CONFERENCE PROGRAM
BOOK OF ABSTRACTS

GRASPA•2015

GRASPA-SIS Biennial Conference

GRASPA–SIS: The Research Group for Environmental Statistics of the Italian Statistical Society

TIES European Regional Meeting

TIES: The International Environmetrics Society

Bari • 15-16 June 2015

UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO

GRASPA 2015

Fondazione
Cassa di Risparmio di Puglia

SANITANOVA
GOVERNANCE LEARNING MANAGEMENT

TIES

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INTRODUCTION

GRASPA 2015 is the biennial conference of the **Italian Research Group for Environmental Statistics** (GRASPA-SIS). GRASPA is active since 1995 and has become a permanent working group of the Italian Statistical Society (SIS) since May 2013. GRASPA-SIS promotes statistical and interdisciplinary research in the field of environmental quality, safety and sustainability including air and water quality, epidemiology, climate, earth science and ecology.

GRASPA 2015 is also the 2015 European regional conference of The International Environmetrics Society (TIES), it is sponsored by the Young section of the Italian Statistical Society and is a connected event of the Spatial Statistics 2015 Conference.

GRASPA 2015 is an opportunity to share research interests related to the development and use of statistical methods in environmental sciences, fostering methodological developments and applications in fields such as spatial and spatio-temporal modelling, functional data analysis, directional data, spatial and spatio-temporal sampling and extreme values. Moreover **GRASPA 2015** endorses co-operation among statisticians, academics from environmental sciences as well as practitioners from government and independent environmental agencies creating a space for the exchange of experiences and ideas on various aspects relevant to the protection of the natural environment including: air quality, groundwater pollution and hydrology, soil science and site remediation, forestry and landscape analysis, climatology and meteorology, ecology and biodiversity, agriculture and natural resources management, disease epidemics and seismic risk.

GRASPA 2015 is hosted by Università degli Studi di Bari Aldo Moro and financially supported by Dipartimento di Scienze Economiche e Metodi Matematici – Università degli Studi di Bari, Dipartimento di Economia – Università degli Studi di Foggia, Fondazione Cassa di Risparmio di Puglia, Istituto di Ricerca sulle Acque – Consiglio Nazionale delle Ricerche and Sanitanova.

COMMITTEES

Scientific Committee

Alessandro Fassò *(Chair)*	Università di Bergamo
Emanuele Barca	CNR-IRSA
Barbara Cafarelli	Università di Foggia
Lorenzo Fattorini	Università di Siena
Angela Ferruzza	ISTAT
Francesco Finazzi	Università di Bergamo
Giovanna Jona Lasinio	Sapienza Università di Roma
Antonello Maruotti	Università di Roma Tre
Jorge Mateu	Universitat Jaume I
Lucia Paci	Università di Bologna
Alessandra Petrucci	Università di Firenze
Alessio Pollice	Università di Bari
Wolfgang Schmid	Europa - Universität Viadrina

Organizing Committee

Alessio Pollice *(Chair)*	Università di Bari
Barbara Cafarelli	Università di Foggia
Crescenza Calculli	Università di Bari
Maria Pia Circella	Università di Bari
Francesco Finazzi	Università di Bergamo
Nunziata Ribecco	Università di Bari


GRASPA 2015
Palazzo Ateneo
Map of the 1st floor
Main stairway
Elevator
Registration area
Coffee brea/lunch
Poster area
Room 1
Room 2
A
B
ATRIO BATTISTI
ATRIO CHIARINO
ATRIO UMBERTO
SCALA 1
SCALA 2
SCALA 6
SCALA 7

Conference program

MONDAY • JUNE 15, 2015

8.30-9.00	Registration
9.00-9.30	Conference Opening and Welcome Address
9.30-10.15	Keynote lecture 1: Visualising the Environment: Data, Models and Graphics
10.15-10.35	Coffee break
10.35-11.35	Poster snapshot session 1
11.35-12.50	Invited track 1: Sampling Strategies for Design-Based Inference on Animal and Plant Communities
12.50-13.40	Lunch break
13.40-14.40	Poster snapshot session 2
14.40-15.55	Invited track 2: Analysis of Spatio-Temporal Data
15.55-16.15	Coffee break
16.15-17.30	Invited track 3: Environmental Official Statistics: Developments and Challenges
17.30-18.25	Invited track 4: Recent Developments in Latent Variable Models with Environmental Applications
18.25-19.20	Invited track 5: New Monitoring Systems for Environmental Data: Statistical Challenges
21.00	Social dinner

TUESDAY • JUNE 16, 2015

9.00-9.45	Keynote lecture 2: Frequency Domain Methods for the Analysis of Stationary Spatio-Temporal Random Processes
9.45-10.45	Contributed papers sessions 1 and 2
10.45-11.05	Coffee break
11.05-12.20	Invited track 6: Statistics for Functional Data with Complex Dependencies
12.20-13.15	Invited track 7: Data, Models and Statistical Problems in Climate Monitoring
13.15-14.05	Lunch break
14.05-15.00	Invited track 8: Modelling Ecological Data
15.00-15.55	Invited track 9: Advances in Directional Statistics
15.55-16.15	Coffee break
16.15-17.30	Invited track 10: Statistical Modelling of Environmental Phenomena and their Interactions
17.30-17.50	Best Poster Awards and Closing Ceremony
17.50-18.50	GRASPA-SIS General Annual Meeting

WEDNESDAY • JUNE 17, 2015

Post-conference short course: *An Introduction to Flexible Regression for Environmental Data*

9.30-11.00	Session 1 - Methods of Flexible Regression (1,2,3 dimensions)
11.00-11.20	Coffee break
11.20-12.50	Session 2 - Spatial and Spatio-temporal Data
12.50-13.30	Lunch break
13.30-15.00	Session 3 - Additive Models
15.00-15.20	Coffee break
15.20-16.50	Session 4 - Gaussian Process and Other Models

Detailed program

8.30-9.00 **Registration**

9.00-9.30 **Conference Opening and Welcome Address**

Angelo Tursi, pro-rector of Università di Bari
Nicola Torelli, president of Società Italiana di Statistica, Università di Trieste
Alessandro Fassò, coordinator of GRASPA-SIS, Università di Bergamo
Alessio Pollice, vice-coordinator of GRASPA-SIS, Università di Bari

9.30-10.15 **Keynote lecture 1: Visualising the Environment: Data, Models and Graphics**

Chair: Daniela Cocchi, Università di Bologna.

Speaker: Adrian Bowman, University of Glasgow.

10.15-10.35 **Coffee break**

10.35-11.35 **Poster snapshot session 1**

Cluster 1: Health and Technology
Cluster 2: Methodological Advances In Environmental Statistics

Chairs: Linda Altieri, Università di Bologna and Patrick Vetter, Europa-Universität Viadrina, Frankfurt.

11.35-12.50 **Invited track 1: Sampling Strategies for Design-Based Inference on Animal and Plant Communities**

Director and chair: Lorenzo Fattorini, Università di Siena.

- *Large scale assessment of ungulate populations via nocturnal distance sampling. Do survey designs based on random footpaths selection provide reliable estimates?*
  V. La Morgia (ISPRA), S. Focardi (CNR-ISC)
- *The estimation of forest cover from remote-sensed two-stage inventories*
  M.C. Pagliarella (Università del Molise), G. Chirici (Università di Firenze)
- *Point and plot sampling for large-scale inventory of trees outside forests*
  N. Puletti, P. Corona (CRA, Forestry Research Centre), G. Chirici (Università di Firenze), M. Mura, M. Marchetti (Università del Molise)

- *Geographically-assisted estimation of the population total*
  D. Cocchi, F. Bruno, A. Vagheggini (Università di Bologna)

12.50-13.40 **Lunch break**

13.40-14.40 **Poster snapshot session 2**

Cluster 3: Flora and Fauna
Cluster 4: Climate

Chairs: Linda Altieri, Università di Bologna and Patrick Vetter, Europa-Universität Viadrina, Frankfurt.

14.40-15.55 **Invited track 2: Analysis of Spatio-Temporal Data**

Director and chair: Wolfgang Schmid, Europa-Universität Viadrina, Frankfurt.

- *Spatio-temporal wind speed predictions for Germany*
  D. Ambach, W. Schmid (Europa-Universität Viadrina, Frankfurt)
- *Identifying trends in the spatial errors of a regional climate model via clustering*
  V. Berrocal (University of Michigan)
- *Multivariate spatio temporal models for large datasets and joint exposure to airborne multipollutants in Europe*
  A. Fassò, F. Finazzi, F.B. Ndongo (Università di Bergamo)
- *Spatio-temporal statistical analysis of the global carbon dioxide cycle*
  P. Vetter (Europa-Universität Viadrina, Frankfurt)

15.55-16.15 **Coffee break**

16.15-17.30 **Invited track 3: Environmental Official Statistics: Developments and Challenges**

Director and chair: Angela Ferruzza, Dipartimento per le statistiche sociali ed ambientali, Istituto Nazionale di Statistica (Istat).

- *International frameworks for environmental statistics and their application to climate change related statistics*
  A. Ferruzza, D. Vignani, G. Tagliacozzo, S. Tersigni, A. Tudini (Istat)

- *Istat survey on energy consumption of households: main characteristic and future applications for the production of estimates by end use*
  P. Ungaro, A. Ferruzza, C. Ceccarelli, V. Greco (Istat)
- *Integration of administrative and survey data for material flow accounts*
  A.M. Femia, P. Panfili, C. Paolantoni, C. Piccini, M. Tripoli (Istat)
- *Environmental quality of urban areas: a cross-cutting approach to measure smart factors and eco-sustainability*
  A. Ferrara, L. Costanzo (Istat)

17.30-18.25 **Invited track 4: Recent Developments in Latent Variable Models with Environmental Applications**

Director and chair: Antonello Maruotti, Università di Roma Tre.

- *A new cylindrical hidden Markov model for the identification of sea regimes*
  F. Lagona (Università di Roma Tre)
- *Bayesian spatio-temporal models for directional and directional-linear variables*
  G. Mastrantonio (Università di Roma Tre)
- *On generating a flexible class of anisotropic spatial models using Gaussian processes*
  S. Mukhopadhyay, S. Sahu (University of Southampton)

18.25-19.20 **Invited track 5: New Monitoring Systems for Environmental Data: Statistical Challenges**

Director: Lucia Paci, Università di Bologna.

Chair: Massimo Ventrucci, Università di Bologna.

- *Patterns and processes revealed in high-frequency environmental data*
  A. Elayouti, M. Scott, C. Miller, S. Waldron (University of Glasgow)
- *Real-time detection of earthquakes through a smartphone-based sensor network*
  F. Finazzi, A. Fassò (Università di Bergamo)

- *Multi-resolution and spatial Independent Component Analysis approaches for geo-referred and time-varying mobile phone data*
  P. Zanini (Politecnico di Milano)

21.00 **Social dinner**

9.00-9.45 **Keynote lecture 2: Frequency Domain Methods for the Analysis of Stationary Spatio-Temporal Random Processes**

Chair: Rognvald Smith, Centre for Ecology and Hydrology, Natural Environment Research Council, UK.

Speaker: Tata Subba Rao, University of Manchester.

9.45-10.45 **Contributed papers sessions 1 and 2**

Room 1 - Contributed papers session 1

Chair: Francesco Finazzi, Università di Bergamo.

- *Evolutionary polynomial regression application for missing data handling in meteo-climatic gauging stations*
  L. Berardi, D. Laucelli, O. Giustolisi (Politecnico di Bari), E. Barca, G. Passarella (CNR-IRSA)
- *Causal effects of extreme hot days on mortality in US cities*
  M.A. Bind, L. Miratrix, D. Rubin (Harvard University)
- *Statistical properties of numerical weather prediction model forecasts, their analysis and improvement strategies*
  M. Brabec (Czech Academy of Sciences)
- *An evolutionary spectum approach to model land/ocean nonstationarities*
  S. Castruccio (Newcastle University)
- *Mixture of experts for sequential PM10 forecasting in Normandy (France)*
  J.M. Poggi, B. Auder (Université Paris-Sud) , B. Portier (Institut National de Sciences Apliquées)

Room 2 - Contributed papers session 2

Chair: Emilio Porcu, Universidad Técnica "Federico Santa Maria", Valparaiso.

- *Improving R and ArcGIS integration*
  K. Krivoruchko (Esri)
- *Statistical models for species richness in the Ross Sea*
  C. Carota, C. R. Nava (Università di Torino), I. Soldani (aizoOn Technology Consulting), C. Ghiglione, S. Schiaparelli (Università di Genova and Italian National Museum of Antarctica)

- *Environmental Smartcities: statistical mapping of environmental risk for natural and anthropic disasters in Chile*
  O. Nicolis (Universidad de Valparaiso)
- *A case-study comparison of methods for factor analysis of spatially correlated multivariate responses*
  S.D. Oman, B. Vakulenko-Lagun (Hebrew University of Jerusalem), M. Zilberbrand (Hydrological Service of Israel)
- *Image similarity assessment based on coefficients of spatial association*
  R.O. Vallejos, D. Mancilla (Universidad Técnica "Federico Santa Maria", Valparaiso)

10.45-11.05 **Coffee break**

11.05-12.20 **Invited track 6: Statistics for Functional Data with Complex Dependencies**

Director and chair: Jorge Mateu, Universitat "Jaume I", Castellón.

- *Spatial dependence in model-based functional clustering procedures*
  P. Girardi (Universita "Ca'Foscari" Venezia)
- *Dynamic social network analysis using functional data models*
  E. Romano (Seconda Università di Napoli)
- *FANOVA models in rectangular and circular domains*
  M.D. Ruiz-Medina, J. Alvarez-Liébana (Universidad de Granada)
- *Modeling functional data with complex dependencies via partial differential regularizations*
  L. Sangalli (Politecnico di Milano)

12.20-13.15 **Invited track 7: Data, Models and Statistical Problems in Climate Monitoring**

Director and chair: Alessandro Fassò, Università di Bergamo.

