தமிழ்நாடு மத்தியப் பல்கலைக்கழகம்

CENTRAL UNIVERSITY OF TAMIL NADU

तमिलनाडु केन्द्रीय विश्वविद्यालय

ESTABLISHED BY AN ACT OF PARLIAMENT IN 2009

Ph.D. GEOGRAPHY PROGRAMME

CURRICULUM STRUCTURE

(from the Academic Year 2026-27 onwards)

Department of Geography

School of Earth Sciences

Central University of Tamil Nadu

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Ph.D. PROGRAMME OUTCOMES

On completion of the programme, students will be able to:

PO1	Identifying, interpreting, and analysing geographic problems and processes.
PO2	Formulating a research methodology and executing formal research projects independently and ethically.
PO3	Defending and communicating facts, ideas and research findings via written, oral, graphical and quantitative outlets.
PO4	Contribute knowledge of geography in response to issues in their specialized area.

PROGRAMME SPECIFIC OUTCOMES

PSO1	To develop original thinking in the field of geography and geospatial sciences
PSO2	To carry out independent research of high quality in their specialized area.
PSO3	To evaluate and suggest optimal measures to solve multi-dimension geographic problems through geospatial techniques.
PSO4	To able to communicate research findings in various forums at national and international level.

Ph.D. Geography Programme

COURSE WORK STRUCTURE

(from the academic year 2026-27 onwards)

Sl. No	COURSES			ASSESSMENT	
	Code	Title	Credits	CIA	ESE
1	GEO3011	Research Methodology	4	40	60
2	GEO3012	Geographic Data Analytics	4	40	60
3	GEO3013	Research and Publication Ethics	2	40	60
4	**	Any One from the List of Specialized Courses	4	40	60
Total			**14**	**400**	

**LIST OF SPECIALIZED COURSES

Course Code	Course Name
GEO3014	Applied Geomorphology
GEO3015	Climate Change and Adaptation
GEO3016	Spatial Decision Support System
GEO3017	Urban Sustainability
GEO3018	Wetland Management
GEO3019	Spatial Epidemiology

Research scholar may also prefer for other specialized course in consultation with the supervisor. In such case, based on the field of interest of the candidate and recent research trends in the field, concerned research supervisor will prepare a syllabus and get approval from the members of the BoS by circulation, before the commencement of the course work.

Credits: 4 Course Code: GEO3011

RESEARCH METHODOLOGY

Learning Outcomes

After completion of this course, the research scholar will able to

1. *understand the scientific way of conducting geographical research*
2. *identify appropriate research designs and methodologies for different research questions*
3. *formulate clear, concise, and testable research questions and demonstrate rigor, and integrity in the research process*
4. *organize and present research findings in written formats*

Unit – I

Research Basics

Fundamental research concepts - Scientific approach to geography – Epistemological frameworks - Concept of scale in geography

Unit – II

Literature Review

Importance of literature review - Types of Reviews: narrative, systematic, scoping, and meta-analytic reviews - Categorizing Literature: Thematic, chronological, methodological grouping - Academic search strategies: keyword planning, Boolean search techniques - Defining a research gap

Unit – III

Research Design

Formulating research problem, objectives, hypotheses and questions – Basic principles in research design - Experimental and non-experimental research designs - Sampling design

Unit – IV

Data Generation

Methods of data collection - Data collection in geography - Geospatial data collection for geographical research - Reliability and validity of data

Unit – V

Research Reporting

Structure and components of scientific reports – Structuring a research proposal - Scientific Communication

Internal Assessment Weightage

- Literature review paper (25%)
- Presentation on selected methodology (25%)
- Research proposal (50%)

REFERENCES:

1. Daniel M., Paul S. (2013) An Introduction to Scientific Research Methods in Geography and Environmental Studies, SAGE Publications Ltd.
2. Basil Gomez, John Paul J. (2010) Research Methods in Geography - A Critical Introduction, John Wiley & Sons Ltd.
3. Nicholas C., Meghan C., Thomas G, Shaun F. (2016) Key Methods in Geography, SAGE Publications Ltd.
4. Ranjit Kumar (2014) Research Methodology - A Step-by-Step Guide for Beginners, SAGE Publications Ltd.

