Course title: Spatiotemporal Data Analysis			
Course code: NRC 142	**No. of credits:** 3	**L-T-P:** 26-12-8	**Learning hours:** 42
Pre-requisite course code and title (if any): Environmental Statistics			
Department: Energy and Environment			
Course coordinator: Dr. Kamna Sachdeva	**Course instructor:** Dr Neeti		
Contact details: neeti@teriuniversity.ac.in			
Course type: Elective	**Course offered in:** Semester 2		

Course description

The course is conceptualised to introduce students to statistical analysis in temporal and spatial domain. It leads students into analysis and interpretation of spatial and temporal data, using different tools. There has been tremendous growth of interest in the analysis of spatial data and the application of statistical methodologies for the same in recent times. The goal of the course is to familiarize the students with the basic techniques for use in further research. It will include physical interpretation of the results and limitations of applicability. The course would enable the students to analyse environmental data for improved decision-making, enabling efficient resource management.

Course objectives

To create an overall idea about various statistical distributions and their properties.

- To understand basic time series components and means to compute them.
- To analyze a data with time series techniques
- To understand the concept of geostatistical modeling for spatial prediction
- To understand spatio-temporal models for gridded time series

Course content

S No	Topic	L	T	P
1.	Introduction: types of data, collection of temporal and spatial data, preparation of data	2	2	
2.	Time series: classification, components, concept of stationarity, decomposition of time series	3	2	
3.	Analysis for trend detection and slope estimation: Parametric approach - Linear Regression; Non-Parametric approach – Turning Point test, Man-Kendall Test, Pre Whitened Mann Kendall test, Theil and Sen's Median Slope	4		
4.	Autocorrelation analysis: Estimation of Autocorrelation coefficient, Correlogram, Moving Average process, Autoregressive Process, Autoregressive Integrated Moving Average Process, Cross correlation analysis	3	2	
5.	Change point detection and its various frameworks	2	2	
6.	Introduction to Geostatistics: Spatial continuity, Anisotropy axes, directional tolerance, variogram, relative variogram, correlogram, cross-variogram	2		2
7.	Estimation: Weighted linear combinations, Global and local estimation, point and block estimates	2		2
8.	Random function models in Geostatistics: Deterministic model, probabilistic models, random variables, parameters for random function	2	2	
9.	Ordinary kriging and block kriging, cokrigging	2	2	

10.	Spatio-temporal models and its applications: S- and T- mode Empirical Orthogonal Function, Canonical Correlation Analysis, Singular Spectrum Analysis, Contextual Mann-Kendall, Seasonal Trend Analysis	4		4
	Total	**26**	**12**	**8**

Evaluation criteria

- Test 1: 25%
- Test 2: 25%
- Test 3: 50%

Learning outcomes

After completion of this course students should be able to

1. Critically analyze a time series data and provide important findings based on them.
2. Execute Geostatistics model on spatial data for spatial prediction
3. Critically analyze time series data for spatial and temporal autocorrelation and then apply appropriate spatio-temporal model

Pedagogical approach

Lectures and Tutorials.

Materials

Required text

- Barnett V. (2004) *Environmental Statistics, Methods and Applications*, John Wiley & Sons, 293pp.
- Box G.E.P., Jenkins G.M. and Reinsel G.C. (2007) *Time Series Analysis Forecasting and Control*, 3e, Pearson Education, Delhi, 598pp.
- Isaaks E.H. and Srivastava R.M. (1989) *Applied Geostatistics*, Oxford University Press, New York, 561pp.
- Jolliffe, I. (2002). Principal component analysis. John Wiley & Sons, Ltd.

Suggested readings

- Anderson D.R., Sweeny D.J and Williams T.A. (2002) *Statistics for Business and Economics*, 8e, Thomson Asia Pte Ltd, Singapore, 885pp.
- Burrough P.A. and McDonnel R.A. (2007) *Principles of Geographical Information Systems*, 3e, Oxford University Press, New York.
- Chatfield C. (2003) *The Analysis of Time Series: An Introduction*, 6e, Chapman and Hall, London, 333pp.
- Conover W.J. (2006) *Practical Nonparametric Statistics*, John Wiley & Sons, 584pp.
- Daniel W.W. (2000) *Applied Nonparametric Statistics*, Houghton Miffin Company, USA, 510pp.
- Draper N.R. and Smith H. (1998) *Applied Regression Analysis*, 3e, Wiley & Sons, Inc., 706pp.
- Helsel D.R. and Hirsch R.M. (1992) *Statistical Methods in Water Resources*, 510pp.
- Longley P. and Batty M. (eds.) (1996) *Spatial Analysis: Modelling in a GIS Environment*, Geoinformation International, Cambridge, 392pp.
- McCuen R.H. (2003) *Modelling Hydrologic Change: Statistical Methods*, Lewis Publishers, Florida, 432pp.
- Van den Dool, H. M., S. Saha, and Åke Johansson. "Empirical orthogonal teleconnections." *Journal of Climate* 13.8 (2000): 1421-1435.
- Piegorsch W.W. and Bailer A.J. (2005) *Analyzing Environmental Data*, John Wiley & Sons, Ltd., 496pp.
- Ppal S. (1998) *Statistics for Geoscientists: Techniques and Applications*, Concept Publishing Company, New Delhi.

- Rao A.R., Hamed K.H. and Chen H.L. (2003) *Nonstationarities in Hydrologic and Environmental Time Series*, Kluwer Academic Publishers, Dordrecht, The Netherlands, 362pp.
- Reddy P.J. (1997) *Stochastic Hydrology*, Laxmi Publications (P) Ltd., Dew Delhi, 259pp.
- Webster R. and Oliver M.A. (2007) *Geostatistics for Environmental Scientists*, 2e, John Wiley and Sons Ltd., Chichester, England, 315pp.
- Zhang C. (2007) *Fundamentals of Environmental Sampling and Analysis*, John Wiley & Sons, Inc., 436pp.
- Hassani, Hossein. "Singular spectrum analysis: methodology and comparison." (2007): 239-257.

Suggested Software:
TerrSet (IDRISI) and R are required for teaching this course with remotely sensed dataset

Journals

- International Journal of Forecasting
- Journal of Time Series Analysis

Additional information (if any)
In this course, R and TerrSet software will be used

Student responsibilities
The students are expected to submit assignments in time and come prepared with readings when provided.

Course Reviewers

1. Dr. Nidhi, Department of Statsistics, Maths and Computer Applications, Faculty of Basic Sciences and Humanities, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar
2. Dr. Benoit Parmentier, Data Scientist, National Socio-environmental Synthesis Center, University of Maryland, Maryland, USA