- *Collocation uncertainty in climate monitoring*
  M. Franco-Villoria, R. Ignaccolo (Università di Torino), A. Fassò (Università di Bergamo), F. Madonna (CNR-IMAA), B.B. Demoz (University of Maryland)

- *Quantifying the value of humidity measurements at GCOS Reference Upper-Air Network sites*
  F. Madonna, M. Rosoldi (CNR-IMAA), J. Gueldner (Deutscher Wetterdienst), A. Haefele (MeteoSwiss), R. Kivi (Finnish Meteorological Institute), M.P. Cadeddu, D. Sisterson (Argonne National Laboratory, US), G. Pappalardo (CNR-IMAA)

- *Space-time covariances for Planet Earth*
  E. Porcu, (Universidad Técnica Federico Santa Maria, Valparaiso) M. Bevilacqua (Universidad de Valparaiso), M. Genton (King Abdullah University of Science and Technology)

13.15-14.05 **Lunch break**

14.05-15.00 **Invited track 8: Modelling Ecological Data**

Directors: Giovanna Jona Lasinio, Sapienza Università di Roma and Antonella Bodini, CNR-IMATI.

Chair: Giovanna Jona Lasinio, Sapienza Università di Roma.

- *Modelling the Percent Affinity Index in Environmental Monitoring: Some Statistical Properties*
  F. Divino (Università del Molise)

- *Spatial point process modelling in biodiversity research – a dialogue*
  J. Illian (University of St. Andrews)

- *Bayesian Belief Networks for modelling Ecosystem Services*
  R. Smith (UK Natural Environment Research Council)

15.00-15.55 **Invited track 9: Advances in Directional Statistics**

Director and chair: Alessandra Petrucci, Università di Firenze.

- *Local likelihood for circular density estimation: theoretical and computational aspects*
  M. Di Marzio, S. Fensore (Università di Chieti), A. Panzera (Università di Firenze), C.C. Taylor (Leeds University)

- *Conditional density estimation for directional data*
  M. Di Marzio, S. Fensore (Università di Chieti), A. Panzera (Università di Firenze), C.C. Taylor (Leeds University)

- *A bivariate wrapped Cauchy model for data distributed on the torus*
  A. Pewsey (Universidad de Extremadura), S. Kato (Institute of Statistical Mathematics, Japan)

15.55-16.15 **Coffee break**

16.15-17.30 **Invited track 10: Statistical Modelling of Environmental Phenomena and their Interactions**

Director: Francesco Finazzi, Università di Bergamo.

Chair: Lucia Paci, Università di Bologna.

- *Looking for changepoints in spatio-temporal earthquake data*
  L. Altieri, D. Cocchi (Università di Bologna), M. Scott (University of Glasgow), F. Greco (Università di Bologna), J. Illian (University of St. Andrews)
- *Multicause trend and cluster analysis of Italian hospitalizations*
  F. Finazzi, M. Cameletti (Università di Bergamo)
- *Bayesian spatial structural equation model for lichen abundance data*
  P. Valentini (Università di Chieti)
- *Non-parametric regression on compositional covariates*
  F. Bruno, F. Greco, M. Ventrucci (Università di Bologna)

17.30-17.50 **Best Poster Awards and Closing Ceremony**

Rognvald Smith, president of TIES, UK Natural Environment Research Council
Alessandro Fassò, coordinator of GRASPA-SIS, Università di Bergamo
Alessio Pollice, vice-coordinator of GRASPA-SIS, Università di Bari

17.50-18.50 **GRASPA-SIS General Annual Meeting**

Post-conference short course: *An Introduction to Flexible Regression for Environmental Data*

Lecturer: Adrian Bowman, University of Glasgow.

Class assistance: Marnie McLean, University of Glasgow.

Environmental data are often characterised by spatial, temporal and seasonal patterns which are smooth but non-linear in shape. There is a wide variety of approaches to building models which are sufficiently flexible to capture these patterns and some of these will be explored in the course. The emphasis will be on regression approaches which allow the inclusion of additional covariates. Topics will include standard methods of constructing curve and surface representations and the use of additive models, but will also include simple Gaussian process and Bayesian approaches. The level will be introductory, suitable for postgraduate students new to the topics, and the style will emphasise conceptual and modelling issues. A variety of datasets will be considered, with strong emphasis on practical work in R.

Time table

9.30-11.00	Session 1 - Methods of Flexible Regression (1,2,3 dimensions)
11.00-11.20	Coffee break
11.20-12.50	Session 2 - Spatial and Spatio-temporal Data
12.50-13.30	Lunch break
13.30-15.00	Session 3 - Additive Models
15.00-15.20	Coffee break
15.20-16.50	Session 4 - Gaussian Process and Other Models

Poster clusters and snapshot sessions

Chairs: Linda Altieri, Università di Bologna and Patrick Vetter, Europa-Universität Viadrina, Frankfurt.

Monday - June 15, 10.35-11.35
Poster snapshot session 1
Cluster 1: Health and Technology

- *Development of biogas and management of the nitrates in Veneto*

  P. Belcaro (Regione del Veneto), F. Schenato (Università di Padova)

- *Energy-efficiency optimization of the biomass pelleting process by using statistical indicators*

  F. Manca (Università di Bari), E. Loiacono, G.L. Cascella, D. Cascella (Idea75 S.r.l., IT)

- *Incidence of brain and Central Nervous System cancer in Foggia's area*

  S. Arcuti, R. Tortelli, G. Logroscino (Università di Bari), F. Saveriano3 (Ospedale "L. Bonomo"), G. Graziano (IRCCS Oncologico Giovanni Paolo II), M.E. Liuni, L.M. Specchio (Università di Foggia), M. Copetti (IRCCS "Casa Sollievo della Sofferenza")

- *Spatio-temporal modelling of zero-truncated disease patterns*

  O. Adegboye (Qatar University), D. Leung (Singapore Management University), Y.G. Wang (University of Queensland)

- *Short term effects of Wind Days on Mortality and Morbidity in Taranto (Italy)*

  M. Serinelli, I. Galise, M. Menegotto, F. Fedele, B. Figorito, L. Angiuli, L. Trizio, G. Assennato (ARPA Puglia), L. Bisceglia (AReS Puglia)

- *Impact of climatic factors on acute bloody diarrhea, dengue and influenza-like illness incidences in the Philippines*

  A. Braga Rarugal, G. Tapang (University of the Philippines Diliman), R.M. Roxas-Villanueva (University of the Philippines Los Baños)

- *Integration of different electronic nose technologies in recognition of odor sources in a solid waste composting plant*

  P. Giungato, A. Demarinis Liotile, E. Tamborra, G. de Gennaro, G. Ventrella (Università di Bari), P. Barbieri, S.C. Briguglio

(Università di Trieste), F. Lasigna (Italcave)

- *Modeling cement distribution evolution during permeation grouting*
  M.B. Demchuk (ACADEMIA-RESEARCH.COM), N. Saiyouri (Université Bordeaux)

- *Statistical analysis on acoustic data combining objective and subjective measures*
  C. Bartalucci, F. Borchi, M. Carfagni, M.S. Salvini, A. Petrucci (Università di Firenze)

- *Environmental sustainable management of urban networks with the use of ICT: Urbanets project. The case of Gallipoli*
  E. Venezia (Università di Bari)

Poster snapshot session 1
Cluster 2: Methodological Advances In Environmental Statistics

- *Modelling spatio-temporal data from mobile monitoring stations*
  S. Del Sarto, M.G. Ranalli, D. Cappelletti, S. Crocchianti, B. Moroni, S. Castellini (Università di Perugia)

- *Approximating likelihoods through precision matrix for large spatial datasets*
  H. Huang (King Abdullah University of Science and Technology, SA)

- *A semi-parametric approach in the estimation of the structural risk in environmental applications*
  R. Pappadà (Università di Trieste), E. Perrone (Johannes Kepler Universität, A), F. Durante (Libera Università di Bolzano), G. Salvadori (Università del Salento)

- *Exploring environmental data through circular boxplots*
  D. Buttarazzi, G.C. Porzio (Università di Cassino e del Lazio Meridionale)

- *Hidden Markov models for longitudinal circular data*
  A. Maruotti, F. Lagona (Università di Roma Tre), A. Punzo (Università di Catania)

- *Assessing the significance of the correlation between the components of a bivariate Gaussian random field*
  M. Bevilacqua, D. Velandia (Universidad de Valparaíso), R. Vallejos (Universidad Tecnica Federico Santa Marìa, Valparaìso)

- *Construction of spatio-temporal covariance functions over the m-dimensional sphere*
- *A. Farinas, E. Porcu (Universidad Tecnica Federico Santa Marìa, Valparaìso)*

Monday - June 15, 13.40-14.40
Poster snapshot session 2
Cluster 3: Flora and Fauna

- *Influence of forest structure on habitat productivity and key foods availability for brown bears in the Apennines*

  G. Jona Lasinio, L. Boitani, P. Ciucci, A. Rositi (Sapienza Università di Roma)

- *Hierarchical space-time model for post-fire vegetation recovery*

  L. Paci (Università di Bologna), A.E. Gelfand (Duke University), M.A. Beamonte(Universidad de Zaragoza)

- *Data-driven and multi-approach sampling scheme optimization: the Alimini Lakes aquifer case*

  E. Barca, M.C. Caputo, L. De Carlo, R. Masciale, G. Passarella (CNR.IRSA, IT)

- *Rarefaction and extrapolation with Hill numbers: a study of diversity in the Ross Sea*

  C. Ghiglione, S. Schiaparelli (Università di Genova), C. Carota, C.R. Nava (Università di Torino), I. Soldani (aizoOn Technology Consulting, IT)

- *Statistical analysis of zoo-agrarian crime*

  C. Cusatelli (Università di Bari), M. Giacalone (Università di Bologna)

- *Fauna characterization of a cold-water coral community network along the Apulian coasts by Bayesian mixed models*

  C. Calculli, G. D'Onghia, N. Ribecco, P. Maiorano, L. Sion, A. Tursi (Università di Bari)

- *Direct and indirect influences of landscape structure on local habitat quality*

  B. Cafarelli (Università di Foggia), P. Mairota, R. Labadessa (Università di Bari), F. Lovergine, C. Tarantino (CNR-ISSIA, IT), H. Nagendra (PES Institute of Technology Campus, IN), R.K. Didham (University of Western Australia and CSIRO)

- *Structural equation modelling in root research: a focus on 0-tillage systems*
  R. Rossi, A.V. Vonella, D. Ventrella (CRA-ZOE, IT), C. Calculli (CoNISMa, IT), M. Amato (Università della Basilicata), A. Pollice (Università di Bari)

Poster snapshot session 2
Cluster 4: Climate

- *Sea state characterization throughout linear and circular data*
  M. Picone, A. Orasi (ISPRA, IT)
- *Official statistics for decision making: an environmental accounting case study related to biodiversity*
  E. Recchini (Istat, IT)
- *Post-processing of the Weather Research and Forecasting (WRF) mesoscale model by Artificial Neural Networks*
  A. Tateo, R. Bellotti (Università di Bari and INFN), F. Fedele, A. Guarnieri Calò Carducci (ARPA Puglia), A. Pollice (Università di Bari)
- *Similarity indices of meteo-climatic gauging stations for missing data handling: definition and comparison with the MICE method*
  E. Barca, G. Passarella (IRSA-CNR, IT)
- *Spatial bias analysis for the Weather Research and Forecasting model (WRF) over the Apulia region*
  F. Fedele, A. Guarnieri Calò Carducci (ARPA Puglia), A. Pollice (Università di Bari), R. Bellotti (Università di Bari and INFN)
- *Avoiding the global change in climate*
  V. Demchuk (Rivne State Humanitarian University, UKR), M.B. Demchuk (ACADEMIA-RESEARCH.COM)
- *The role of ISPRA in the field of environmental statistical information*
  M. Bultrini, A. Orasi, M. Picone, D. Romano (ISPRA, IT)
- *Joint downscaling of temperature and precipitation*
  D. Cocchi, L. Paci, C. Trivisano (Università di Bologna)

Book of Abstracts

Keynote lectures

VISUALISING THE ENVIRONMENT: DATA, MODELS AND GRAPHICS

Adrian Bowman
School of Mathematics and Statistics, University of Glasgow, UK; email: adrian.bowman@glasgow.ac.uk

This talk aims to reflect a little on the languages we use to explain, discuss and communicate statistical concepts, models and analysis, both within our own community and beyond it. There will be particular emphasis on how we communicate uncertainty. Several types of analysis will be considered, mostly involving flexible regression and focussed largely on different forms of spatiotemporal data. However, there will be a strong focus on the role of graphics, which can provide a powerful means of conceptual communication and give clear expressions of the insights provided by models, while remaining true to the issues associated with uncertainty.

FREQUENCY DOMAIN METHODS FOR THE ANALYSIS OF STATIONARY SPATIO-TEMPORAL RANDOM PROCESSES

Tata Subba Rao
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Consider a stationary spatio-temporal random process Z (s, t), where s belongs to R^d (d is the dimension of the space), and t belongs to Z (a set of integers). Let us assume we have data at m locations, and at each location we have n time series (equally spaced). One of the problems of interest to environmental scientists is to estimate an observation at a known location s_o, where no observations are available. This problem is widely known as a spatio-temporal kriging. If one proceeds to estimate this (even under the Gaussianity assumption), one needs to evaluate an inverse of a very high dimensional variance covariance of the data vector (which is a column vector of dimension mn x 1) which can be unwieldy if m and n happen to be large. In fact, in real situations they are large. Besides this, if one follows time domain approach in solving this problem, it is well known that the formulation of data vector from the data can be arbitrary, resulting in an unsatisfactory situation. In addition to this problem, to calculate the elements of the covariance matrix, one needs a parametric function of the spatio-temporal covariance function. Any function chosen to be a covariance function needs to be a positive semidefinite function. Several authors proposed various functions, considered the estimation of the parameters using spatio-temporal variogram, using its similarity with classical spatial methods. We point out draw backs of these time domain methods. In the present talk, we present an alternative methodology based on frequency domain methodology. We consider the Discrete Fourier Transforms (DFT) of the data (taken over time) at each location, consider these complex valued random processes as our data. Like in Matern and Whittle, we now define complex stochastic partial differential equations (of Laplacian type) and derive an explicit variance-covariance function which is spectral in time, and function of spatial distance. Using this function, we obtain predictors for the data at a known location. We also define a frequency domain variogram (which we call frequency variogram) and show how it could be used to estimate the parameters of the defined covariance function. This frequency variogram is nothing but a new way of defining the time domain variogram, but easy to compute, easy to study the sampling properties. We illustrate the methodology with real data. (The results presented are based on a paper written jointly with Gy Terdik, University of Debrecen, Hungary).