Mapping of Program Outcomes with Course Outcomes:

	PO1	PO2	PO3	PO4
CO1	x			
CO2	x	x		
CO3		x	x	
CO4			x	x

Credits: 4 Course Code: GEO3012

GEOGRAPHIC DATA ANALYTICS

Learning Outcomes

After completion of this course, the research scholar will able to

1. *appreciate various spatial and statistical methods in analyzing geographical data including machine learning techniques*
2. *demonstrate advanced spatial statistical methods, techniques and software packages*
3. *conduct spatial modeling and predictive analytics for environmental and social applications*
4. *visualize and communicate geographic data insights effectively*

Unit –I

Foundations

Principles of Statistics - Use and Abuse of Statistics - Statistical Methods for Geography - Descriptive and Inferential Statistics: Confidence Intervals, Hypothesis Testing and Sampling - Data Quality, Uncertainty, and Ethics in Spatial Analytics

Unit –II

Spatial Statistics

Analysis of Variance - Correlation - Regression Analysis - Data Reduction: Factor Analysis and Cluster Analysis - Spatial Patterns - Geostatistics: Variograms, Kriging, Interpolation methods - Spatial Autocorrelation

Unit –III

Spatial Interaction Analysis

Gravity and Potential Models - Network Analysis - Location-Allocation Models - Trend Surface Analysis - Geodemographic Analysis - Spatial Interaction Models - Spatio-Temporal Analysis

Unit – IV

Machine Learning in Geographic Analytics

Regression models for spatial data - Decision trees, random forests, and gradient boosting - Neural networks for geospatial applications - Spatial deep learning - Geo AI

Unit – V

Visualization and Communication

Advanced cartography and thematic mapping - Cloud-based geospatial platforms (Google Earth Engine, Sentinel Hub, GitHub) - Interactive dashboards and story maps - Spatial Decision Support System

REFERENCES:

1. Rogerson, P.A. (2014) Statistical Methods for Geography - A Student's Guide, SAGE Publications Ltd
2. Harris R. (2016) Quantitative Geography - The Basics, SAGE Publications Ltd
3. Jacek Malczewski (1999) GIS and Multicriteria Decision analysis, John Wiley & Sons, Inc, New York.
4. Ningchuan Xiao (2015) GIS Algorithms, SAGE Publications Ltd
5. Chris B., Alex S. (2015) Geocomputation - A Practical Primer, SAGE Publications Ltd
6. Minshull, R. (1975) Introduction to Models in Geography, Longman.
7. Najma Khan, (1998): Quantitative Methods in Geographical Research, Concept Publishing Company, New Delhi.
8. David W. Allen, (2011). GIS Tutorial 2: Spatial Analysis Workbook for ArcGIS10, ESRI Press, Red Lands, USA.
9. Andy Mitchell, (1999). GIS Analysis - Volume 1: Geographic Patterns and Relationships, ESRI Press, Red Lands, USA.
10. Andy Mitchell, (2009). GIS Analysis - Volume 2: Spatial Measurements and Statistics, ESRI Press, Red Lands, USA.
11. Abler, R., Adams, J. S., and Gould, P., (1971). Spatial organization: The geographer's view of the World, Englewood Cliffs, N.J., Prentice-Hall. Englewood Cliffs.
12. Tsung Chang Kang, (2002). Introduction to Geographic Information Systems, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Mapping of Program Outcomes with Course Outcomes:

	PO1	**PO2**	**PO3**	**PO4**
CO1	x	x		
CO2	x	x	x	
CO3			x	x

Credits: 2 Course Code: GEO3013

RESEARCH AND PUBLICATION ETHICS

Learning Outcomes

After completion of this course, the research scholar will able to

1. *understand the basics of philosophy of science and ethics, research integrity, and publication ethics*
2. *identify research misconduct and predatory publications*
3. *demonstrate indexing and citation databases, open access publications, research metrics (citations, h-index, impact factor, etc.) and plagiarism tools*

Unit – I

Philosophy and Ethics

Introduction to Philosophy: definition, nature and scope, concept, branches - Ethics: Definition, moral philosophy, nature of moral judgments and reactions.

Unit – II

Scientific Conduct

Ethics with respect to science and research - Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP) - Redundant publications - Selective reporting and misrepresentation of data

Unit – III

Publication Ethics

Publication ethics - Best practices/standards setting initiatives and guidelines - Conflicts of interest - Publication misconduct - Violation of publication ethics - Identification of publication misconduct - Predatory publishers and journals

Unit – IV

Open Access Publishing

Open access publications and initiatives - Software tool to identify predatory publications - Journal finder/journal suggestion tools (JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.)

