals with the interdisciplinary management of water resources (legal, institutional, environmental, and economic).

OBJECTIVES: The general objective of the course is to enable the students to develop a comprehensive understanding of water resources management, and analyze and propose solutions to pertinent issues related to water resources. The following are the specific objectives of this course.

- Identify and analyze the challenges associated with water resources.
- Understand the legal, regulatory, and policy frameworks governing water resources at local, national, and international levels, examining their implications on water management.
- Explore techniques, technologies, and best practices for water conservation, including efficient irrigation methods, recycling, and sustainable water use in agriculture, industry, and households.
- Engage in problem-solving and case studies to propose and evaluate practical solutions for water resource management, considering real-world complexities and interdisciplinary approaches.

LEARNING OUTCOMES: After completion of the course, the students are expected to have the following skills.

- Analyze and explain the legal, regulatory, and policy frameworks governing water resources at local, national, and international levels.
- Identify and evaluate the challenges associated with water resources, including scarcity, and pollution.
- Demonstrate the ability to assess and propose sustainable water use practices in various sectors, such as agriculture, industry, and urban settings, considering efficiency and conservation.
- Comprehend the challenges and solutions in managing transboundary water resources, including conflict resolution, cooperation, and the significance of international treaties and diplomacy.
- Theoretical knowledge to real-world situations, engaging in problem-solving and case studies to propose practical, sustainable solutions for managing water resources.

COURSE CONTENTS

UNIT 1: GLOBAL CONTEXT OF WATER RESOURCES (4)

- 1.1 Water Distribution, Hydrological Cycle, and its Components
- 1.2 The Global Water Crisis: Availability, Need and Demand, Water in Ancient Civilization (Mesopotamia, Egypt, Indus Valley Civilization)
- 1.3 Importance of Water in Various Sectors – Domestic, Agriculture, Hydropower, Industrial, Recreational, Environmental (aquatic environment)
- 1.4 Overview of Current Global Water Challenges – Urbanization, Pollution, and Water Scarcity Climate Change; Importance and Significance of Effective Water Management in Modern Society
- 1.5 Water Resources in Nepal

UNIT 2: WATER AND CULTURE (4)

- 2.1 Significance of Water in Cultural Contexts; Historical Perspectives on Water's Cultural Importance
- 2.2 Water in Indigenous Culture, Traditional Methods of Water Management in Different Countries, the Cultural Significance of Water in Defining Societal Roles, Water and its Connection to Cultural Identity
- 2.3 Modern Articulations of Water and Culture – Contemporary Expressions of Water in Art, Music, and Popular Culture, Water-Related Activities and Cultural Movements, Initiatives to Preserve Water-Related Cultural Heritage.

UNIT 3: WATER USE AND MANAGEMENT (6)

- 3.1 Urban Water Management – Challenge and Solutions, Smart Technologies in Urban Water Management, Drinking Water – Water Treatment and Distribution Process
- 3.2 Agricultural Water Management – Challenges, Irrigation Techniques and Practices,
- 3.3 Industrial water management – industrial water requirements and water usage, water Treatment in Industries, Best Practices for Industrial Water Management
- 3.4 Water Use in Energy Production – Water's Role in Energy Production, Water Use in Various Energy Generation Processes
- 3.5 Groundwater Use and Management
- 3.6 Community-Based Water Resource Management e.g., Water User Association, Farmer's Managed Irrigation System
- 3.7 Innovation and Future Trends in Water Management

UNIT 4: HUMAN INTERFERENCES IN THE WATER RESOURCE SYSTEM (4)

- 4.1 Human Attitude and Activities Towards Water Resources Systems
- 4.2 Water Pollution and Quality: Type and Causes of Water Pollution, Impacts on Water Quality and Ecosystems,
- 4.3 Climate Change and Water Systems
- 4.4. Social and Economic Implications on Water Systems: Gender Equality and Social Inclusions and Social Equity and Access to Clean Water

UNIT 5: WATER GOVERNANCE AND INSTITUTIONS (6)

- 5.1 Water Governance and its Structures, Key Concepts and Theories in Water Governance, Historical Evolution of Water Governance

- 5.2 Interplay Between Federal, State and Local Entities in Water Governance
- 5.3 Water Governance and Institutional Challenges – Analysis of Challenges in Water Governance, Legal and Institutional Complexities in Water Resources Management

UNIT 6: INTERNATIONAL WATER LAWS, POLICIES AND TREATIES (8)