Invited track 1: Sampling Strategies for Design-Based Inference on Animal and Plant Communities

GEOGRAPHICALLY-ASSISTED ESTIMATION OF THE POPULATION TOTAL

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Estimation of the population total of a geographically distributed variable has been usually tackled from a design-based point of view. More specifically, several efficient probabilistic sampling designs have been proposed for taking advantage of the spatial nature of the phenomenon at hand. Conversely, very few contributions have been proposed to enhance estimators. This work aims to enrich the proposal of estimators by exploiting the geographical information on the population locations in the spatial domain. Spatial coordinates are population characteristics known before sampling and are here used to construct a proper weighting system as customary under the design-based inference paradigm. Starting from a new individual design-based spatial predictor, an estimator of the total is straightforwardly obtained. Simple random sampling without replacement is considered. A Monte Carlo experiment is developed on an original ecological dataset, consisting of vegetation cover measured in terms of the number of vascular plants species on a 30 by 30 grid. Sampling sizes of 1, 2, 4, 8 per cent and two settings of 1000 and 5000 Monte Carlo replicates were considered. Under this framework, three alternative estimators for the population total are checked and assessed via a number of summary measures.

LARGE SCALE ASSESSMENT OF UNGULATE POPULATIONS VIA NOCTURNAL DISTANCE SAMPLING. DO SURVEY DESIGNS BASED ON RANDOM FOOTPATHS SELECTION PROVIDE RELIABLE ESTIMATES?

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Conventional Distance Sampling (CDS) recently emerged as an advantageous technique to avoid the assumption of constant detectability implicit in many monitoring surveys of ungulate abundances carried on in large study areas. CDS can be applied for large mammals with relatively high detectability and, compared to capture-mark-recapture, it has the advantage of providing an estimate of detection probability without catching animals. In spite of this, when the ungulate population of interest occupies a large, forested study area, the terrain roughness and the lack of an adequate road networks may prevent CDS application. Or, at least, the environmental constraints may not allow an appropriate placement of the samplers across the study area, thus introducing systematic biases in the survey design, resulting also in an uneven coverage probability. In nocturnal surveys where animals are detected by thermal imagining, a common solution is to collect data along existing footpaths but, till now, nobody has investigated whether this approach provides reliable estimates. In this study, we consider two sampling designs for CDS along footpaths: i) random selection of footpaths, and ii) two-stage sampling selection of footpaths. Adopting a simulation approach, we apply them to arbitrary-distributed populations and we evaluate the performance of the estimators in terms of accuracy and precision, showing that the two-stage sampling designs with few blocks may emerge as a cost-effective design to improve the estimate of ungulate abundances at a landscape scale. We demonstrate our ideas by applying this method to a red deer (Cervus elaphus) population in the Italian Apennines.

THE ESTIMATION OF FOREST COVER FROM REMOTE-SENSED TWO-STAGE INVENTORIES

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In tropical and subtropical countries remote-sensed inventories are mandatory to estimate forest cover and also for constructing historical records as forest cover baselines. Owing to the high costs and forest inaccessibility (e.g. REDD projects), ground inventories cannot be carried out regularly at a large scale. In these context of survey, the study area consists of a grid of imagery segments of pre-fixed size and the proportion of forest cover is obtained measuring within segments the classification of satellite imagery. The classification process results from a combination of unsupervised automated or semi-automated procedures and manual enhancements, clearly with different time efforts. Therefore manual classifications are achieved only for a sample of segments selected in a first stage, hence forest cover is estimated in a second stage through a sample of pixels selected within each previous selected segment. As unsupervised satellite imagery classification data may be freely available over the whole study area, they may be treated as good proxies of the manually classified forest cover data, in order to be used at estimation level. So, how to choose the segments where manual imagery classification is carried out is the issue to be assessed. This contribution investigates the efficiency of the one-per-stratum stratified sampling in both stages of selection and the efficiency of the difference estimator. This strategy is then compared with the simple random sampling without replacement. From a real map of pixels concerning an area located in the Central Italy, three artificial populations are constructed from the Landsat classification of forest/non forest, presuming three levels of error rates of the unsupervised classification of satellite imagery.

POINT AND PLOT SAMPLING FOR LARGE-SCALE INVENTORY OF TREES OUTSIDE FORESTS

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Trees outside forest (TOF) are prominent features in many landscapes worldwide, including natural, cultural and recently modified landscapes. The methods usually employed to assess TOF owe more to experimentation than to careful operational planning: such considerations have motivated the present study aimed at investigating survey methods for assessment of TOF abundance and coverage based on point and plot sampling, as usual in the framework of large-scale inventories by remotely sensed imagery. A sequence of points or plots are placed onto the survey area in accordance with a probabilistic scheme, each point or plot is pinpointed from remotely sensed imagery and TOF selected by points or plots are identified. The purpose of this study is to compare one-phase inventory with sampling units selected by Tessellation Stratified Sampling (TSS) and two-phase inventory where TSS is joined by one-per-stratum stratified sampling (OPSS) to select

polygons from the grid in the second phase. Estimation obtained by Uniform Random Sampling is also carried out as a benchmark for TSS. Sampling schemes to select TOFs considered in this study are: (i) point sampling, (ii) centroid-based plot sampling with a plot radius of 50 m, (iii) centroid-based plot sampling with a plot radius of 100 m, (iv) plot intersect sampling with a plot radius of 50 m, (v) plot intersect sampling with a plot radius of 100 m. Five second-phase sample sizes, corresponding to sampling fractions of about 50, 25, 10, 5 and 1%, are supposed. The census of about 50,000 TOF within Molise Region (Italy) was acquired by visual on-screen interpretation of aerial ortho-photos as the reference population. The performance of sampling schemes was tested in terms of relative standard error, expected sample size and approximate expectation of relative standard error estimator. One-phase inventory with centroid-based 50-m-plot sampling proves to be the best scheme for large scale TOF assessment, among those tested.

Invited track 2: Analysis of Spatio-Temporal Data

SPATIO-TEMPORAL WIND SPEED PREDICTIONS FOR GERMANY

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State of the art wind forecasting models, like Numerical Weather Predictions utilize huge amounts of computing time. Some of them have rather low spatio-temporal resolution. Time series prediction model accomplish good results in high temporal settings. Moreover, their consumption of computing capacities is relatively low and return accurate short-term to medium-term forecasts. The recent literature shows increasing interest in the topic of spatial interdependence. This article deals with a spatial and temporal model for wind speed. We describe the temporal model structure independently on spatial correlations. Therefore, seasonality and a huge correlation structure are included. Subsequently, the model is extended and a spatial structure is included. The data set includes ten minute observations of several measurement stations in Eastern Germany. The validation procedure shows that the model is reliable.

IDENTIFYING TRENDS IN THE SPATIAL ERRORS OF A REGIONAL CLIMATE MODEL VIA CLUSTERING

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Since their introduction in 1990, regional climate models (RCMs) have been widely used to study the impact of climate change on human health, ecology, and epidemiology. To ensure that the conclusions of impact studies are well founded, it is necessary to assess the uncertainty in RCMs. This is not an easy task since two major sources of uncertainties can undermine an RCM: uncertainty in the boundary conditions needed to initialize the model and uncertainty in the model itself. Building upon the work of Berrocal et al. (2012), in this paper we present a statistical modelling framework to assess an RCM driven by analyses. More specifically, our scientific interest here is determining whether there exist time periods during which the RCM in consideration displays the same type of spatial discrepancies from the observations. The proposed model can be seen as an exploratory tool for atmospheric modellers to identify time periods that require a further in depth examination. Focusing on seasonal average temperature and seasonal maximum temperature, our model relates the corresponding observed seasonal fields to the RCM output via a hierarchical Bayesian statistical model that, at the first stage specifies either a normal distribution or a GEV continuous spatial process, and at a second stage includes a spatio-temporal calibration term provided with a Dirichlet process prior, thus enabling clustering of the errors in time. We apply our modelling framework to data from Southern Sweden spanning the period December 1, 1962 to November 30, 2007

MULTIVARIATE SPATIO-TEMPORAL MODELS FOR LARGE DATASETS AND JOINT EXPOSURE TO AIRBORNE MULTIPOLLUTANTS IN EUROPE

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We consider the distribution of population by exposure to multiple airborne pollutants at various spatial and temporal resolutions over Europe. The estimation of this distribution and its uncertainty are obtained via model based high resolution semiparametric estimates of daily average concentrations for seven pollutants in years 2009-2011. In order to exploit the spatial information content and allow the computation of daily multipollutant exposure distribution, uncertainty included, we use a multivariate spatio-temporal model capable to handle non Gaussian large datasets such as multivariate and multi-year daily air quality, land use and meteorological data over Europe.

SPATIO-TEMPORAL STATISTICAL ANALYSIS OF THE GLOBAL CARBON DIOXIDE CYCLE

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As a major contributor of the greenhouse effect, rising carbon dioxide concentration levels in the atmosphere are the main cause for global climate change. A complete picture of the ongoing processes driving the carbon cycle is needed to identify sources and sinks of carbon dioxide, which is an important input to global climate change negotiations. In this paper, remote-sensing data on total column measurements of CO_2 together with statistical space-time models and dimension reduction methods are used to derive smoothed estimates of the CO_2 concentration and its sources and sinks. In particular, different methods for approximating the spatial covariance functions are compared and are applied to tropospheric CO_2 concentrations. In order to quantify the Net Ecosystem Exchange, i.e. the net carbon dioxide flux between an ecosystem and the atmosphere, a spatio-temporal statistical framework based on remotely-sensed carbon dioxide ground concentrations together with data on the Normalized Difference Vegetation Index, the Gross Primary Production and the Land cover classification is introduced. The model is based on spatial and temporal latent random effects, that act as space-time varying coefficients, which allows for a flexible modelling of the spatio-temporal auto- and cross-correlation structure. The intra- and inter-annual variations of the Net Ecosystem Exchange are evaluated and dynamic maps are provided on a nearly global grid and in intervals of 16 days.

Invited track 3: Environmental Official Statistics: Developments and Challenges

INTEGRATION OF ADMINISTRATIVE AND SURVEY DATA FOR MATERIAL FLOW ACCOUNTS

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In the framework of Economy-wide Material Flow Accounts (EW-MFA), data on materials extracted from quarries and mines play an important role. Non-metallic minerals extraction accounts for 40% of the Italian economic system's direct material input. Having a good knowledge of this phenomenon is important not just because of the direct environmental pressures and impact on landscape of extraction, but also because the man-made stocks, in which the extracted materials are eventually embodied, have great additional impact on Nature and greatly determine the way our territory responds to phenomena such as extreme climatic events. In this paper we describe how administrative data and survey data are used jointly at Istat in order to derive more complete and reliable estimates of the quantities of non-metallic minerals extracted in Italy. We discuss the way microdata have been collected from the local authorities covering almost all the Italian territory, organized, re-classified according to EW-MFA standards, linked to business registers, analysed, and finally compared to the PRODCOM survey microdata in order to derive an adjusted microdata set which was used in order to estimate the extracted quantities at the national level.

ENVIRONMENTAL QUALITY OF URBAN AREAS: A CROSS-CUTTING APPROACH TO MEASURE SMART FACTORS AND ECO-SUSTAINABILITY

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To set out a national urban agenda means primarily to plan actions and policies for the improvement of urban quality, aiming to make our cities places of good living. The environmental quality of urban areas (in terms of noise and air pollution, availability of green areas, etc.), as well as the local policies in matter of energy, water resources, waste management, and urban mobility, are all dimensions to be considered, because of their direct influence on citizens' well-being and sustainability of urban development. In this scope, the recent, increasing demand for measuring the evolution of urban communities towards the model of the "smart city" – a concept that can hardly be separated from that of eco-sustainability – represents one of the major challenges that official statistics is facing nowadays. In this presentation we describe a recent experimentation, based on 60 response indicators (according to the DPSIR model) on urban environment, produced by the Istat survey "Dati ambientali nelle città". Following a new approach, it is proposed a cross-reading of data set, that was not structured according to the classical thematic breakdown but by indicators classification according to their relevance to six cross-cutting dimensions, each representing a different aspect of "smartness" and eco-sustainability in the governance of the 116 Italian provincial capitals: 1. Planning instruments; 2. Environmental policies (actions fostering sustainable urban development); 3. Technological innovation; 4. Eco-social innovation (actions bridging environmental benefits, social inclusion and environmental awareness); 5. Transparency and participation; 6. "Self-governance" (sustainable management of the Municipality as an organization).

INTERNATIONAL FRAMEWORKS FOR ENVIRONMENTAL STATISTICS AND THEIR APPLICATION TO CLIMATE CHANGE RELATED STATISTICS

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The last decades witnessed increasing demand of statistics and accounts in order to adequately describe environmental issues. The information required cover a wide range of interlinked statistical domains. For Climate Change (CC), linkages of environmental statistics with economic and social ones are particularly strong. Referenced frameworks – among the several national and international initiatives responding to the growing demand – have the advantage of structuring the overwhelming amount of information produced. The aim of this work is to present how two main international frameworks can be used for providing environmental statistical information, especially on CC. The first framework, the UNSD-FDES 2013 and its methodological 2014-2016 developments, is based on a multi-purpose conceptual and statistical approach, defining standardized concepts, definitions and methodologies. The second is the System of Environmental Economic Accounting 2012 – Central Framework (SEEA-CF) providing the first international statistical standard for environmental-economic accounting. In the UN-ECE context, FDES and SEEA are both primary sources in the work to define an internationally comparable set of key CC related statistics and indicators. A main objective of the UN-ECE Groups is to enhance the role of NSOs in the development of statistics on CC related phenomena. Istat provides a significant contribution to these frameworks development in building and implementing harmonized methods and definitions. The challenge is to adequately transform data into environmental statistics, relevant to official statistics production, ensuring a coherent system at national and international level, suitable to meet the increasing information demand on environment and especially on Climate Change.

