

<b>Course title:</b> Environmental Statistics				
<b>Course code:</b> NRE 111		<b>No. of credits:</b> 3	<b>L-T-P:</b> 28-14-0	<b>Learning hours:</b> 42
<b>Pre-requisite course code and title (if any):</b> No pre-requisite required				
<b>Department:</b> Department of Natural Resources				
<b>Course coordinator:</b>		<b>Course instructor:</b> Prof. Prateek Sharma		
<b>Contact details:</b>				
<b>Course type:</b> Elective		<b>Course offered in:</b> Semester 1		
<b>Course Description</b> As the world gets more crowded and technology continues to develop, environmental problems multiply. There are many aspects of these problems—economic, political, psychological, medical, scientific and technological. Addressing such problems often involves quantitative aspects; in particular, the acquisition and analysis of environmental data. Treating these quantitative problems effectively involves the use of statistics. When one is confronted with a new problem that involves the collection and analysis of data, two crucial questions exist: “How will using statistics help this problem?” and “Which techniques should be used?” The course has been designed and intended to help budding environmental scientists/ managers to answer these questions in order better to understand and design systems for environmental protection. The course is about how to extract information from data and how informative data are generated in the first place. Analysing data is part science, part craft and part art. An effort has been made through this course to provide some useful tools ‘to get to the grips’ of environmental problems and to encourage the students to develop the necessary craft and art.				
<b>Course objectives</b>				
<b>Course content</b>				
<b>SNo</b>	<b>Topic</b>	<b>L</b>	<b>T</b>	<b>P</b>
1.	<b>Introduction</b> Mathematical models—deterministic and stochastic; generation of environmental data; stochastic processes in environment; the nature of random variables; populations and samples; parameters and statistics.	1		
2.	<b>Review of basic concepts</b> Measurement theory, levels of measurement; statistical descriptors of environmental data – numerical and graphical; Chebyshev’s theorem; measurement uncertainty—accuracy, precision and bias. Probability theory: probability concepts; probability distribution functions and their applications—discrete and continuous distributions.	3 3	2 2	
3.	<b>Data sampling</b> Methods for selecting sampling locations and times; types of sampling designs—probability and non-probability sampling; sampling theory, sampling distributions; parameter estimation, point and interval estimates; confidence interval estimation of—means, differences of means, proportions, difference of proportions, variances, ratio of variances sample size determination for different sampling designs	10	5	
4.	<b>Tests of hypothesis</b> Hypothesis testing—parametric and non-parametric tests (concerning means, differences of means, proportions, difference of proportions, variances, ratio of variances)	8	4	
5.	<b>Correlation and simple regression analysis</b> Correlation analysis: graphical analysis, bivariate correlation, covariance, correlation coefficient, distribution of correlation coefficient and its statistical significance. Simple regression analysis: assumptions and definitions, principle of least	3	1	