- 6.1 Overview of International Water Laws, Principles and Sources of International Water Law, Transboundary Water Issues and Agreement (cooperative frameworks), Cases – International Water Disputes
- 6.2 Water Treaties in Nepal – Overview of International Water Treaties and their Significance, Analysis of Major Transboundary Water Treaties, Successes and Challenges in Implementing Transboundary Water Agreements, Implication of Diplomacy and International Cooperation. Compliance Mechanisms and Monitoring in Water Agreements
- 6.3 National Water Policies and Legal Frameworks- National Water Laws and Regulations, Implementation and Challenges in Enforcing Water Policies (Water Resources Act, Water Resources Strategy, National Water Plan, Water Resources Policy)
- 6.4 Water Rights and Allocation – Analysis of Water Rights Systems, Challenges in Equitable Water Allocation, Indigenous Water Rights and their Legal Implications
- 6.5 Water rights and allocation – Analysis of water rights systems, challenges in equitable water allocation, indigenous water rights and their legal implications

PRACTICAL (16)

Field Excursion: Students will be taken to a nearby hydropower or an irrigation project site or water treatment plant to demonstrate different water resources management methods adopted for the smooth operation of the project. This will also include interaction with the water user groups, water users, and other relevant stakeholders to get insight on the management of water resources.

Students will be taken to traditional water sources within the valley to get familiarized with the ancient water supply system and its management (e.g., potential water systems nearby are the Alko Hiti system, Chyaasaa Hiti system, rainwater harvesting systems, and spring) where they can interact with the old people on the ancient construction and management of the water systems. The students work in group and conduct a small survey in and around the water system with the primary objective of gathering information in regard to water and the cultural and religious significance of the systems.

Contents	Equipment/tools	Methodology/methods	Link to Unit (s)
Case study report: nearby hydropower or an irrigation project site or water treatment plant or ancient water supply system (e.g., potential water systems nearby are the Alko Hiti system, Chyaasaa Hiti system, rainwater harvesting systems)	Fieldwork, Literature review, and presentation	Analysis	Unit 1, 2, 3, 4
National and International Water Sector Policies and Guidelines	Literature review	Report	Unit 5, 6

KEY REFERENCES

Unit 1

1. Anisfeld, S.C. (2015). *Water Resources*. Island Press, ISBN -10: 1-59726-494-6
2. Biswas, A. K., Tortajada, C., & Izquierdo, R. (Eds.). (2009). *Water Management in 2020 and Beyond*. Springer.
3. Eslamian, S., Barua, P., & Eslamian, F. (Eds.). (2022). *Water Scarcity: Global Perspectives, issues and Challenges*. doi:<https://doi.org/10.52305/TAUM8926>
4. Grigg, N.S. (1996). *Water Resources Management: Principles, Regulations and Cases*. McGraw-Hill Engineering.
5. Lükenga, W. (2015). *Water Resources Management*, ISBN 978-87-403-0978-2

Unit 2

1. Amatya, S. (2006). *Water and Culture*. Kahmandu: Jalsrot Vikas Sanstha.
2. Stang, V. (2015). *Water: Nature and Culture*. Earth Series (Reaktion Books).
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Unit 3

1. Filho, W.L. & Sumer, V. (2015). *Sustainable Water use and Management: Examples of New Approaches and perspectives*. Springer.
2. Chen, D. H. (2016). *Sustainable Water Management*. CRC Press.
3. Molden, D. (2013). *Water for food water for life: A comprehensive assessment of water management in agriculture*. Routledge.

Unit 4

1. Zhou, T., Haddeland, I., Nijssen, B., & Lettenmaier, D. P. (2016). Human-induced changes in the global water cycle. *Terrestrial water cycle and climate change: Natural and human-induced impacts*, 55-69.
2. Abbott, B. W., Bishop, K., Zarnetske, J. P., Minaudo, C., Chapin III, F. S., Krause, S., ... & Pinay, G. (2019). Human domination of the global water cycle absent from depictions and perceptions. *Nature Geoscience*, 12(7), 533-540.

Unit 5

1. Pahl-Wostl, C. (2015). *Water governance in the face of global change*. Switzerland: Springer.
2. Pahl-Wostle, C., & Gupta, J. (Eds.). (2022). *Water Governance - Concept, Methods and Practics* (Vol. Book series).