ISTAT SURVEY ON ENERGY CONSUMPTION OF HOUSEHOLDS: MAIN CHARACTERISTIC AND FUTURE APPLICATIONS FOR THE PRODUCTION OF ESTIMATES BY END USE

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As part of Istat statistical production dedicated to energy issues, a crucial role is played by the new survey on energy consumption of households, carried out for the first time in Italy in 2013, in collaboration with Enea and the Ministry of Economic Development. The energy consumption of households has become increasingly important over time in the determination of total national consumption. As a consequence, the residential sector has been affected by a number of EU and national policy measures for the promotion of energy efficiency and renewable sources. The survey on energy consumption of households provides the essential information to quantify residential sector consumption according to different uses and sources of energy, with a focus on renewable energy and biomass. This wealth of information is necessary to fill in information gaps at the international level. Data on the consumption of renewable sources, in fact, is essential for monitoring the so-called 20-20-20 targets for Europe. The survey also will also supply the annual data on residential energy consumption, the collection of which has recently made mandatory by the European Regulation on energy statistics (no. 1099/2008). With this goal, Istat, in cooperation with Enea, is undergoing an activity of statistical modelling aimed at estimating annual energy

consumption and its distribution by final destination and source. For 2016 we plan to perform a new survey edition and, at the same time, the survey data integration with administrative records on the consumption of electricity and gas at the level of individual users.

Invited track 4: Recent Developments in Latent Variable Models with Environmental Applications

A NEW CYLINDRICAL HIDDEN MARKOV MODEL FOR THE IDENTIFICATION OF SEA REGIMES

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The identification of sea regimes requires special methods for clustering mixed linear and circular data. Classification of marine data should account for the cylindrical support of the data, the skewness of the observed variables and the temporal autocorrelation of the measurements. We address these issues simultaneously by developing a new hidden Markov model where mixed linear and circular data are assumed as samples drawn from a cylindrical distribution, whose parameters evolve according to a latent Markov chain. Estimation of the model allows to segment the data into cylindrical clusters by means of the inferred sequence of latent states. We illustrate an efficient EM algorithm to estimate the parameters of the new model and the simulation routines that allow for computation of bootstrap standard errors, to account for classification uncertainty. These methods are illustrated for a multivariate marine time series of wave heights and directions in the Adriatic Sea.

BAYESIAN SPATIO-TEMPORAL MODELS FOR DIRECTIONAL AND DIRECTIONAL-LINEAR VARIABLES

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Directional data arises in many areas of application, for example meteorology (wind direction) and biology (animal movement data). The non-Euclidean nature of such data poses difficulties in applying ordinary statistical methods developed for linear data, motivating the need for specialized modelling framework. Moreover often directions are recorded along with linear variables, for example wind direction and velocity, and a joint modelling is challenging. We first illustrate spatio-temporal models for directional data based on the wrapped Gaussian, the wrapped skew Gaussian and projected Gaussian processes and we show how, introducing suitable latent variables, the inference within a Bayesian framework is straightforward. Then we move to temporal setting. We propose two multivariate directional-linear distributions and we use them as emission distribution in hidden Markov models. The first distribution, based on the projected normal and the skew normal, is suitable to jointly model continuous multivariate directional-linear data while the second is suitable to model multivariate discrete circular-linear variables. Here again the inference is simplified introducing suitable latent variables.

ON GENERATING A FLEXIBLE CLASS OF ANISOTROPIC SPATIAL MODELS USING GAUSSIAN PROCESSES

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Stochastic spatial models based on Gaussian processes are experiencing a surge of popularity in recent literature due to their abilities to investigate spatial variation in many physical quantities of interest in diverse application areas. A stationary Gaussian process with an isotropic covariance function is often the default choice for statistical modellers since such an assumption implies a tractable model leading to easily amenable analysis and computation. Non-stationary and

anisotropic models are generally avoided because of their complexity both in formulation and in implied analysis methods. This work proposes a flexible class of non-stationary and anisotropic spatial models by using recently developed Gaussian predictive processes. So far these are only used as approximate dimension reduction models for analysing large spatial data sets. The contribution of the current article lies in proposing these models even for small sizes and studying the nature of anisotropy implied by these predictive processes under various scenarios of selection of knot locations where the predictive process is to be anchored for both small and large data sets. Results obtained here show that different random and non-random choices lead to new flexible forms of anisotropic covariance functions not yet studied in the literature. These new covariance functions give rise to new flexible and accurate Bayesian predictive models but do not complicate the fitting and analysis methods unlike other models based on anisotropic covariance functions. The proposed methods are illustrated using two practical data sets on modelling air-pollution exposure in London and other on modelling a well-known data set on scallop abundance in the Atlantic Ocean near the City of New York.

Invited track 5: New Monitoring Systems for Environmental Data: Statistical Challenges

PATTERNS AND PROCESSES REVEALED IN HIGH-FREQUENCY ENVIRONMENTAL DATA

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High-frequency data are informative but also very challenging to analyze. Appropriate statistical tools are required to extract useful information from such data. A 15-minute resolution sensor generated time series of the $EpCO_2$ from October 2003 to August 2007 in a small order river system in Scotland is used as an illustrative dataset. The aim of this paper is to study the daily patterns and dynamics of $EpCO_2$ using a Functional Data Analysis (FDA) approach. Using FDA, the discrete data within each day have been transformed to a smooth curve; then, a K-means clustering procedure has been applied to the spline coefficients defining the daily curves to identify the common daily patterns which can then be linked to underlying climatological and hydrological conditions.

REAL-TIME DETECTION OF EARTHQUAKES THROUGH A SMARTPHONE-BASED SENSOR NETWORK

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The Earthquake Network project implements a world-wide smartphone-based sensor network for the detection of earthquakes. The accelerometric sensor onboard each smartphone is used to detect vibrations which are immediately reported to a server. The server analyses the information coming from the entire network and when a quake is detected it is notified to all smartphone users in quasi real-time. In this work we propose and compare two solutions to the detection problem. One solution is based on a likelihood approach and the other is based on filtering.

MULTI-RESOLUTION AND SPATIAL INDEPENDENT COMPONENT ANALYSIS APPROACHES FOR GEO-REFERRED AND TIME-VARYING MOBILE PHONE DATA

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The aim of this work is to provide different statistical tools to catch meaningful and useful information from geo-referred quantities varying along time. In particular a mobile-phone traffic dataset is analyzed to decompose the spatiotemporal information in order to identify spatial and temporal patterns. Two different approaches have been followed. The first one is an Independent Component Analysis (ICA) approach, where sources are assumed to be spatial stochastic processes on a lattice, in order to take into account the spatial dependence between pixels. This method is called spatial colored Independent Component Analysis (Shen, Truong, Zanini, 2014). The second one is a multi-resolution approach, where a temporal sparsity to the final representation is imposed through a wavelet-inspired data-driven procedure. This method is called Hierarchical Independent Component Analysis (Secchi, Vantini, Zanini, 2014). Results highlight urban features related to residential, leisure and mobility activities.

Invited track 6: Statistics for Functional Data with Complex Dependencies

SPATIAL DEPENDENCE IN MODEL-BASED FUNCTIONAL CLUSTERING PROCEDURES

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Functional data clustering procedures often involve classifications of geo-referenced curves. In this case, the role of spatial dependence has to be considered and investigated. We present a model-based approach for clustering time-varying functions that are spatially interdependent, by assuming that the clustering membership is a realization from a Markov random field. This methodology was applied to the concentration of chlorophyll on the surface of the Adriatic Sea, a relevant and well-studied semi-closed part of the Mediterranean Sea. This analysis is conducted in order to identify homogeneous areas considering only the behaviours: such zonation is becoming extremely relevant for the implementation of European policies, such the Marine Strategy Framework Directive.

FANOVA MODELS IN RECTANGULAR AND CIRCULAR DOMAINS

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FANOVA models on rectangular and circular domains are analyzed. Dirichlet boundary conditions are imposed to define the corresponding covariance operators of the Hilbert-valued components of the vector error term. Minimal conditions are imposed on the fixed effect design matrix to obtain the generalized least-squares estimator of the Hilbert-valued vector of fixed effects.

DYNAMIC SOCIAL NETWORK ANALYSIS USING FUNCTIONAL DATA MODELS

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Social networks analyses have become increasingly popular in recent years, and a growing interest is related to even more large data availability on this topic. In this paper we give a different look at social network analysis and propose to study a network evolution into the scope of a functional model. Specifically, we describe the underlying dynamic system to analyze the changes of an ongoing relationship. By dynamic, we mean that the model can describe the change in the network dynamic and can update its behaviour based on newly arriving information. Our approach accounts for peculiar network statistics by using modern functional data analysis techniques. Specifically, we estimate a network's change velocity and acceleration and use these dynamics, together with other network-related information, to develop a dynamic functional network model

MODELLING FUNCTIONAL DATA WITH COMPLEX DEPENDENCIES VIA PARTIAL DIFFERENTIAL REGULARIZATIONS

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We present a class of models for the analysis of functional data with complex dependencies, such as spatially dependent curves or time dependent surfaces. The models are based on the idea of regression with partial differential regularizations. We focus in particular on a separable spacetime version of the model. Among the various modelling features, the proposed method is able to deal with spatial domains featuring peninsulas, islands and other complex geometries. Space-varying covariate information is included in the models via a semiparametric framework. The estimators have a penalized regression form, they are linear in the observed data values, and have good inferential properties. The use of numerical analysis techniques, and specifically of finite elements, makes the models computationally very efficient. The model is compared via simulations to other spatio-temporal techniques and it is illustrated via an application to the study of the annual production of waste in the municipalities of Venice province.

Invited track 7: Data, Models and Statistical Problems in Climate Monitoring

COLLOCATION UNCERTAINTY IN CLIMATE MONITORING

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Understanding collocation mismatch is particularly relevant for atmospheric profiles obtained by radiosondes, as the balloons containing the measuring instruments tend to drift uncontrollably from their initial launch position. We propose a heteroskedastic functional regression model capable of explaining the relationship between collocation uncertainty and a set of environmental factors, height and distance between imperfectly collocated trajectories. Along this line, a five-fold decomposition of the total collocation uncertainty is proposed, giving both a profile budget and an integrated column budget. Considering the profiles as three-dimensional trajectories, we extend the model to include a trivariate smooth function that accounts for time and space mismatch. Results from a case study where we model collocation error of relative humidity and atmospheric pressure show that model fitting is improved once heteroskedasticity is taken into account.

QUANTIFYING THE VALUE OF HUMIDITY MEASUREMENTS AT GCOS REFERENCE UPPER-AIR NETWORK SITES

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The potential for measurement redundancy to reduce uncertainty in atmospheric variables has not been investigated comprehensively for climate observations. We evaluated the usefulness of entropy and mutual correlation concepts, as defined in information theory, for quantifying random uncertainty and redundancy in time series of the integrated water vapour (IWV) and water vapour mixing ratio profiles provided by five highly instrumented GRUAN (GCOS Global Climate Observing System Reference Upper-Air Network) stations in 2010-2012. The aims of this work are: (i) to show the potential of entropy and MC as metrics for quantifying uncertainty (in a probabilistic sense) and the value of redundancy in climate time series, (ii) to study, according to GRUAN standards, the uncertainty and the value of redundancy of in situ and ground-based remote sensing techniques for estimating ECVs and to provide recommendations for the establishment of an observation protocol to reduce the uncertainty of a measurement time series through measurement redundancy, (iii) to aid site scientists, managers, and funders in making informed decisions on new instrument procurements to maximize the scientific return on the capital expenditure. The present

study identifies mutual correlation as a fast and efficient metric to quantify the value of redundant measurements. Entropy and mutual correlation can be successfully used to study the redundancy of co-located measurements provided by different surface-based techniques and to correlate the redundancy with other factors such as number of instruments, measurement techniques, and retrieval algorithms.

SPACE-TIME COVARIANCES FOR PLANET EARTH

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In this paper, we propose stationary covariance functions for processes that evolve temporally over a sphere, as well as cross-covariance functions for multivariate random fields defined over a sphere. For such processes, the great circle distance is the natural metric that should be used in order to describe spatial dependence. Past literature has been based on Euclidean distance based on map projections, or on chordal distance. They both constitute an approximation of the state of nature. After proposing some general result for obtaining space-time covariances based on great circle distance, we inspect the impact of using the correct metric with respect to estimation as well as prediction. In particular, our evidences are confirmed by simulation studies as well as through revisiting the TOMS data, being modelled through chordal distance in the past.

Invited track 8: Modelling Ecological Data

MODELLING THE PERCENT AFFINITY INDEX IN ENVIRONMENTAL MONITORING: SOME STATISTICAL PROPERTIES

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The percent model affinity (PMA) index is a measure of community composition based on the percent abundances in taxonomic groups. The PMA index is intended for use in conjunction with other biological indices to assess the ecological status of environmental ecosystems and it is widely used in aquatic biomonitoring. In particular, the PMA index measures the level of similarity between two communities in terms of similarity between two probability distributions which are defined over the same domain of categorical values. The probability profiles are referred to two distinct experimental conditions, as for instance the composition of two populations of individuals with respect to a taxonomic classification under different environmental statuses. In many environmental applications the two profiles are generally named impacted profile and reference profile, respectively. In fact, in this framework, the PMA index is often used to measure the level of degradation of an impacted environment with respect to a reference standard. The goal of this work is to study the statistical properties of the PMA index under the Multinomial modelling, we consider several scenarios and derive the exact representation of expectation and variance. We also present some asymptotic results in the case of reference composition known. Through a large Monte Carlo simulation study we investigate the effect of sample size, number of groups and entropy on those statistical moments. Moreover we present results from real data applications and discuss some guidance suggestions for decision makers involved in environmental monitoring that uses the PMA index.