Unit – V

Databases and Research Metrics

Indexing databases - Citation databases: Web of Science, Scopus - Reference management software: Mendeley, Zotero - Anti-plagiarism software: Turnitin - Research Metrics - Impact factor of journal: Journal Citation Report, SNIP, SJR, IPP, CiteScore Metrics: h-index, g-index, i-10 index

REFERENCES

1. Alexander Bird (2006). Philosophy of Science. Routledge
2. Resnik DB (2005). The Ethics of Science–An Introduction. Taylor & Francis-elibrary
3. INSA, Ethics in Science Education, Research and Governance. https://www.insaindia.res.in/pdf/Ethics_Book.pdf
4. Chaddah, P. (2019). Ethics in Competitive Research: Do not get scooped, do not get plagiarized. https://www.researchgate.net/publication/331470963_Ethics_in_Competitive_Research_Do_not_get_scooped_do_not_get_plagiarized
5. David B. Resnik (2020). What Is Ethics in Research & Why Is It Important? https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm
6. Jeffrey Beall (2012). Predatory publishers are corrupting open access. Nature, 489, 179. https://www.nature.com/news/predatory-publishers-are-corrupting-open-access-1.11385

Mapping of Program Outcomes with Course Outcomes:

	PO1	PO2	PO3	PO4
CO1		x	x	
CO2		x	x	
CO3			x	x

Credits: 4 Course Code: GEO3014

APPLIED GEOMORPHOLOGY

Learning Outcomes

After completion of this course, the research scholar will able to

1. *Understand the fluvial and coastal processes and landforms*
2. *Apply advanced methods and techniques in analysis of sediments and environmental geochemistry*
3. *Assess the human impacts on fluvial and coastal environment*
4. *Create a research design to assess geomorphic dynamics for landscape and environmental management*

Unit 1 - Fluvial dynamics

- River system, base level and cycle of erosion
- Dynamic equilibrium, isostatic adjustment and rejuvenation
- Sediment transport dynamics in rivers
- Role of lithology, tectonics and climate in transience of fluvial landscapes

Unit 2 - Coastal geomorphology

- Coastal processes: destructional and constructional
- Delta: types, morphology and dynamics
- Estuaries: formation, types, estuarine circulation and mixing
- Coastal sediments: textural parameters, magnetic susceptibility and geochemistry

Unit 3 - Environmental geochemistry

- Fundamental principles of geochemistry
- Trace elements in water and sediment samples
- Metal pollution in the natural environment
- Isotope geochemistry

Unit 4 – Field and lab techniques for applied geomorphology

- Field methods for identification and mapping of geomorphic features
- Tools and techniques for surface, river bed and subsurface/core sediments
- Lab protocols for granulometry and geochemistry analysis
- Construction of graphs/charts for characterization and discrimination of water and sediment samples

Unit 5 – Advanced instrumentation for applied geomorphology

- Instruments for sediment characterization (FTIR, AAS, ICPMS, ICPOES, QICPMS, XRF, XRD)
- Principles and applications of Raman Spectroscopy, SEM, and EDS.
- Dating techniques: Relative, absolute, palaeomagnetic
- Proxies to understand climate and sea level changes

REFERENCES:

1. Allen R.L. John. (1977). Physical Processes of Sedimentation: An Introduction. Allen and Unwin.
2. Davidson-Arnott R, Bauer B, Houser C. (2019). Introduction to Coastal Processes and Geomorphology. 2nd ed. Cambridge University Press.
3. Goudie AS, Viles HA. (2016). Geomorphology in the Anthropocene. Cambridge University Press.
4. Gupta, Avijith. (2011). Tropical Geomorphology. Cambridge University Press.
5. Michael A. Summerfield. (1991). Global Geomorphology – An introduction to study of landforms. Pearson Education Limited.
6. Rhoads, L. Bruce. (2020). River Dynamics-Geomorphology to Support Management. Cambridge University Press.
7. Thornbury, D. William. (1954). Principles of Geomorphology (1958). John Wiley & Sons, lnc.
8. Thornton, Lain. (1983). Applied Environmental Geochemistry. Academic Press.