Unit 6

1. Sharma, L., Gupta, N. & Basnayake, S. (2021), Water Sector Policies and Guidelines of Nepal: Review Report. Bangkok: ADPC, https://www.adpc.net/igo/category/ID1811/doc/2022-otj7NA-ADPC-Water_Sector_Policies_and_Guidelines_of_Nepal.pdf
2. Upadhyay, S. N. (2012). International watercourses law and a perspective on Nepal-India cooperation. (*No Title*).
3. WECS. (2002). Water Resources Strategy Nepal
4. WECS. (2005). National Water Plan-Nepal <https://faolex.fao.org/docs/pdf/nep158194.pdf>

COURSE TITLE: NATURAL RESOURCE PROFESSIONAL ETHICS (OPTIONAL)

Course Code	Credit	Lecture Hours (Theory +Practical)	Total Marks (External/final + Internal)
SFM 606	3	48 (32+16)	75 (45+30)

Note: 1 Credit= 16 Lecture Hours

SCOPE: This course focuses on the ethical aspects of the delivery of professional services in the field of natural resource management. It emphasizes the importance of conducting one's work in a just, fair, and ethically responsible manner, especially when balancing the demands of resource conservation and the fulfillment of legitimate human needs. The course offers valuable guidance on how to navigate these complex ethical dilemmas and make decisions that align with a strong moral and environmental compass. Students will gain the knowledge and skills necessary to address these issues in a professional and responsible manner, ensuring sustainable management of natural resources for the benefit of current and future generations.

OBJECTIVES: Upon completion of the course, students will have acquired a deep understanding of professional ethics in natural resource management and developed the ability to apply ethical principles to real-world challenges in this field, leading to responsible and sustainable resource management practices. The specific objectives are:

- Students will demonstrate a comprehensive knowledge of historical and contemporary ethical frameworks in the management of natural resources, allowing them to recognize ethical dilemmas and principles in this context.
- Students will develop problem-solving skills to address practical ethical challenges through case analysis, discussions, and group work within a professional setting.
- Students will cultivate a personal commitment to ethical conduct and develop a code of professional behavior consistent with the principles of professional ethics in the management of natural resources.

LEARNING OUTCOMES

- **Ethical competence:** Graduates will have a strong ethical foundation and deep understanding of professional ethics in natural resource management, enabling them to navigate complex ethical challenges in their careers.
- **Problem-solving:** Graduates will demonstrate the ability to effectively address practical ethical dilemmas within the field of natural resource management, employing analytical skills and critical thinking to develop sound ethical solutions.
- **Personal ethical commitment:** Graduates will cultivate a personal code of professional conduct consistent with the principles of professional ethics in natural resource management, reflecting a commitment to ethical behavior in their careers.

COURSE CONTENTS

UNIT 1: INTRODUCTION (4)

- 1.1 Define Ethics, Areas of Ethics (meta, normative, and applied), Norms and Values.
- 1.2 Applied Ethics Approaches (utilitarianism, deontological, virtue) and Major Subfields.

- 1.3 Profession, Professionalism, Professional Ethics, and Professional Practice.
- 1.4 Developing Professional Ethical Reflections on Natural Resource Management.

UNIT 2: NATURE AND ETHICS (8)

- 2.1 Rights of Trees and Nature, Animal Rights and Welfare.
- 2.2 Definition, Types, Principles and Importance of Environmental Ethics in Nature Conservation and Protection.
- 2.3 Anthropocentrism vs. Ecocentrism Views on Nature.
- 2.4 Environmental Justice: Concept of Justice and Fairness, Distributional Inequality and Environmental Injustice, Interlinkage Between Environmental Ethics, Social Justice and Sustainable Resource Management.

UNIT 3: PROFESSIONAL ETHICS (8)

- 3.1 Loyalty to Employer, Responsibility and Duty, Confidentiality and Proprietary Information, Occupational Safety and Ethics, Digital and Cyber Ethics Including the Use of Robotics and Artificial Intelligence (AI)
- 3.2 Public Duties: Moral Obligations of Government Servants, NGOs, INGOs and Other Public Institutions, Professional Consulting and Advertising
- 3.3 Conflicts of Interest in Decision Making: Recognizing and Resolving Conflicts of Interest in Professional Judgments in Natural Resources Management
- 3.4 Program Operation and Activities: Institutional Ethical Board/Committee, Code of Conduct, Program Activity Plans and Inclusiveness, Prior Informed Consent, Request for Permission

UNIT 4: ETHICAL DECISION-MAKING METHODS AND TOOLS (6)