	squares, regression parameters their distribution and statistical significance, applications in process description and prediction			
	<b>Total</b>	<b>28</b>	<b>14</b>	
<b>Evaluation criteria</b>				
<ul style="list-style-type: none"> <li>▪ 2 minor test: 20% each</li> <li>▪ Tutorials: 20%</li> <li>▪ Major test: 40%</li> </ul>				
<b>Learning outcomes</b>				
<b>Pedagogical approach</b>				
<b>Materials</b>				
<b>Textbooks</b>				
<ol style="list-style-type: none"> <li>1. Ayyub, B.M. and McCuen, R.H. (2011) <i>Probability, Statistics and Reliability for Engineers and Scientists</i>, CRC Press, Boca Raton, FL.</li> <li>2. Helsel D.R. and Hirsch R.M. (1997) <i>Statistical Methods in Water Resources</i>, Elsevier Science Ltd., UK.</li> <li>3. Hoshmand A.R. (1997) <i>Statistical Methods for Environmental and Agricultural Sciences</i>, CRC Press, Boca Raton, FL.</li> <li>4. Kottegoda N.T. and Rosso R. (2008) <i>Applied Statistics for Civil and Environmental Engineers</i>, McGraw-Hill, International Edition.</li> <li>5. Shaefer S.J. and Theodore L. (2007) <i>Probability and Statistics Applications for Environmental Science</i>, CRC Press, Boca Raton, FL.</li> </ol>				
<b>Suggested Readings</b>				
<ol style="list-style-type: none"> <li>1. Berthouex P.M. and Brown L.C. (1994) <i>Statistics for Environmental Engineers</i>, Lewis Publishers, CRC Press, Boca Raton, FL.</li> <li>2. Caulcutt R. and Boddy R. (1983) <i>Statistics for Analytical Chemists</i>, Chapman &amp; Hall, London.</li> <li>3. Cothorn C.R. and Ross N.P. (1994) <i>Environmental Statistics, Assessment and Forecasting</i>, Lewis Publishers, Boca Raton, FL.</li> <li>4. Csuros M. (1997) <i>Environmental Sampling and Analysis, Lab Manual</i>, Lewis Publishers, Boca Raton, FL.</li> <li>5. Ebdon D. (1984) <i>Statistics in Geography</i>, 2<sup>nd</sup> edn., Blackwell, Oxford.</li> <li>6. Everitt B.S. (1999) <i>Chance Rules: An Informal Guide to Probability, Risk and Statistics</i>, Springer-Verlag, New York.</li> <li>7. Fisher L.D. and Van Belle G. (1993) <i>Biostatistics: A Methodology for the Health Sciences</i>, John Wiley &amp; Sons, New York.</li> <li>8. Gibbons R.D. (1994) <i>Statistical Methods for Groundwater Monitoring</i>, John Wiley &amp; Sons, New York.</li> <li>9. Gibbons R.D. and Coleman D.E. (2001) <i>Statistical Methods for Detection and Quantification of Environmental Contamination</i>, John Wiley &amp; Sons, Inc., New York.</li> <li>10. Gilbert R.O. (1987) <i>Statistical Methods for Environmental Pollution Monitoring</i>, New York, Van Nostrand Reinhold.</li> <li>11. Ginevan M.E., Splistone D.E. (2004) <i>Statistical Tools for Environmental Quality Measurement</i>. John Wiley &amp; Sons Hoboken, NJ.</li> <li>12. Graham R.C. (1993) <i>Data Analysis for the Chemical Sciences: A Guide to Statistical Techniques</i>, VCH Publishers, New York.</li> <li>13. Gregoire T.M. and Valentine H.T. (2008) <i>Sampling Strategies for Natural Resources and the Environment</i>, Chapman &amp; Hall/CRC, Boca Raton.</li> <li>14. Keith L.H. (1991) <i>Environmental Sampling and Analysis: A Practical Guide</i>, Lewis Publishers, Boca Raton, FL.</li> </ol>				

15. Keith L.H. (ed) (1996) *Principles of Environmental Sampling*, Second Edition, American Chemical Society, Washington, D.C., Distributed by Oxford University Press, New York.
16. Manly B.F.J. (2001) *Statistics for Environmental Science and Management*. Chapman & Hall/CRC, Boca Raton, FL.
17. McBean E.A. and Rovers R.A. (1998) *Statistical Procedures for Analysis of Environmental Monitoring Data & Risk Assessment*, Prentice-Hall PTR, Upper Saddle River, NJ.
18. McBride G.B. (2005) *Using Statistical Methods for Water Quality Management: Issues, Problems and Solutions*, John Wiley & Sons, Hoboken, NJ, USA.
19. Meier P.C. and Zund R.E. (1993) *Statistical Methods in Analytical Chemistry*, John Wiley & Sons, New York.
20. Moore D.S., McCabe G.P. and Craig B.A. (2009) *Introduction to the Practice of Statistics*, W.H. Freeman and Co., New York.
21. Ott W.R. (1995) *Environmental Statistics and Data Analysis*, Lewis Publishers, Boca Raton, FL.
22. Piegorsch W.W. and Bailer A.J. (1997) *Statistics for Environmental Biology and Toxicology*, Chapman & Hall, New York.
23. Reichman W.J. ((1961) *Use and Abuse of Statistics*, Penguin, Harmondsworth.
24. Rogerson P.A. (2006) *Statistical Methods for Geographers: A Student's Guide*, Los Angeles, CA.
25. Taylor J.K. (1987) *Quality Assurance of Chemical Measures*, Lewis Publishers, CRC Press, Boca Raton, FL.
26. Walford N. (2011) *Practical Statistics for Geographers and Earth Scientists*, John Wiley & Sons, New Jersey, USA.
27. Williams R.B.G. (1984) *Introduction to Statistics for Geographers and Earth Scientists*, Macmillan, London.
28. Wrigley N. (1985) *Categorical Data Analysis for Geographers and Environmental Scientists*, Longman, Harlow.
29. Zhang C. (2007) *Fundamentals of Environmental Sampling and Data Analysis*, John Wiley & Sons, NJ, USA.

### **Journals**

1. Applied Statistics
2. Biometrika
3. Environmental and Ecological Statistics
4. Environmetrics
5. International Statistical Review
6. Journal of Statistical Computing and Simulation
7. Journal of the American Statistical Association
8. Risk Analysis
9. Statistical Science
10. Technometrics
11. The American Statistician

### **Additional information (if any)**

### **Student responsibilities**

Attendance, feedback, discipline, guest faculty etc