Mapping of Program Outcomes with Course Outcomes:

	PO1	PO2	PO3	PO4
CO1	x			
CO2	x	x		
CO3		x	x	x
CO4			x	x

Credits: 4 Course Code: GEO3015

CLIMATE CHANGE AND ADAPTATION

Learning Outcomes

After completion of this course, the research scholar will be able to

1. *critically evaluate the scientific basis, impacts, and uncertainties of climate change.*
2. *analyse climate vulnerability, resilience, and adaptation using interdisciplinary and geospatial approaches.*
3. *assess adaptation policies, governance frameworks, and emerging research in climate change.*
4. *formulate independent research proposals integrating advanced tools and evidence-based adaptation strategies.*

Unit – I: Climate Change: Scientific Basis

Climate system and Earth energy balance – Climate variability and anthropogenic climate change – Greenhouse gases and radiative forcing – Climate feedbacks and tipping points – Climate models, RCPs and SSPs – Uncertainty in climate projections.

Unit – II: Climate Change Impacts and Vulnerability

Impacts on natural and human systems – Climate extremes and disaster risk – Vulnerability, exposure, adaptive capacity and resilience – Climate justice and indigenous knowledge – Methods of climate vulnerability and resilience assessment.

Unit – III: Climate Change Adaptation

Theories and approaches to adaptation – Ecosystem-based Adaptation (EbA), Nature-based Solutions (NbS) and Community-Based Adaptation (CBA) – Adaptation pathways and transformational adaptation – Mainstreaming adaptation into development planning – Monitoring and evaluation of adaptation.

Unit – IV: Tools and Techniques for Adaptation Research

Climate data and observational networks – Climate modelling and downscaling – GIS, Remote Sensing and geospatial analytics – Climate risk and vulnerability mapping – AI, Machine Learning and decision-support systems in adaptation research.

Unit – V: Climate Governance and Emerging Research

UNFCCC, Paris Agreement, NDCs and National Adaptation Plans – Climate finance and adaptation economics – Loss and Damage framework – Urban resilience, climate migration, food–water–energy nexus and planetary health – Research frontiers and proposal development.

REFERENCES:

1. IPCC (2023). *Climate Change 2023: Synthesis Report*. Geneva. https://www.ipcc.ch/report/sixth-assessment-report-cycle/?utm_source=chatgpt.com
2. IPCC (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Cambridge University Press. https://www.ipcc.ch/report/sixth-assessment-report-cycle/?utm_source=chatgpt.com
3. Adger, N. W., Lorenzoni, I. & O'Brien, K. (Eds.) (2009). *Adapting to Climate Change: Thresholds, Values, Governance*. Cambridge University Press. https://www.cambridge.org/core/books/adapting-to-climate-change/6F4D22C5B3B09E7E88E6D0D5B0D7E3A4?utm_source=chatgpt.com
4. Pelling, M. (2011). *Adaptation to Climate Change: From Resilience to Transformation*. Routledge.
5. Leal Filho, W. (Ed.). (2015). *Handbook of Climate Change Adaptation*. Springer.
6. Singh, R. B. (Ed.). (2012). *Climate Change: Adaptation and Mitigation Strategies for India*. Springer.
7. Hulme, M. (2016). *Weathered: Cultures of Climate*. SAGE Publications.
8. National Research Council (2010). *Adapting to the Impacts of Climate Change*. National Academies Press. https://nap.nationalacademies.org/catalog/12783/adapting-to-the-impacts-of-climate-change?utm_source=chatgpt.com
9. UNEP. *Adaptation Gap Report* (latest edition). https://unepccc.org/publications/adaptation-gap-report-2023/?utm_source=chatgpt.com
10. Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. *National Action Plan on Climate Change* and related policy documents.

Mapping of Program Outcomes with Course Outcomes:

	PO1	**PO2**	**PO3**	**PO4**
CO1	X			
CO2	X	X		
CO3		X	X	X
CO4			X	X

Credits: 4 Course Code: GEO3016

SPATIAL DECISION SUPPORT SYSTEM

Learning Outcomes:

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

1. *understand the foundational concepts of location analytics and spatial data.*
2. *integrate remote sensing and GIS with simulation, optimization, and multi-criteria decision-making.*
3. *develop and evaluate SDSS applications for real-world problems.*
4. *communicate spatial decision outcomes effectively to stakeholders.*

Unit I: Introduction to Spatial Decision Support System

Spatial Decision Support System: concepts and evolution – Role of spatial data in decision-making – Components of a Spatial Decision Support System - SDSS architecture: data, models, and user interface