- 4.1 Methods: Situation Analysis, Moral Reasoning, Practical Reasoning, Precautionary Principle
- 4.2 Tools: Ethics Codes and Professional Standards; Compliance with Laws, Regulations and Standards; Code of Conduct; and Ethical Checklists
- 4.3 Audits: Social Audit, Social Media Audit

UNIT 5: ETHICAL ISSUES AND DILEMMAS (6)

- 5.1 Ethical Issues: Corruption, Lack of Transparency, Prioritizing Private Interests Over Public Good, and Influence of Special Interests and Politics on Policies
- 5.2 Ethical Dilemmas: Balance Economic Interests with Conservation, Managing Competing Demands on Land Resources, Weighing Single vs. Multiple Values in Forests, and Conflicts between Short-term and Long-term Goals

PRACTICAL (16)

At least two practical tasks (1 individual and 1 group work) must be performed, and the instructor of the course should organize a workshop in which students present their individual assignments.

- **Ethical reflection paper (Individual):** This assignment encourages students to engage in individual ethical reflection on a specific interest, aligning their personal ethical values with the course's ethical principles.

- **Role-play scenario (Group):** Through this group assignment, students will investigate ethical dilemmas within various environmental philosophies, allowing them to apply ethical principles in a practical context.
- **Conflict resolution (Individual):** By providing students with a real case of conflict of interest in resource management, this assignment assesses their ability to recognize and manage conflicts of interest in a professional context.
- **Situation analysis (Group):** Student groups engage in situation analysis by examining real-world case studies with ethical dilemmas. This promotes their practical skills in ethical decision-making.
- **Professional ethics workshop (Individual/Group):** Student groups organize and conduct a workshop on professional ethics in natural resource management, providing an opportunity for them to demonstrate and share their understanding of the course's ethical principles and their practical application by presenting their ethical reflection paper.

Contents	Equipment/tools	Methodology/methods	Link to Unit(s)
Ethical reflection paper (individual)	A case for a student	Review of the literature	Unit 1, 2, 3, 4, 5
Role-play scenario (group)	Ethical dilemmas and environmental philosophy	Assign student groups a role-play scenario on an ethical dilemma using environmental philosophy	Unit 2
Conflict resolution (individual)	Cases of conflict of interest, one per student	Provide real cases of conflict of interest in resource management and guide students in solving it	Unit 3
Situation Analysis (Group)	Ethical dilemmas in decision-making in resource conservation	Provide student groups with real-world case studies that involve ethical dilemmas in decision-making	Unit 4
Professional ethics workshop	Space for workshops, audiovisual aids	The teacher/students organize an in-house presentation workshop on professional ethics in natural resource management, and students present their individual assignment	Unit 1, 2, 3, 4, 5

KEY REFERENCES

Unit 1

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2. Jamieson, D. (2008). Ethics and the environment: an introduction. Cambridge University Press. United Kingdom. www.cambridge.org/9780521864213. [Chapter 1]
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4. T. Airaksinen. (2012). Professional Ethics: Ruth Chadwick, Encyclopedia of Applied

Ethics (Second Edition), Academic Press, Pages 616-623. ISBN 9780123739322.
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Unit 2

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3. Mohai, P., Pellow, D. & Roberts, J.T. (2009). Environmental justice. *Annual Review of Environment and Resources*, 34, pp.405-430. <https://doi.org/10.1146/annurev-environ-082508-094348>
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Unit 3

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2. Kelly, T.M. (2018). Professional ethics: a trust-based approach. Lexington Books, London. [Chapter 3, 6]
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Unit 4

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2. Lee, W. N. (2022). This is environmental ethics: an introduction. John Wiley and Sons Ltd. United Kingdom. [Chapter 1]
3. Hale, B., Light, A., & Lawhon L. A. (2023). The Routledge Companion to Environmental Ethics. Taylor and Francis, New York and London. [Chapter 58]

Unit 5

1. Jamieson, D. (2008). Ethics and the environment: an introduction. Cambridge University Press. United Kingdom. www.cambridge.org/9780521864213 [Chapter 6]
2. Meyers, C. (2018). The professional ethics toolkit. John Wiley and Sons Ltd. United Kingdom. [Chapter 9]
3. Hale, B., Light, A., & Lawhon L. A. (2023). The Routledge Companion to Environmental Ethics. Taylor and Francis, New York and London. [Chapter 54-56]

SEMESTER IV

Proposal
Pre-defense
Dissertation
Manuscript of Research Work