SPATIAL POINT PROCESS MODELLING IN BIODIVERSITY RESEARCH: A DIALOGUE

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Strongly motivated by interdisciplinary research substantial advances have been made in the development of practically relevant, spatial statistical methodology. In particular, in the context of biodiversity research, an intense dialogue has been fruitful and been of mutual benefit. In the context of spatial point process models, this has been the case, in particular, for log Gaussian Cox processes. Facilitated by the recent development of efficient and very accurate approximation methods for fitting models based on spatial random fields it has become possible to develop and apply flexible and realistically complex spatial models without prohibitive computational cost. The R library R-INLA has been instrumental in making these methods available to non-specialist users and promoting their usage in practice. This talk outlines the mutual benefits of developing both methodology and software as part of a continuing dialogue between method developers and ecologists in this specific context. Highlights of this symbiosis and recent developments resulting from it are presented.

BAYESIAN BELIEF NETWORKS FOR MODELLING ECOSYSTEM SERVICES

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The Ecosystem Services concept is being promoted as a way of valuing the contributions of ecosystems and the environment generally to human wellbeing. This valuation is of most relevance when there is a decision to be made or a scenario to be explored, and the process on coming to that valuation involves connecting together many types of information including ecological/environmental models, socio-ecological perceptions, and economic returns. Bayesian Belief Networks (BBN) provide a way of pulling together such different types of information but introduce various simplifications. This talk will illustrate the use of BBNs in a range of situations and discuss the appropriate use of ecological models within this framework.

Invited track 9: Advances in Directional Statistics

CONDITIONAL DENSITY ESTIMATION FOR DIRECTIONAL DATA

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As it is known, conditional densities provide the most informative summary on the relationship between explanatory and response variables. We need to estimate it in place of the simple conditional mean when its shape is not well-behaved (multi-modality, significant asymmetry, and/or heavy tails constitute classical cases for this). Also, conditional densities constitute an important tool in the field of statistical prediction. There is not a large amount of literature concerning estimation of conditional probability density functions for directional data, and our aim is to discuss this within a non-parametric context. In particular, we treat conditional density estimation as a local polynomial fitting problem as proposed by Fan, Yao and Tong (Estimation of conditional densities and sensitivity measures in nonlinear dynamical systems, Biometrika 83, 189-206, 1996). In the Euclidean setting, and discuss a class of estimators in the cases when one variable or both have a directional nature. Asymptotic properties for the proposed class of estimators are derived. The effectiveness of the methods for finite sample sizes is illustrated by simulative experiments and real-data applications.

LOCAL LIKELIHOOD FOR CIRCULAR DENSITY ESTIMATION: THEORETICAL AND COMPUTATIONAL ASPECTS

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We propose a class of local estimators for multivariate circular densities. The idea lies in optimizing a kernel-weighted version of the log-likelihood function, where the logarithm of the unknown density is locally approximated by a p-th degree polynomial: different values of p lead to different estimators within the same class. As a general advice, we use an higher value of p if the population density has a complex shape and samples are large. Since such estimators do not have a closed form, the computational aspects become central. Major issues concern the choice of suitable weight functions, which have to be periodic, and the use of local approximations of log-densities, which need to be specific to the toroidal domain. Asymptotic properties of the proposed estimators are derived with the result of a bias reduction when the polynomial degree increases. In order to facilitate the practical use, we provide explicit results for the particular case when a d-fold product of von Mises densities is employed as the weight function. When the approximating polynomial has degree one we reduce the computational burden by exploiting the properties of Bessel functions. On the other hand, when an approximating polynomial of order two is considered, we obtain an analytical form for an approximation of the estimator which holds in an asymptotic fashion. Concerning the smoothing degree selection, we propose different strategies ranging from some simple plug-in approaches to various versions of constrained cross-validation. Some simulations are also employed to show the effectiveness of the methods.

A BIVARIATE WRAPPED CAUCHY MODEL FOR DATA DISTRIBUTED ON THE TORUS

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A five-parameter bivariate wrapped Cauchy distribution is proposed as a unimodal model for toroidal data. The model is highly tractable, displays a range of desirable properties, including marginal and conditional distributions that are all wrapped Cauchy, and arises as a submodel of a six-parameter distribution obtained by applying Möbius transformation to a pre-existing model for toroidal data. Two other derivations of the distribution are also available. A single dependence parameter controls the relationship between the two component circular variables, ranging from independence to perfect correlation. The distribution's trigonometric moments of can be expressed in closed form, as can three popular correlation coefficients. The model also provides the basis for a new Markov process for circular data and a distance measure on the torus. Method of moments and maximum likelihood estimation are both very fast, and tests for independence and goodness-of-fit are available. The application of the new model is illustrated in the mixture modelling of data on the direction of steepest descent and the direction of lateral ground movement before and after, respectively, an earthquake that took place in Noshiro, Japan.

Invited track 10: Statistical Modelling of Environmental Phenomena and their Interactions

LOOKING FOR CHANGEPOINTS IN SPATIO-TEMPORAL EARTHQUAKE DATA

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This work presents an application of a new method for change-point detection on spatio-temporal point process data. We summarise the methodology, based on building a Bayesian hierarchical model for the data and priors on the number and positions of the change-points, and introduce two approaches to taking decisions on the acceptance of potential change-points. We present the dataset collecting Italian seismic events over 30 years and show results for multiple change-point detection. Finally, concluding comments and suggestions for further work are provided.

NON-PARAMETRIC REGRESSION ON COMPOSITIONAL COVARIATES

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Methods to perform regression on compositional covariates have recently been proposed using isometric log-ratios (ilr) representation of compositional parts. This approach consists of first applying standard regression on ilr coordinates (with no need for either constraint on regression coefficients or the use of Moore Penrose generalized inverse) and second, transforming the estimated ilr coefficients into their contrast logratios counterparts which give easy-to-interpret parameters for the linear effect of each compositional part, in relative terms, on the response. In this work we present an extension of this framework, where compositional covariate effects are allowed to be smooth in the ilr domain. This is achieved by fitting a smooth function over the multidimensional ilr space, using a basis of B-splines and a set of associated spline coefficients. Smoothness is achieved by assuming random walk priors on spline coefficients in a hierarchical Bayesian framework. The proposed methodology is illustrated on a dataset from an ecological survey on a gypsum outcrop located in the Emilia Romagna Region, Italy. Data consists of measurements of vegetation cover and substrate compositions in a grid format. The application goal is to estimate substrate suitability for vegetation, regarding four different substrate typologies found in the area. With the proposed method non-linear effects of substrate compositions on vegetation cover can be investigated.

MULTICAUSE TREND AND CLUSTER ANALYSIS OF ITALIAN HOSPITALIZATIONS

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In this work, hospitalizations data of the Italian healthcare system over the temporal period 2010-2012 are considered. The data set is provided by the Italian Ministry of Health and includes anonymized personal records of all the hospitalizations occurred in both public and private health care facilities. Each hospitalization record gives information on the patient, the health care facility, the hospitalization cause and the subsequent treatments. The first aim of this work is to provide a clustering of the hospitalization data with respect to their temporal pattern, for the Italian

provinces and for different groups of diagnosis as given by the ICD-9 classification. This should allow to identify spatial patterns and thus possible common hospitalization causes. To accomplish this, normalized hospitalization rates are computed with weekly temporal granularity for each province and diagnosis group, and the time series are clustered using a novel model-based clustering approach. The second aim is to derive a synthetic index able to assess whether a given province is improving or worsening with respect to the hospitalization trends related to all the diagnosis groups. This is done considering the average time series of each cluster which is tested to understand whether the trend is positive, null or negative. Preliminary results are discussed in terms of value and spatial distribution of the index.

BAYESIAN SPATIAL STRUCTURAL EQUATION MODEL FOR LICHEN ABUNDANCE DATA

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Lichen functional traits are widely used as ecological indicators of environmental quality and, especially, of air pollution. However, due to the high variability of lichen flora across geographic, climatic and ecological gradients, it is often difficult to differentiate the effects of atmospheric pollutants and those of other environmental variables. For this reason, we aim to evaluate the synergistic effect of three main pollutants (SOx, NOx and PM10) on the distribution of lichen functional groups, accounting for a set of environmental variables related to climate and habitat type. In particular, we consider three functional traits: nitrogen tolerance, growth form and reproduction strategy. In order to evaluate this complex relationship, a Bayesian generalized common spatial factor model has been applied to a real data set concerning lichen biodiversity in the Liguria region (NW Italy). The proposed model, here referred to as the Generalized Spatial Structural Equation (GSSE) model, has an intuitive appeal and it is preferable when the interest is in studying the effects of exogenous variables and covariates on endogenous variables through common factors with spatial structure. Moreover, GSSE model allows to deal with observed variables of mixed distributional forms. Full probabilistic inference is performed by applying Markov chain Monte Carlo (MCMC) techniques.

Contributed papers

SPATIO-TEMPORAL MODELLING OF ZERO-TRUNCATED DISEASE PATTERNS

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This paper focuses on the spatio-temporal pattern of Leishmaniasis incidence in Afghanistan. We hold the view that correlations that arise from spatial and temporal sources are inherently distinct. Our method decouples these two sources of correlations, there are at least two advantages in taking this approach. First, it circumvents the need to inverting a large correlation matrix, which is a commonly encountered problem in spatio-temporal analyses (e.g., Yasui and Lele, 1997). Second, it simplifies the modelling of complex relationships such as anisotropy, which would have been extremely difficult or impossible if spatio-temporal correlations were simultaneously considered. The model was built on a foundation of the generalized estimating equations (Liang and Zeger, 1986). We illustrate the method using data from Afghanistan between 2003-2009. Since the data covers a period that overlaps with the US invasion of Afghanistan, the zero counts may be the result of no disease incidence or lapse of data collection. To resolve this issue, we use a model truncated at zero.

INCIDENCE OF BRAIN AND CENTRAL NERVOUS SYSTEM CANCER IN FOGGIA'S AREA

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(i) Background: Disease mapping techniques are widely used in small-area studies to account for spatial patterns in the disease rates. We screened the trends in the geographical patterns of brain and Central Nervous System (CNS) cancer incidence in the province of Foggia over a period of 5 years (2005-2009). (ii) Methods: Case data were collected in 60 municipalities. Standardized incidence ratios (SIR) were calculated for each town under an internal standardization. For map plotting purposes, smoothed relative risks were calculated using the conditional autoregressive model proposed by Besag, York and Mollié. It fits a Poisson spatial model adjusting for the presence of spatial correlation and extra-Poisson variation in area-specific relative risks. The adjustment for an area-specific urbanization index was also considered. Results were estimated for women, men and both sexes. (iii) Results: The annual crude incidence rate for brain and CNS tumours in the Foggia province was 11.40 (95% CI 9.7-13.1) per 100,000 men and 12.42 (95% CI 10.7-14.1) per 100,000 women. Adjusted smoothed SIRs varied from 0.43 (95% CI 0.10-0.87) to 2.22 (95% CI 0.89-5.81), showing higher risks in the central of the province, in particular in Foggia. (iv) Conclusion: Bayesian spatial models are increasingly used by public health because they produce smooth risk surfaces which identify well-defined geographical clusters. This study reveals significant geographic differences in brain and CNS tumours incidence, with higher incidence in the main urban areas. Urbanization is a possible surrogate of real determinants of this phenomenon. Further investigations are needed to explore this hypothesis.

EVOLUTIONARY POLYNOMIAL REGRESSION APPLICATION FOR MISSING DATA HANDLING IN METEO-CLIMATIC GAUGING STATIONS

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One of the most often encountered modelling problems is that of handling missing data, i.e. the problem of intermediate data gaps, where data/observations before and after the missing observations are available. The gaps in data represent discontinuities, which can pose difficulties both for model construction and model application phases. Evolutionary Polynomial Regression (EPR-MOGA) is a data-driven hybrid technique, which combines the effectiveness of genetic programming with the numerical regression for developing simple and easily interpretable mathematical model expressions. Evolutionary Polynomial Regression takes advantage of the evolutionary computing approach that allows the construction of several model expressions based on training data and least squares methodology to estimate numerical parameters/coefficients. These models can then be verified on a test set and gaps can be in-filled in test datasets by using one selected model. Because of the pseudo-polynomial formulations achievable by EPR-MOGA, it requires fewer numbers of parameters to be estimated, which in turn requires shorter time series for training. Another advantage of the EPR-MOGA approach is the ability to choose objective functions pertaining accuracy and parsimony. In the present work, an application of EPR-MOGA is shown on some sites belonging to the Apulian meteo-climatic monitoring network.

DATA-DRIVEN AND MULTI-APPROACH SAMPLING SCHEME OPTIMIZATION: THE ALIMINI LAKES AQUIFER CASE

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Due to the high wells drilling cost, monitoring sites are usually selected among existing wells; nevertheless, the resulting monitoring network must assure a good assessment of the main characteristics of the considered aquifer. Groundwater managers, need to find a good balance between two conflicting objectives: maximizing monitoring information and minimizing costs. In this paper, a couple of groundwater monitoring optimization methods are presented, related to the local shallow aquifer of the Alimini Lakes, located in Apulia (South-Eastern Italy) where a large number of existing wells have been pinpointed and the need of optimally reducing exists. The proposed methods differ each other for the required amount of prior information. The first proposed method, namely Greedy Deletion, just requires the geographical position of the available sites, while the second, the Simulated Annealing, also requires the knowledge of the spatial law of the considered phenomenon. The managerial need was to halve the number of monitoring sites minimizing the information loss.