Unit II: Sources of Data for SDSS

Satellite data sources – Ground-based data: IoT sensors, land use, elevation, infrastructure – Cloud Sources: ArcGIS Online, OpenStreetMap, NASA Earthdata Cloud, IBM Cloud, CartoDB, and Sentinel Hub – Data quality, metadata and interoperability standards for spatial decision support

Unit III: Spatial Analysis for SDSS

Overlay and buffer analysis – Multi-criteria decision analysis (MCDA) - Spatial statistics and geostatistics – Suitability analysis and spatial decision modelling – Scenario building and predictive modeling - Risk and uncertainty analysis

Unit IV: Geovisualization for SDSS

Principles of spatial visualization – Time-series mapping – 3D terrain and slope visualizations – Web-based and cloud-based SDSS - Web mapping using Leaflet and Mapbox for spatial decision-making –

Unit V: Interactive Decision Mapping

Linking GIS with DSS tools - Dashboard tools for real-time monitoring – Participatory SDSS and stakeholder engagement - Ethical considerations in SDSS.

REFERENCES:

1. Goodchild, Michael F, and Donald G Janelle (2023). Spatially Integrated Social Science, Oxford Academic.
2. O'Sullivan, D., & Unwin, D. (2010). Geographic Information Analysis. Wiley.
3. Longley, P., Goodchild, M., Maguire, D., & Rhind, D. (2015). Geographic Information Systems and Science. Wiley.
4. Mitchell, A. (2005). The ESRI Guide to GIS Analysis, Volume 2: Spatial Measurements and Statistics. ESRI Press.
5. Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). Data Mining: Practical Machine Learning Tools and Techniques. Elsevier.
6. Peter B. Keenan. 2002. Spatial decision support systems. Decision making support systems: achievements, trends and challenges for. IGI Global.

Mapping of Program Outcomes with Course Outcomes:

	PO1	**PO2**	**PO3**	**PO4**
CO1	x	x	x	x
CO2	x	x	x	
CO3	x	x	x	x
CO4	x		x	x
CO5	x	x	x	x

Credits: 4 Course Code: GEO3017

URBAN SUSTAINABILITY

Learning objectives:

1. *To analyze global and Indian sustainable urban practices through SDG 11 and IUWM frameworks.*
2. *To apply advanced techniques like Sprawl Metrics, Urban Expansion Modeling, and Vertical Sprawl Analysis to assess LULC changes and urban sprawl.*
3. *To build climate risk maps and conduct urban vulnerability assessments using GIS and remote sensing for urban climate resilience.*
4. *To develop circular city designs and resource management strategies using circular economy principles and urban metabolism analysis.*
5. *To construct urban growth models using CA, ABM, and ArcGIS Pro for resilient urban planning and simulation.*

Unit I

Urban sustainability frameworks - SDG 11, case studies worldwide for sustainable practices, Case studies of Sustainable practices in India. Integrated Urban Water Management (IUWM), Global Practices in IUWM, Urban Water Management in India, Applicability of Global IUWM Practices in India. Advancing Sustainable Development in Practice (UN CC: e-Learning)

Unit II

Land use and land cover (LULC) change processes, Drivers of LULC change in megacities (economic, demographic, political), urban sprawl assessment - Sprawl Metrics and Indices, Time-Series Analysis, Urban Expansion Modelling using CA, SLEUTH, and Neural network. Parameters to Assess Urban Sprawl - Vertical Sprawl, Urban connectivity and fragmentation, urban densification.

Unit III

Urban climate challenges (heatwaves, flooding, extreme weather), Resilience strategies in megacities, Climate adaptation vs. mitigation in urban contexts, Nature-based solutions in cities, Urban vulnerability assessments using GIS and remote sensing, Climate risk mapping, and urban resilience frameworks. Ecosystem-based Adaptation (EbA) - Building Climate Resilience through Ecosystem-based Adaptation Planning (UN CC: e-Learning)

Unit IV

Circular economy principles (reduce, reuse, recycle), Transitioning from linear to circular urban systems, Urban metabolism and resource flow analysis, Circular city design (regenerative urban systems), Sustainable urban waste management (zero waste cities), Circular resource systems in water, energy, and materials

Unit V

Cellular automata (CA)-based models, and Agent-based models (ABMs). Urban Model Building, Model Building in Urban Planning, Open-Source Platforms for Urban Model Building, Model Building Using ArcGIS Pro, Applications of Urban Models for Resilient City Design.

