

CORE PAPER IV

LAND AND SOIL CONSERVATION AND MANAGEMENT

Introduction: This paper introduces students to the fundamentals of land and soil degradation. Each unit covers a range of topics, which will help students develop basic understanding of properties of soil and how the quality of land and soil degrades due to anthropogenic activities.

UNIT 1: Fundamentals of soil science

Land as a resource, ecological and economic importance of soil; Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity; soil taxonomy maps.

UNIT 2: Soil degradation - causes

Types and causes of soil degradation; Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, impact soil degradation on agriculture and food security; industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil nutrients.

UNIT 3: Land use changes and land degradation

Land resources: types and evaluation; biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors; drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.

UNIT 4: Land degradation and its control

Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries Sustainable land use planning; role of databases and data analysis in land use planning control and management; land tenure and land policy; legal, institutional and sociological factors; integrating land degradation assessment into conservation.

Practicals: Based on the theory/fieldwork.

Text Books:

- Brady, N.C. & Well, R.R. 2007. *The Nature and Properties of Soils* (13th edition), Pearson Education Inc.

Reference Books:

- Gadgil, M. 1993. Biodiversity and India's degraded lands. *Ambio* **22**: 167-172.
- Johnson, D.L. 2006. *Land Degradation* (2nd edition). Rowman & Littlefield Publishers.
- Marsh, W. M. & Dozier, J. 1983. *Landscape Planning: Environmental Applications*. John Wiley and Sons.
- Oldeman, L. R. 1994. The global extent of soil degradation. *Soil resilience and sustainable land use*, 9. (http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf).
- Pandit, M.K. et. al. 2007. Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. *Biodiversity Conservation* **16**: 153-163.
- Pandit, M.K. & Kumar, V. 2013. Land use and conservation challenges in Himalaya: Past, present and future. In: Sodhi, N.S., Gibson, L. & Raven, P.H. *Conservation Biology: Voices from the Tropics*. pp. 123-133. Wiley-Blackwell, Oxford, UK ([file:///Users/mkpandit/Downloads/Raven%20et%20al.%202013.%20CB%20Voices%20from%20Tropics%20\(2\).pdf](file:///Users/mkpandit/Downloads/Raven%20et%20al.%202013.%20CB%20Voices%20from%20Tropics%20(2).pdf)) .
- Peterson, G. D., Cumming, G. S. & Carpenter, S. R. 2003. Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* **17**: 358-366.
- Scherr, S. J. 1999. *Soil degradation: A threat to developing-country food security by 2020?* (Vol. 27). International Food Policy Research Institute.

CORE PAPER VI

ENVIRONMENTAL BIOTECHNOLOGY

Introduction: This paper presents an objective view of the application of biotechnological know-hows in tackling environmental problems. It starts with basic knowledge about molecular biology and later links to application-based processes and techniques.

UNIT 1: Structure and Function of DNA, RNA and Protein

DNA: structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation and renaturation kinetics; biological significance of different forms; Synthesis. RNA: structural forms and their characteristics. Protein: hierarchical structure, types of amino acids; posttranslational modifications and their significance; synthesis; types and their role: structural, functional (enzymes). Central dogma of biology; genetic material prokaryotes, viruses, eukaryotes and organelles; mobile DNA; chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin).

UNIT 2: Recombinant DNA Technology

Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes; nucleic acid microarrays, R-DNA technology in environmental management.

UNIT 3: Ecological restoration and bioremediation

Wastewater treatment: anaerobic, aerobic process, methaneogenesis, treatment schemes for waste water: dairy, distillery, tannery, sugar, antibiotic industries; solid waste treatment: sources and management (composting, vermiculture and methane production, landfill, hazardous waste treatment). Specific bioremediation technologies: land farming, biopiles, composting, bioventing, biosparging, pump and treat method, phytoremediation; remediation of degraded ecosystems; advantages and disadvantages; degradation of xenobiotics in environment, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.

UNIT 4: Ecologically safe products and processes

PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction, use of bioreactors for bioremediation.

Practicals: Based on the theory.

Text Books:

- Evans, G.G. & Furlong, J. 2010. *Environmental Biotechnology: Theory and Application* (2nd edition). Wiley-Blackwell Publications.
- Scagg, A.H. 2005. *Environmental Biotechnology*. Oxford University Press.

Reference Books:

- Jordening, H.J. & Winter J. 2005. *Environmental Biotechnology: Concepts and Applications*. John Wiley & Sons.
- Lodish, H.F., Baltimore, D., Berk, A. Zipursky, S.L. Matsudaira, P. & Darnell, J. 1995. *Molecular Cell Biology*. W.H. Freeman.
- Nelson, D.L. & Cox, M.M. 2013. *Lehninger's Principles of Biochemistry*. W.H. Freeman.
- Rittman, B.E. & McCarty, P.L. 2001. *Environmental Biotechnology. Principles and Applications*. McGraw-Hill, New York.
- Snustad, D.P. & Simmons, M.J. 2011. *Principles of Genetics* (6th edition). John Wiley & Sons.
- Wainwright, M. 1999. *An Introduction to Environmental Biotechnology*, Springer.