SIMILARITY INDICES OF METEO-CLIMATIC GAUGING STATIONS FOR MISSING DATA HANDLING: DEFINITION AND COMPARISON WITH THE MICE METHOD

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The meteo-climatic datasets are at the basis of a great deal of studies on environmental state and its consequent management. In this frame, the completeness of meteo-climatic datasets is required for accurate and reliable analysis. Unfortunately, completeness is a rare in practice and, consequently, a preliminary treatment for filling in all gaps is needed. In this work, two intuitive and easy procedures for handling missing data are presented based on the "similarity station" concept. Finally, a comparison between the proposed methods and the Multiple Imputation Chained Equations, which is the state of the art in the field of missing data handling, has been carried out.

STATISTICAL ANALYSIS ON ACOUSTIC DATA COMBINING OBJECTIVE AND SUBJECTIVE MEASURES

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This paper presents a statistical approach to analyze a set of data collected by QUADMAP (QUiet Areas Definition and Management in Action Plans), a LIFE+2010 Project on Quiet Urban Areas (QUAs). This Project aims to define a method regarding identification, outlining, characterization, improvement and managing of QUAs as meant in the Environmental Noise Directive 2002/49/EC. The project will also help to understand the definition of a QUA, the meaning and the "added value" for the city and their citizens in terms of health, social safety and lowering stress levels. At the beginning of 2013 the first version of a methodology to select, analyze and manage QUAs has been produced and subsequently applied in ten pilot areas chosen in Firenze, Bilbao and Rotterdam. During the analysis phase, quantitative (noise maps and acoustic measurements) and qualitative (end-users questionnaires, general and non-acoustic information) data have been collected and examined. Once the ante-operam phase of analysis has been completed, the interventions' realization in the pilot areas started and was followed by post-operam surveys. Logistic models are applied to part of the quantitative (noise measurements) and qualitative (results of interviews about noise perception in an urban setting) data collected in the city of Florence during the ante-operam phase. The results underline the importance of the survey's design, in order both to obtain information combining the different type of data and to be able to evaluate the net effect of single variables.

DEVELOPMENT OF BIOGAS AND MANAGEMENT OF THE NITRATES IN VENETO

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This study aims to analyze the development of biogas from an agricultural and animal husbandry matrix in the Veneto in order to evaluate its effects in terms of the involvement of animal biomass and production of nitrates. The analysis showed that the use of the digestate, from the process of biogas production, such as fertilizer, reduces the final quantity of nitrogen distributed directly on the ground in comparison with that derived from the traditional use of livestock and agricultural effluents, thereby reducing the possibility of groundwater pollution. The data on the location of the plants and the production of biogas, in connection with those related to the management of livestock manure and the production of nitrates, form a base of information that is useful for designing policies aimed at protecting the areas vulnerable to nitrates in the Veneto region.

ASSESSING THE SIGNIFICANCE OF THE CORRELATION BETWEEN THE COMPONENTS OF A BIVARIATE GAUSSIAN RANDOM FIELD

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Assessing the significance of the correlation between the components of a bivariate random field is of great interest in the analysis of spatial data. This problem has been addressed in the literature using suitable hypothesis testing procedures or using coefficients of spatial association between two sequences. In this paper, testing the association between autocorrelated variables is addressed for the components of a bivariate Gaussian random field using the asymptotic distribution of the maximum likelihood estimator of a parametric class of covariance models. Explicit expressions for the asymptotic variance of the maximum likelihood estimator of the correlation between the components are given for three different correlation structures, leading to an asymptotic test. A simulation study compares the type I error and the power of the suggested test with the modified t test (Clifford et al, 1989). The empirical evidence supports our proposal, and as a result, in most of the cases, the new test performs better than the modified t test. Finally, to illustrate how the proposed test works in practice, we study a real dataset concerning the relationship between arsenic and lead from a contaminated area in Utah, USA.

CAUSAL EFFECTS OF EXTREME HOT DAYS ON MORTALITY IN US CITIES

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(i) Introduction. Exposure to extreme hot temperatures has been associated with cardiovascular mortality. However, evidence of causality still needs to be demonstrated. (ii) Methods. We obtained individual mortality data from the National Center for Health Statistics (NCHS) for the years 1999 to 2006. Mortality files provided information on the exact date of death and the underlying cause of death. For this study, our primary outcome of interest is cardiovascular disease (CVD, ICD-10: I01 through I59) and stroke (ICD-10: I60 through I69) related mortality. We consider a causal

framework by reconstructing a hypothetical experiment in which "Nature" randomizes "treatment", i.e., exposure to hot days between 1999 and 2006 in 20 US cities with population greater than 250,000 (i.e., Atlanta, Bakersfield, Baltimore, Boston, Charlotte, Chicago, Cleveland, Dallas, Denver, Detroit, Fresno, Houston, Los Angeles, New York City, Philadelphia, Pittsburg, Riverside, Sacramento, San Diego, and Washington DC). This work aims to examine and quantify the causal effect of heat waves on daily counts of deaths. We use a propensity score approach by Gutman and Rubin (Statistics in Medicine, 2013) and check balance of "pre-treatment" covariates (e.g., day of week, year, month, dew point, wind speed, precipitation, ozone, and PM2.5). We also compare the propensity score approach to exact matching methods. (iii) Results. Preliminary results (i.e., analyzing Los Angeles data) suggest that there is a causal effect of extreme hot temperatures in summer on cardiovascular-related mortality.

STATISTICAL PROPERTIES OF NUMERICAL WEATHER PREDICTION MODEL FORECASTS, THEIR ANALYSIS AND IMPROVEMENT STRATEGIES

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In this paper, we will explore various aspects of long-term statistical behaviour of the numerical weather prediction (NWP) model errors, both from time and space perspectives. As an example, we will consider NWP of solar radiation whose need is nowadays well motivated by predictions of photovoltaic power output. We will start by demonstrating that, unlike typical statistical models, the NWP output suffers from under-smoothing. Surprisingly large portion of the NWP variability is not matched by the data variability. In principle, this can be improved substantially by a statistical calibration model. Obviously, the calibration model has to be semi-parametric in order to reflect that parts of the error behaviour are unknown a priori. Spatial, model-ensemble and nonlinear transformation-based strategies showed to be helpful in the calibration based on penalized regression. Moreover, since the NWP errors show several complicating features (like time and covariate varying bias, heteroscedasticity and skewness), use of models like GAMLSS can be motivated, depending on the exact goals of the forecasts. On real data, we will illustrate also that statistical modelling can help not only in improving the forecasts but also in understanding the nature of the NWP errors and their differences among different NWP models and hence that it can help in NWP improvements.

THE ROLE OF ISPRA IN THE FIELD OF ENVIRONMENTAL STATISTICAL INFORMATION

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ISPRA reporting activities are generally focused on the country's needs to monitor the status and dynamics of the environment in Italy. The environmental information collected by ISPRA comes mainly from monitoring networks organised on a regional basis. The Environmental Data Yearbook is the most extensive and comprehensive collection of environmental data available in Italy. This report provides a framework of objective, accurate and up to date information on the environmental conditions of our country. Aim of the yearbook is ensuring that the knowledge and environmental information is transparent and available to everybody. The National Inventory Report and the Informative Inventory Report are documents describing the annual

communication of the national emission inventory of greenhouse gases and transboundary substances in the framework of the United Nations Convention on Climate Change and Kyoto Protocol and the United Nations Economic Commission for Europe Convention on Long Range Transboundary Air Pollution and relevant Protocols. The reports contain an explanation of methodologies, data sources and verification activities applied to the inventory compilation process, with an analysis of emission trends and a description of key categories. ISPRA Municipal Waste Report provides data concerning municipal waste generation, separate collection and management at national, regional and provincial level as well as data on municipal waste import/export. The Quality of the urban environment Report has become a well-established reference for researchers, local administrators and other users thanks to the assessments of the numerous data provided and the expert-based analysis through which phenomena are analyzed and intervention strategies outlined.

EXPLORING ENVIRONMENTAL DATA THROUGH CIRCULAR BOXPLOTS

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The box-and-whiskers plot is a very useful exploratory tool that quickly summarizes some of the most important information about an observed distribution. In spite of its many extensions, a proper boxplot for circular data is not yet available. Indeed, such a visualization would be especially useful in environmetrics thanks to its simplicity and strong visual impact: circular measures arise as wind directions, movements of animals from points of release, orientation of fracture planes, just to cite a few. However, while on the line the structure of the box is uniquely defined once the observations are sorted in non-decreasing order, in the circular space this is not allowed given the lack of a natural ordering. Beyond an attempt presenting significant drawbacks, boxplots that take into account the periodic features of circular data are not available in the literature. For this reason, we introduce circular boxplots exploiting some data depth concepts, in analogy with the bagplot for bivariate data. A rule of thumb useful to draw the whiskers is obtained by means of a simulation study. In addition, a discussion on the choice of the depth function is offered. An application to real environmental data is finally provided along with a proposal of a visual display of 'parallel' circular boxplots.

DIRECT AND INDIRECT INFLUENCES OF LANDSCAPE STRUCTURE ON LOCAL HABITAT QUALITY

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Besides modelling the relationships between habitat quality and species distribution patterns, to understand human impacts on biodiversity it is important to appreciate the influence of surrounding landscape structure on local habitat quality, across multiple spatial scales. Traditional

models reporting the "habitat amount" in the landscape alone explains patterns of biodiversity, irrespective of habitat configuration or spatial variation in habitat quality, implicitly treat each unit of habitat as interchangeable and ignore the high degree of interdependence between spatial components of land-use change. We tested the contrasting hypothesis, that local habitat units are not interchangeable in their habitat attributes, but are instead dependent on variation in surrounding habitat structure at both patch- and landscape levels. The statistical approaches needed to implement such hierarchical causal models are observation-intensive, therefore very high resolution Earth observation images were used to rapidly generate fine-grained measures of habitat patch internal heterogeneities over large spatial extents. The influence by surrounding patch or landscape structure on remotely-sensed proxies for habitat quality was tested by means of linear mixed-effects models. The significant influence of surrounding patch and landscape context on local habitat quality was demonstrated. This can be direct, when a landscape variable alone influences the habitat structure variable, and/or indirect when the landscape and patch attributes have a conjoined effect on the response variable. A substantial degree of interaction among spatial configuration effects is likely to be the norm in determining the ecological consequences of habitat fragmentation, thus corroborating the notion of the spatial context dependence of habitat quality.

FAUNA CHARACTERIZATION OF A COLD-WATER CORAL COMMUNITY NETWORK ALONG THE APULIAN COASTS BY BAYESIAN MIXED MODELS

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The exploration of a cold-water coral (CWC) community network connecting the Southern Adriatic fish populations with those of the Northern Ionian Sea has many challenging implications involving biodiversity conservation and fisheries management. To characterize the species assemblages of the CWC community network, we analyze the size of six mostly abundant species to highlight the main differences among five CWC areas along the Apulian coasts. Data are surveyed by experimental longlines casted in all CWC areas between 2013 and 2014. Bayesian Generalized Additive Mixed Models (GAMMs) are applied to analyze the variation of the fishes length in the five CWC areas according to species and covariates such as depth and abundance. GAMMs allow to account for various effects of variability components on the overall length of fishes. Appropriate smooth functions are available to describe the physical effect of each covariate and specific random area effects are allowed to induce correlation among individuals of all species captured in the same area. Parameter estimation is carried out by maximization of the joint posterior probability distribution, where marginal posterior probabilities associated to specific model terms are obtained by a spike-and-slab prior structure, that can be viewed as a scale mixture of Gaussians. This approach is implemented in the R package spikeSlabGAM, able to deal with most common distributional assumptions and allowing efficient variable selection and model choice. Results show that the size of fishes is collectively affected by random effects of the CWC areas and by smooth effects of their depth and abundance.

STATISTICAL MODELS FOR SPECIES RICHNESS IN THE ROSS SEA

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In recent years, a large international effort has been placed in compiling a complete list of Antarctic mollusc distributional records based both on historical occurrences, dating back to 1899, and on newly collected data. Such dataset is highly asymmetrical in the quality of contained information, due to a variety of sampling gears used and the amount of information recorded at each sampling station (e.g. sampling gear used, sieve mesh size used, etc.). This dataset stimulates to deploy all statistical potential in terms of data representation, estimation, clusterization and prediction. In this paper we aim at selecting an appropriate statistical model for this dataset. Given their counting nature, we preliminary implement a Poisson regression model and we extend it with a Negative Binomial regression to manage over-dispersion. Generalized linear mixed models (GLMM) and generalized additive models (GAM) are also explored to capture a possible extra explicative power of the covariates. However, preliminary results under them suggest that more sophisticated models are needed. Therefore, we introduce a hierarchical Bayesian model, involving a nonparametric approach through the assumption of random effects with a Dirichlet Process prior.

AN EVOLUTIONARY SPECTUM APPROACH TO MODEL LAND/OCEAN NONSTATIONARITIES

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We introduce a nonstationary spatial-temporal statistical model for gridded data on the sphere. The model specifies a computationally convenient covariance structure that depends on heterogeneous geography. Widely used statistical models on a spherical domain are stationary for data at the same latitude, but nonstationary for different latitudes (axial symmetry). This assumption has been acknowledged to be too restrictive for quantities such as surface temperature, whose statistical behaviour is influenced by large scale geographical descriptors such as land and ocean. We propose an evolutionary spectrum approach that is able to account for different regimes across the Earth's geography, and results in a more general and flexible class of models that vastly outperforms axially symmetric models and captures longitudinal patterns that would otherwise be assumed constant. The model can be expressed in a multi-step conditional likelihood form that allows for easily distributed computations: we show how the fit of a data set larger than 20 million data can be performed in less than one day on a state-of-the-art workstation, but once the parameters are estimated, it is possible to instantaneously generate surrogate runs from a common laptop. Further, the resulting estimates from the statistical model can be seen as a synthetic description (i.e. a compression) of the space-time characteristics of the entire initial condition ensemble. Compared to traditional algorithms aiming at compressing the bit-by-bit information on each climate model run, the proposed approach achieves vastly superior compression rates.