REFERENCES

1. Weng, Q., Quattrochi, D., & Gamba, P. E. (2018). Urban Remote Sensing. CRC Press.
2. Ramachandran, R. (1989). Urbanization and Urban System in India. Oxford University Press.
3. Bayley, D. H. (1969). The Police and Political Development in India. Princeton University Press.
4. Frers, L., & Meier, L. (2007). Encountering Urban Places Visual and material performance in the city. Ashgate Publishing Limited.
5. Kevell, P. (1993). Land and the City Patterns and processes of Urban Change. Verso.
6. Chatterjee, C., Biswas, A., Mukherjee, J., Majumdar, S., (2022) Advances in Urbanism, Smart Cities and Sustainability, CRC Press.
7. Rani, M. (2018). Essential of Urban Geography. MANISHA PUBLICATION.
8. Siddhartha, K., & Mukherjee, S. (2016). Cities, Urbanization and Urban systems. Kitab Mahal.
9. Verma, L. N. (1990). Urban Geography. Rawat.
10. Le Gates. R. T., Stout. F., (ed), The City Reader, 2011 (fifth edition), Routledge, London.
11. Juliana Maantay, John Ziegler, John Pickles, GIS for the Urban Environment, Esri Press 2006.
12. Michael F. Goodchild, Louis T. Steyaert , Bradley O. Parks, Carol Johnston, David Maidment, Michael Crane , Sandi Glendinning, GIS and Environmental Modeling: Progress and Research Issues (Hardcover) by,Publisher: Wiley; 1 edition, 1996.

Mapping of Program Outcomes with Course Outcomes:

	PO1	PO2	PO3	PO4
CO1	x			
CO2	x	x		
CO3		x	x	x
CO4			x	x

Credits: 4 Course Code: GEO3018

WETLAND MANAGEMENT

Learning Outcomes:

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

1. *critically analyze the structure and functioning of different wetland types and evaluate wetland hydrology, biogeochemical processes, and nutrient cycling.*
2. *investigate anthropogenic threats and climate change impacts on wetland ecosystems.*
3. *design and implement wetland conservation and restoration strategies with the help of contemporary geospatial tools and techniques*
4. *analyze international and national wetland policies, governance, and management frameworks.*

Unit 1: Introduction to Wetland Ecosystems and related processes

- Definition and characteristics of wetlands; Wetland classification (Ramsar Convention, Cowardin System, and other classification methods)
- Wetlands in the global carbon and water cycle
- Water balance in wetlands - Wetland Hydrology and Biogeochemical Processes
- Biogeochemical cycling: carbon sequestration, nitrogen and phosphorus dynamics
- Wetland soil properties: redox potential, organic matter decomposition
- Greenhouse gas fluxes in wetlands: methane, carbon dioxide, and nitrous oxide emissions

Unit 2: Wetland Biodiversity and Ecological Interactions

- Adaptations of wetland flora and fauna
- Species diversity and trophic interactions in wetland ecosystems
- Ecosystem services (biodiversity support, water purification, flood control)
- Functional roles of keystone species in wetlands

Unit 3: Human Impact and Climate Change Effects on Wetlands

- Land-use change and habitat fragmentation
- Pollution, eutrophication, and wetland degradation
- Invasive species and their impact on wetland ecosystems
- Climate change effects: sea-level rise, altered hydrological regimes, extreme weather events (flooding, drought etc.)

Unit 4: Wetland Conservation, Restoration, and Management

- Wetland conservation and management principles, restoration techniques - Case studies
- Ecological indicators and monitoring methodologies for sustainable wetland management approaches
- Wetland Governance, Policies, and International Frameworks - Ramsar Convention, National wetland policies and legal frameworks (country-specific examples)
- Integrated wetland and watershed management approaches - Community participation and stakeholder engagement

Unit 5: Advanced Research Methods in Wetland Studies

- Remote sensing and GIS applications in wetland assessment
- Field-based methods for hydrological, chemical, and biological monitoring
- Experimental approaches and data analysis techniques in wetland ecology
- Open Source Geospatial Tools and Algorithms for Wetland Mapping and Monitoring
- Development of research proposals and scientific communication in wetland studies

REFERENCES

1. Finlayson, C.M., Milton, G.R., Prentice, R.C., & Davidson, N.C. (2018). The Wetland Book: I & II. Springer.
2. Junk, W.J., An, S., Finlayson, C.M., Gopal, B., & Květ, J. (Eds.). (2013). Wetlands: Ecosystem Services, Restoration, and Wise Use. Springer.
3. Keddy, P.A. (2010). Wetland Ecology: Principles and Conservation. Cambridge University Press.
4. Mitsch, W.J., & Gosselink, J.G. (2015). Wetlands (5th Edition). John Wiley & Sons.

