26CE801 Advanced Disaster Risk Management and Geospatial Analytics 3-0-2-4

Year of Introduction: 2026-2027

Course Description:

This PhD-level course provides an advanced integration of disaster risk governance and geospatial technologies. It comprehensively covers the core concepts of disaster management, including hazard identification, vulnerability assessment, resilience building, preparedness, and the complete disaster management cycle. Building upon these foundations, the course equips researchers with robust methodologies in Geographical Information Systems (GIS), geocomputation, and web-based spatial services. Students will utilize open-source geodata repositories, programming languages (Python and R), and cloud-based processing to model complex natural and anthropogenic hazards, ultimately developing spatial decision-support systems for effective disaster mitigation and natural resource management.

Learning Objectives:

- Deconstruct the multidimensional paradigms of disasters, hazards, vulnerability, capacity, resilience, and risk within the context of the disaster management cycle.
- Master advanced GIS spatial analysis, including vector/raster operations, network analysis, and error propagation, utilizing open-source tools.
- Develop proficiency in geocomputation, web GIS, and cloud-based geospatial data processing using Python and R.
- Apply Remote Sensing (RS) and GIS techniques specifically for disaster mitigation, geological studies, and water resource management.

Pedagogy:

The course is delivered through a combination of theoretical lectures and hands-on geo-computational laboratory sessions. The pedagogy includes case-study analyses of historical disasters, interactive programming workshops for spatial data, and independent geospatial modeling projects utilizing ISRO Geo-web services and open geo-data repositories.

Syllabus:

Definitions and conceptual frameworks of hazards, disasters, vulnerability, exposure, coping capacity, and resilience. Classification of natural and anthropogenic disasters. *The Disaster Management Cycle:* Phases of disaster management including prevention, mitigation, preparedness, response, recovery, and rehabilitation. *Vulnerability and Risk:* Physical, social, economic, and environmental vulnerability analysis. Mathematical and conceptual formulations of disaster risk.
Overview of GIS, geographic phenomena, concepts, and examples. Map projection concepts and their use in spatial mapping. GIS data models encompassing both spatial and non-spatial structures. *Spatial Analysis:* Data inputting, editing, and comprehensive spatial analysis using both vector and raster data. Network analysis for emergency routing and map visualization techniques. *Data Quality and Tools:* Overview of spatial data quality, addressing uncertainty in GIS and error propagation. Hands-on utilization of open-source software technology and tools.

Web-based Spatial Architecture: Introduction to geo-computation, Online GIS, and Geo-web services. Overview of WebGIS and custom application development. *Geospatial Programming:* Programming concepts for geo-computation with an intensive introduction to Python and R for spatial data manipulation. *Data Repositories & Cloud Processing:* Utilizing Open Geo-data Repositories and ISRO Geo-web Services for thematic applications. Demonstration and implementation of cloud-based geospatial data processing techniques.
RS & GIS applications in geological studies (earthquakes, landslides) and atmospheric studies (cyclones, severe weather). *Hydrological Hazards:* RS & GIS applications in water resources management, focusing on flood inundation modeling and drought assessment. *Coastal & Ecological Impacts:* RS & GIS applications in coastal zone management (tsunamis, storm surges) and forestry/ecology (forest fires). Overview of specific RS & GIS applications in disaster mitigation and management.
Integrating big data analytics into disaster preparedness. Developing early warning systems and spatial decision-support systems for resource allocation during emergencies. *Urban Resilience:* RS & GIS applications in urban and regional planning to minimize physical vulnerability and enforce disaster-resilient zoning. *Case Studies:* Critical evaluation of recent trends in geo-informatics applied to real-world disaster recovery and damage assessment models.

References:

1. *Coppola, D. P. Introduction to International Disaster Management. Butterworth-Heinemann.*
2. *Wisner, B., Blaikie, P., Cannon, T., & Davis, I. At Risk: Natural Hazards, People's Vulnerability and Disasters*. Routledge.
3. Indian Institute of Remote Sensing (IIRS), ISRO. *Basics of Remote Sensing, Geographical Information System and Global Navigation Satellite.*
4. Kerle, N., van Westen, C. J., & Theilen-Willige, B. *Remote Sensing and GIS for Risk Management*. ITC Educational Textbook Series, University of Twente.
5. National Disaster Management Authority (NDMA), Government of India. *National Guidelines on Disaster Management*.

Course Outcome:

CO1: Critically evaluate and model the components of disaster risk, analyzing the interplay between natural hazards and systemic vulnerability.

CO2: Execute complex spatial operations, network analyses, and error assessments utilizing advanced GIS data models and open-source software.

CO3: Develop automated geospatial workflows and WebGIS applications using Python, R, and cloud-based platforms to process large-scale environmental data.

CO4: Design geospatial mitigation models for specific natural hazards, integrating ISRO Geoweb services and natural resource management applications.

Evaluation Pattern:

- Internal Assessment : 30 marks
  - *Mid-semester examination : 30 marks*
- External Assessment : 70 marks
  - *Project : 70 marks*

Employability:

Prepares doctoral scholars for high-level technical and policy roles such as Geospatial Risk Scientist, Disaster Management Consultant, Urban Resilience Planner, and Academic Researcher. Graduates will be highly sought after by government space and disaster agencies (e.g., ISRO, NDMA), international humanitarian organizations, and environmental research institutes.