JOINT DOWNSCALING OF TEMPERATURE AND PRECIPITATION

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Numerical models are widely used to estimate and forecast most of the environmental variables under study. Calibration and uncertainty quantification of numerical model output can be addressed via a downscaling approach, comparing the output with observed data. Most downscaling works are based on the Gaussian assumption and focus on univariate problems. However, numerical models usually provide joint estimates of several environmental variables. In this work we propose an extension of downscaling approach beyond the Gaussian assumption within a multivariate setting. Moreover, we stress the characterization of uncertainty in the numerical model output via stochastic modelling to allow the propagation of such uncertainty from the deterministic output to the responses. We are motivated by the joint downscaling of surface temperature and precipitation coming from a weather numerical model over a common spatial domain. Due to the physical association between the two weather variables, it is expected that information regarding one will help to improve calibration and prediction of the other. For precipitation, we relax the usual Gaussian assumption, in order to accommodate point masses at zero (no precipitation) and model positive precipitation accumulation. Finally, we allow for spatial dependence and handle the spatial misalignment between the observed data and the numerical model output. We illustrate our modelling approach to combine observed temperature and precipitation with the output from a numerical model over the Emilia-Romagna Region (Italy).

STATISTICAL ANALYSIS OF ZOO-AGRARIAN CRIME

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Environmental crime is a concept not easily defined as it necessarily encloses several, and dissimilar, types of offenses. Legislation too does not help as it lacks of a unique definition of environment. The current definition of "ecomafia", given by Legambiente a few years ago and now in the vocabulary of Italian language Zingarelli, includes a variety of criminal actions even in animals racket and in agriculture: the so-called "zoomafia" and "agromafia". The first flourishes on the control of illegal activities related to animals (illegal slaughter, cheating in horse shows, animal doping, theft thoroughbred, kennel business, fights between animals, illegal imports of puppies, poaching). The second affects, in Italy, a farmer out of three that are victims of threats, pressure and harassment, theft of equipment and agricultural vehicles or the commodities produced, theft of cattle for illegal slaughter and trade of meat, potentially dangerous to the health of consumers. Contrary to a mild and generalized decline in the number of offenses over the previous year, in 2013 both the agricultural sector, which has seen a surge of offenses (9,540: more than doubled), the waste cycle (5,025 crimes: +14.3%) and illegality committed against wildlife (8,504: +6.6%) recorded a growth.

MODELLING SPATIO-TEMPORAL DATA FROM MOBILE MONITORING STATIONS

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Environmental data are typically indexed in space and time. This work deals with modelling spatio-temporal air quality datasets, when multiple measurements are available for each space-time point. Typically this situation arises when different measurements referred to several response variablesare observed in each space-time point, e.g. different pollutants or size resolved data on particular matter. Nonetheless, such a kind of data can also be obtained when using a mobile monitoring station moving along a path for a certain time period. High-frequency measurements are then obtained that refer to different space and time points. These data can be dealt with by discretising the space and time information on a grid, and then summarizing response variable(s) within each space-time point, so to have point-referenced data. Now, each spatio-temporal datum has different measurements referred to the response variable observed several times over several locations in a close neighbourhood of a specific space-time point. We model this type of data within a Bayesian hierarchical modelling framework, in which observed measurements are modelled in the first stage of the hierarchy, while the unobserved spatio-temporal process is considered in the following stages. The final model is very flexibleand includes autoregressive terms in time, different structures for the variance-covariance matrix of the errors, and can manage covariates available at different space-time resolutions. This approach is applied and tailored to data coming from the PMetro project (http://www.pmetro.it), which studies urban pollution dynamics in the town of Perugia (Italy) since September, 2012: fast measure of gases and size resolved particulate matter is collected using an Optical Particle Counter located on a cabin of the Minimetro, a public conveyance that moves on a monorail on a line transect of the town. Urban microclimate information is also available for including covariates.

MODELLING CEMENT DISTRIBUTION EVOLUTION DURING PERMEATION GROUTING

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Permeation grouting is a proper technique for strengthening dry sand before a tunnel construction in it. In the fifties of the past century, N.N. Verygin modeled this technique with 1-dimensional problems formulated in domains with a free moving boundary and came up with their analytical solutions. As for the 2-dimensional set ups, respective problems are formulated in domains that have complicated shapes and contain free moving boundaries. Until recently these difficulties seemed to be insuperable and all 2-dimensional grouting models in the framework of the continuum approach were based on the convective dispersion equation. They can be classified as the ones that describe pollution propagation. Nevertheless, M.B. Demchuk has lately come up with numerical solutions of 2-dimensional problems with free moving boundaries which set ups correspond to in situ grouting. Moreover, he has shown the following: adoption of the continuum approach is relevant for the set of input parameters used, among the curvilinear grids the calculations are performed on there are the ones that have chaotic dispositions of their nodes in space on some time layers. In this work, rough estimates are performed that indicate that the use of problems with free moving boundaries in the numerical modeling in hand is relevant.

AVOIDING THE GLOBAL CHANGE IN CLIMATE

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Nowadays, humankind extracts most of the energy it consumes from fossil fuels. Unfortunately, it entails building up the carbon dioxide in the atmosphere. People have to cut the emissions of this gas drastically to avoid the global change in the climate in few decades. One of the options they have consists in using solar energy as a primary energy source. In this case, the main difficulty consists in the large scale energy storage needed for satisfying needs in energy at night. In this work, we give an example of energy storage in polymer surface layers of a polymer matrix composite filled with magnetic microparticles. Specifically, in the recent research V.B. Demchuk argued that improvement of mechanical properties of Polyvinyl chloride (PVC) composite materials filled with ferrite microparticles reached at sufficiently high filler concentrations through influencing the formation of these microcomposites by constant magnetic fields (CMFs) occurs thanks to the fact that PVC macromolecules situated in the polymer surface layers of these microcomposites are pushed out of regions of high magnetic field intensity. His reasoning is based on integrated analysis of laboratory measurements and numerical calculations. In this paper, we present computational abstractions that allow handling the chaotic disposition of the filler particles during calculation of magnetic fields in polymer surface layers of microcomposites near phase transition points under the constraint due to limited performance of modern computers.

CONSTRUCTION OF SPATIO-TEMPORAL COVARIANCE FUNCTIONS OVER THE M-DIMENSIONAL SPHERE

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In spatial statistics it is very usual to deal with the modeling of covariance functions. In the common case, they are constructed over an Euclidean domain, in the general case they are constructed over Riemannian manifolds. The theory concerning this case is dispersed. The motivation in this manuscript is to provide the fundamental theory that allows these constructions taking into account that the geometry and distance notions change according to the space. We put particular emphasis on the Riemannian surface that arises when the m-dimensional sphere crosses the real line, in order to give tools that may improve the analysis of isotropic Gaussian spatio-temporal processes on the sphere.

SPATIAL BIAS ANALYSIS FOR THE WEATHER RESEARCH AND FORECASTING MODEL (WRF) OVER THE APULIA REGION

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The Weather Research and Forecasting mesoscale model (WRF) based on CORINE land-cover database has been used to simulate hourly 10m wind speed and 2m temperature over the Apulia region. It is a state-of-the-art numerical weather prediction system that solves the fully compressible, non-hydrostatic Euler equations. Some atmospheric processes occur at spatial and temporal scales not resolved by the numerical models even for high-resolution models like WRF and are represented by parameterizations based on several approximations. This aspect, together with the uncertainties of the initial and boundary conditions provided by global models, leads to the introduction of a bias in the model outputs. Many studies demonstrate the existence of a bias for 10m wind speed and 2m temperature, for several physical parameterizations. A validation procedure against ground data from 48 monitoring stations provided by the Agrometeorological Service of Apulia Region (Assocodipuglia) for a winter and a summer period has been performed in order to inform on the spatial distribution of the model bias. A preliminary analysis based on three indices of model performance revealed that the summer period is better simulated than the winter one. Computation of Moran's index for model bias spatial distribution shows that summer 10m wind speed bias results to be weakly autocorrelated while this autocorrelation is absent for both winter and summer 2m temperature as well as for winter 10m wind speed. On the other hand, semivariogram analysis shows a slight correlation with a range value less than 20 Km for 2m temperature's winter and summer biases.

RAREFACTION AND EXTRAPOLATION WITH HILL NUMBERS: A STUDY OF DIVERSITY IN THE ROSS SEA

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The Ross Sea can be considered, in a biological sense, one of the better-known areas in Antarctica due to the high number of expeditions engaged since 1899. Hundreds of mollusc species have been collected and classified along years in a unique database. The possibility to access such impressive information offers the opportunity to apply important results in the study of biodiversity for that area. Recent influential contributions induce us to study species diversity by means of accumulation curves based on Hill numbers, i.e. the effective number of equally frequent species.

INTEGRATION OF DIFFERENT ELECTRONIC NOSE TECHNOLOGIES IN RECOGNITION OF ODOR SOURCES IN A SOLID WASTE COMPOSTING PLANT

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Due to the continuous expansion of urban areas, the problem of emissions in the atmosphere of odours from solid industrial waste composting plants, are often cause of dissatisfaction and complaints by the communities surrounding emission sources. Characterization of emission sources by electronic noses is becoming a valuable approach in the management of odour emission, as are required high time resolution instrumental approaches and fast intervention on identified critical wastes, by using abatement systems. In this paper the authors compare complementary technologies: MOSs and polymer/black carbon (Nano Composite Array - NCA) based sensors electronic noses to monitor odours emitted from an industrial solid waste composting plant, in the aim to implement integrated policies for a better management of composting operations. 10 MOS sensors in the PEN3 (Airsense), operating at high temperature and 32 polymer/black carbon (Nano Composite Array - NCA) based sensors in the Cyranose 320 (Sensigent), operating almost at ambient temperature, were tested on samples collected above three odour sources in the composting plant: biogas, sludge and urban waste. The integrated dataset obtained from measures were explored by Principal Component Analysis and Discriminant Analysis to identify sensor discrimination capabilities, strengths and weaknesses of the technologies used. The results obtained highlight the advantages of monitoring the composting process with a multi-tech sensor approach, in order to provide complementary information useful to better discriminate the emissions from a waste composting plant.

APPROXIMATING LIKELIHOODS THROUGH PRECISION MATRIX FOR LARGE SPATIAL DATASETS

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Environmental datasets are often very large and irregularly spaced. To model such datasets, the widely used Gaussian process models in spatial statistics face tremendous computational challenges due to the calculation required by the large precision matrix. Various methods based on covariance function approximations have been introduced to reduce the computational cost. However, most of them rely on unrealistic assumptions of the underlying process and retaining statistical efficiency remains an issue. In this work, we develop a new approximation scheme through precision matrix approximation. We show how the composite likelihood method can be adapted to provide different types of precision matrix approximations that allow for efficient computation of the maximum likelihood estimation. The statistical efficiency of the proposed method is evaluated by numerical and simulation studies. To be able to handle very large datasets, we also explore parallel computing techniques and demonstrate our method on real datasets for environmental applications.

INFLUENCE OF FOREST STRUCTURE ON HABITAT PRODUCTIVITY AND KEY FOODS AVAILABILITY FOR BROWN BEARS IN THE APENNINES

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The Apennine brown bear (Ursus arctos marsicanus) survives with a relict population in forest-dominated habitats in the central Apennines, Italy. In Italy forests have been exploited since remote times, and as a result they feature a simplified composition and structure. Despite the critical conservation status of the Apennine brown bear, there are no scientific studies that relate forest structure to productivity of key foods and their availability to bears on a seasonal basis. Forest management can influence the long-term productivity of bear habitats through timber harvesting, and can affect accessibility of key foods through interactions with humans. In this study, founded by G.A.L. "Gran Sasso Velino", we aim to explore the effects of forest structure on the availability of key foods for the Apennine brown bear, in order to identify those forest management practices that most correspond to productivity of seasonal foods in the medium and long-term. Data have been collected in 90 randomly identified plots (radius: 20 m) in central Apennines forests, using a system of circular areas and perpendicular transects. In each plot, the parameters related to topography, forest structure, dead wood and key bear foods have been measured. A subset with high explanatory power of the initial 50 parameters has been selected and used for further statistical analysis. Two main directions are explored (i) the joint behaviour of trophic resources measures is analysed through a multivariate Bayesian mixed effects model, (ii) measures are summarized in seasonal composite indices and modelled always in a Bayesian framework.

IMPROVING R AND ARCGIS INTEGRATION

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We discuss a new approach for integrating R with ArcGIS. Later this year Esri plans to release an open source R package that provides a solution inside the application process for passing data between ArcGIS and R. Using this new methodology, the researchers can easily build geoprocessing tools which wrap R scripts. This new methodology will potentially support a community of people who develop and share R-based geoprocessing tools for ArcGIS.

ENERGY-EFFICIENCY OPTIMIZATION OF THE BIOMASS PELLETING PROCESS BY USING STATISTICAL INDICATORS

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Biomass pelleting process strongly depends on a number of variables hard to be simultaneously controlled. This paper suggests a method to ensure pellets moisture optimization and process energy saving. An experimental testbed was arranged in order to validate the performance of the proposed strategy. It is based on a closed-loop control system that regulates material moisture and flow rate, but its robustness is affected by the control-loop delay (the actuator delay is about 10 minutes) and by the random arrangement of the pellets inside the cooler that strongly affects product moisture (the measurement errors are not negligible). To overcome those problems, a robust statistical approach was adopted to reach the best trade-off between estimation accuracy and computational effort. It was derived by the well-known Random Close Packing model and statistical estimator. Experimental results prove the effectiveness of the proposed approach that provides moisture errors less than 7.2% with a continuous limitation of energy consumption. The present work is part of Idea75's project – SEI Smart supervisor for Energy efficiency optimization of Industrial processes – funded by Regione – PO FESR 2007-2013, Asse I, Linea di Intervento 1.1. Azione 1.1.3 – Aiuti alle piccole imprese innovative di nuova costituzione.