ONLINE COURSES / MATERIALS:

- https://eo-college.org/courses/wet-ecosystems/
- https://www.ramsar.org/sites/default/files/documents/library/manual6-2013-e.pdf
- https://indianwetlands.in/resources-and-e-learning/online-courses-training-material/
- https://www.coursera.org/learn/managing-wetlands-conservation-restoration
- https://www.open.edu/openlearncreate/course/view.php?id=7286

OPEN DATASETS AND TOOLS:

- https://data.jrc.ec.europa.eu/dataset/jrc-gswe-global-surface-water-explorer-v1
- https://web.nateko.lu.se/timesat/timesat.asp
- https://openmrv.org/web/guest/w/modules/mrv/modules_2/landtrendr#1-background
- https://geetimeseriesexplorer.readthedocs.io/en/latest/content.html
- https://wetland-data-explorer.wwt.org.uk/
- https://www.mdpi.com/2072-4292/14/23/6104

Mapping of Program Outcomes with Course Outcomes:

	PO1	PO2	PO3	PO4
CO1	x			
CO2	x	x		
CO3		x	x	x
CO4			x	x

Credits: 4 Course Code: GEO3019

SPATIAL EPIDEMIOLOGY

Learning Outcomes

After completion of this course, the research scholar will able to

1. *understand the core concepts of spatial epidemiology*
2. *critically appraise spatial epidemiology literature and evaluate study design, choice of spatial scale, variable selection, and methods used in spatial epidemiology*
3. *handle and manage spatial health data and interpret disease maps and visualisations*
4. *analyse spatial disease patterns and exposure surfaces and communicate spatial epidemiological findings to diverse audiences*

Unit 1 - Foundations of Spatial Epidemiology

- Definition and scope of spatial epidemiology; historical roots in public health
- Types of spatial epidemiology problems: disease mapping, cluster detection, spatial risk modelling
- Overview of applications: vector-borne diseases, chronic disease, environmental exposures, health services access

Unit 2 - Disease Mapping and Spatial Analysis

- Kernel density estimation for cases; mapping relative risks and exceedance probabilities
- Visual and exploratory tools for identifying patterns and potential clusters
- Applications to infectious disease epidemiology, vector ecology, and environmental hazards

Unit 3 - Spatial Autocorrelation

- Concepts of spatial dependence; global measures (Moran's I, Geary's C) and their interpretation
- Local measures and cluster indicators (LISA, Getis–Ord, scan statistics)
- Point pattern concepts (homogeneous Poisson process, clustering, inhibition)

Unit 4 – Spatial Regression and Risk Modelling

- Generalized linear models (Poisson, binomial) for disease counts and rates with spatial covariates
- Generalized additive models (GAMs) with smooth spatial terms; spline-based spatial surfaces
- Spatial variations in risk; interpretation of model coefficients and residual spatial structure

Unit 5 – Bayesian Spatial Models

- Introduction to Bayesian hierarchical models
- Overdispersion, spatial clustering, and heterogeneity in transmission
- Spatio-Temporal Infectious Disease Modelling with INLA

REFERENCES:

1. Lawson AB, Banerjee S, Haining RP, Ugarte MD (eds.). 2016. Handbook of Spatial Epidemiology , CRC Press.
2. Pfeiffer D, Robinson TP, Stevenson M, Stevens KB, Rogers DJ, Clements AC. 2008. Spatial Analysis in Epidemiology, Oxford University Press.
3. Andreas Tsatsaris et al., 2026. Health Geography: Innovative Geospatial Epidemiology, Elsevier.
4. Daniel A. Griffith, Bin Li. 2025. Spatial Autocorrelation: A Fundamental Property of Geospatial Phenomena, Elsevier.

Mapping of Program Outcomes with Course Outcomes:

	PO1	PO2	PO3	PO4
CO1	x			
CO2	x	x		
CO3		x	x	x
CO4			x	x