HIDDEN MARKOV MODELS FOR LONGITUDINAL CIRCULAR DATA

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The use of longitudinal data has become increasingly popular in statistics over the last decade. The central question in modelling longitudinal data is how to formalize the unobserved heterogeneity of the data, that is, the heterogeneity that cannot be explained by means of observable covariates. This is often accomplished by introducing subject-specific random effects that can have either a continuous or a discrete distribution. However, time-constant unobserved heterogeneity only is accounted for. These considerations are obviously pertinent when we deal with circular longitudinal data. In this paper we propose an approach for modelling longitudinal circular data base on discrete time-varying random effects. Indeed, the problem of adequately representing the unobserved heterogeneity is addressed by including time-varying subject-specific random effects which follow a finite-state first-order Markov chain. The proposed approach may be cast

in the literature about hidden Markov models (HMMs) for longitudinal data. Under the model we propose, the conditional (with respect to random effects and covariates) distribution of the circular response is projected normal or von Mises. We further introduce a joint approach to time-varying clustering and bad points detection under a longitudinal setting, extending the Hidden Markov model for circular data. We replace the state-dependent distribution with a two-component mixture where one mixture (reference) component represents the data we would expect from the given state (i.e. good points) while the other mixture component clusters the atypical data and has a small prior probability, the same component-specific mean and an inflated scale parameter. This change makes the model more robust. We estimate model parameters by using an ad hoc version of the expectation-conditional-maximization (ECM) algorithm, extending the Baum-Welch iterative procedure to deal with contaminated distribution.

ENVIRONMENTAL SMARTCITIES: STATISTICAL MAPPING OF ENVIRONMENTAL RISK FOR NATURAL AND ANTHROPIC DISASTERS IN CHILE

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The main aim of the work is to build statistical environmental risk maps for natural disasters in Chile, using spatio-temporal models in order to improve the assessment, prevention and mitigation of impacts. To this end, we analyze the spatial and temporal variability of the observed points, we study the dependence from the exogenous variables, and we create risk maps. Finally, we display the results in web platforms for mobile devices. Several environmental phenomena are considered such as earthquakes, wildfires, and air pollution. In all cases the methodology is based on the assumption that data can be modeled as a spatio-temporal process, although specific models are proposed for each category.

A CASE-STUDY COMPARISON OF METHODS FOR FACTOR ANALYSIS OF SPATIALLY CORRELATED MULTIVARIATE RESPONSES

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Many environmental and biostatistical applications involve spatially dependent vectors, observed at different sites in a sampling region. Examples are concentrations of different chemicals in topsoil samples, and percent cover of different species on line transects or in subplots. It is often useful to perform a principal component or factor-analytic type of analysis, in order to understand and model both the correlations within the vectors and the structure of their spatial correlation. A model commonly used in geostatistical applications is the Linear Model of Coregionalization (LMC). We shall first give a brief description of the LMC, together with three recently proposed alternatives. We shall then apply the four methods to analyze data on concentrations of major ions in water samples taken from springs in a carbonate mountain aquifer. The methods give quite different results, with those of the LMC being much more interpretable. We conclude with some possible explanations for this difference in interpretability

HIERARCHICAL SPACE-TIME MODEL FOR POST-FIRE VEGETATION RECOVERY

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Wildfires represent one of the most widespread ecological disturbance of ecosystems, particularly in the Mediterranean region. Fires usually destroy or deplete vegetation rapidly, while post-fire vegetation regeneration might be a long-term process. Post-fire recovery is widely monitored using indicators of the ground vegetation amount such as the Normalized Difference Vegetation Index (NDVI). Since fires produce a drop in NDVI values, vegetation recovery is often performed by visual inspection or simple descriptive analysis of post-fire NDVI relative to pre-fire conditions. More rigorous methods include approximations of the post-fire NDVI trajectory by monotone curves. However, such methods fail to capture spatio-temporal dynamics of post-fire vegetation recovery which is fundamental for understanding the effects on fire-driven ecosystems. We propose a general approach to infer about recovery rates of vegetation after a fire using spatio-temporal hierarchical modeling. We estimate the entire space-time NDVI surface over a region in the absence of fire, i.e. what the NDVI would have been if no fire had occurred. We introduce local dynamics within the spatial dynamic framework to capture local features of NDVIs. Then, we compare observed NDVI in burned pixels with the estimate of the NDVI if the pixel had never burned and see the proportion of recovery over time and space. Full inference and uncertainty associated with vegetation recovery are provided within the Bayesian framework. We investigate spatio-temporal vegetation recovery using 24-year time series of NDVI images over a sample region at roughly 40 km from Zaragoza (Spain) which is subject to recurrent forest fires.

A SEMI-PARAMETRIC APPROACH IN THE ESTIMATION OF THE STRUCTURAL RISK IN ENVIRONMENTAL APPLICATIONS

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In environmental applications, the estimation of the structural risk is crucial. A statistical model for the behaviour of the input variables is generally required, possibly accounting for different dependence structures among such variables. Copulas represent a suitable tool for dealing with natural extremes and non-linear dependencies. Two semi-parametric procedures for the approximation of, respectively, Extreme Value and Archimedean copulas, are proposed in order to provide a model for the estimation of the structural risk. The approximating techniques are evaluated by Monte Carlo tests, and illustrated via a case study concerning a preliminary rubble mound breakwater design.

SEA STATE CHARACTERIZATION THROUGHOUT LINEAR AND CIRCULAR DATA

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The sea state analysis often deals with the combined use of linear and directional data, as the wave direction which is a fundamental parameter in the oceanographic studies. This topic is being more and more frequent and of relevant importance, e.g. both in the extreme waves analysis and in the numerical model forecast verification, where up to now the prevalent use of the significant wave height have to be integrated with the multiple sources of available data from buoy or remote sensing. ISPRA is involved in many institutional and research activities, as for instance the analysis of in situ data coming from the national buoy network, the extreme waves analysis of these data and the provision of a bulletin with a synthesis of the mainly information about wave climate. More recently has been operational, at ISPRA, the Mediterranean Coastal WAve Forecasting (Mc-waf) system to provide medium-range wind wave forecast at the Mediterranean, regional and coastal scale. The connection of the forecast system with the network of deep-sea buoys provided by the Italian National Wave Buoy, makes the integrated sea-state information valuable for the security of maritime transport, the planning of operational activities and for the elaboration of statistics on wave energy, coastal exposure and coastal dynamics. The verification of this system, however, as well the analysis described above require the implementation of updated statistical methods able to provide information about accuracy of linear and directional wave parameters and their ability to describe the sea state.

MIXTURE OF EXPERTS FOR SEQUENTIAL PM10 FORECASTING IN NORMANDY (FRANCE)

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Within the framework of air quality monitoring in Normandy, we experiment the methods of sequential aggregation for forecasting concentrations of PM10 of the next day. Besides the field of application and the adaptation to the special context of the work of the forecaster, the main originality of this contribution is that the set of experts contains at the same time statistical models built by means of various methods and different sets of predictors, as well as experts which are deterministic chemical models of prediction modeling pollution, weather and atmosphere. Numerical results on recent data from April 2013 until March 2014, on three monitoring stations, illustrate and compare various methods of aggregation. The obtained results show that such a strategy improves clearly the performances of the best expert both in errors and in alerts and reaches an unbiased observed-forecasted scatterplot, difficult to obtain by usual methods.

IMPACT OF CLIMATIC FACTORS ON ACUTE BLOODY DIARRHEA, DENGUE AND INFLUENZA-LIKE ILLNESS INCIDENCES IN THE PHILIPPINES

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The effect of climate variability on the weekly incidence of acute bloody diarrhoea, dengue and influenza-like illness in the 17 regions of the Philippines is examined using correlation, mutual information and transfer entropy. Results show that the correlations between climate variables and disease incidences differ from one region to another. Interestingly, the diseases are directly correlated to each other for each region. This is explained by their common driving climate factors which are shown by large transfer entropy values. This work is important in further understanding the role of climate variability to the temporal dynamics of disease incidences.

OFFICIAL STATISTICS FOR DECISION MAKING: AN ENVIRONMENTAL ACCOUNTING CASE STUDY RELATED TO BIODIVERSITY

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An increasing awareness among decision-makers that biological resources are vital to humanity's economic and social development and the UN Convention on Biological Diversity (CBD) have led to include biodiversity among the main topics dealt with by official statistics, thus potentially enabling an extension of analyses based on traditional social and economic data to cover crucial environmental and sustainability aspects. Within official statistics, environmental-economic accounts can play a specific role in supporting initiatives stemming from CBD. Indeed the latter accounts, as well as national accounting as a whole, are involved even directly in the implementation of the Aichi Biodiversity Targets (ABT) agreed in the context of the Strategic Plan for Biodiversity 2011-2020: according to ABT2, biodiversity values are to be incorporated into reporting systems and into national accounting as appropriate. Data for monitoring the mobilization of financial resources for the implementation of this Strategic Plan as well as for assessing resource needs are of interest in particular (ABT20). For these purposes, data derived from official statistics' environmental accounting on actual expenditure for biodiversity protection has special merits, due to its high quality and to the fact that those figures are linked to core national accounts and hence particularly suitable for use in modelling. On the other hand, while policies can easily be developed by committing financial flows to given purposes, it may be not that easy, from politicians' viewpoint, to monitor the same policies based on information on actual utilization of money. The use of data on funding vs data on actual expenditure may be an issue.

STRUCTURAL EQUATION MODELLING IN ROOT RESEARCH: A FOCUS ON 0-TILLAGE SYSTEMS

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During its downward growth a plant root experiences a combination of internal and external stimuli that shape its architecture. The extent to which roots respond to the surrounding media, termed "plasticity", governs plant's ability to capture resources in variable soil environments.

Identifying direct and indirect relationships involved in and triggered by root spatial arrangement is crucial for assessing crop response to changing agricultural practices (i.e. conversion to reduced tillage systems). We analyze data collected in one season from a long term tillage trial (conventional versus o-tillage). Within a randomized block design with 3 replicates, data on roots biomass and soil physico-chemical parameters were sampled along vertical depth profiles. The main purpose is to evaluate if the tillage practice affects the distribution of roots along the vertical depth profile and if the latter has an influence on wheat yield and quality. Due to root and soil samples being repeated along a depth gradient, data are suited to be analyzed in a variety of ways, such as growth models, multilevel models and random regression/mixed-effects models. Here, to allow characteristics of the roots trajectory vary across individuals, the slope and intercept parameters are modeled as latent variables, thus leading to latent growth curve models (LCMs) characterized by great flexibility to examine roots change over depth. LCMs are framed in the context of structural equation modelling providing a framework for the assessment of causal relationships in complex inter-correlated data with several applications in root research.

SHORT TERM EFFECTS OF WIND DAYS ON MORTALITY AND MORBIDITY IN TARANTO (ITALY)

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(i) Background and objective. Taranto is an industrial town located in the Apulia region on the Ionian sea, where several large plants are located nearby the urban area, including the largest European integrated-cycle steel plant. Several multi-city studies have found significant associations of short-term exposures to PM10 with mortality and cardio-respiratory morbidity outcomes. A previous study performed by ARPA Puglia has identified specific wind conditions (called "Wind Days" - WD) leading to deterioration of air quality with respect to PM10 concentrations in a small neighbourhood called "Tamburi", located near the steel plant, downwind at wind direction from the North-West quadrant. In the present study, within the Taranto Environment and Health Program, we evaluated the short term effects of WDs on mortality and morbidity in two urban areas of Taranto (Tamburi and Taranto - except Tamburi), in the period 2002-2012. (ii) Methods. All causes of mortality and hospital admissions (HA) were selected among residents; we classified as WDs the days characterized by wind speed higher than 3m/s for at least 3 hours and as non-wind days (nWDs) all the remaining days. A time series analysis was applied and Poisson regression was used to adjust for temperature, holidays, influenza epidemic and summer population decrease. Single-lag structure (from lag 0 to lag 5) in the WDs - mortality/HA association was evaluated. (iii) Results. Effects of WDs on cardiovascular (25.2% (Confidence Interval 95%: 3.8- 51.8), lag 2), cardiac (56.6% (CI 95%: 28.2-91.1), lag 2) and respiratory mortality (30.94% (CI 95% 7.5-59.5), lag 3) were observed in Tamburi. There is similar but non significant effect for cardiac HA at lag 2; no associations are observed for those who live in the rest of Taranto. Conclusions. WDs, which are a proxy indicator of bad air quality at Tamburi, are strongly associated with cardio-respiratory events in the same area.

POST-PROCESSING OF THE WEATHER RESEARCH AND FORECASTING (WRF) MESOSCALE MODEL BY ARTIFICIAL NEURAL NETWORKS

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The Weather Research and Forecasting mesoscale model (WRF) has been used to simulate hourly 10m wind speed. This model is able to solve atmospheric equations with a resolution up to tens of meters. However, since processes as turbulence, radiation exchange, cumulus and microphysics are represented by means of physical parameterizations, WRF surface outputs are affected by systematic errors also due to uncertainties of the initial and boundary conditions provided by global models. In this study a preliminary approach to develop bias correction and reduction is presented, based on post-processing WRF output by Artificial Neural Networks (ANN). Post-processed WRF output at a single location in the city of Taranto, in the southern part of Apulia region, has been validated against ground data from a weather monitoring station. In particular, the ANN algorithm has a feed-forward multilayer perceptron architecture. In order to achieve better correction of the bias, a feature selection has been performed. Moreover, to estimate the best ANN setup, a tuning on the representative network parameters (hidden layer number, neuron number per layer, transfer and training function) was also carried out. The performances of whole procedure (deterministic model post-processed by statistical algorithm) have been evaluated in terms of root mean squared error (RMSE) and Pearson's correlation (PC).

IMAGE SIMILARITY ASSESSMENT BASED ON COEFFICIENTS OF SPATIAL ASSOCIATION

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In this talk we deal with the construction of image similarity indices that consider the hidden spatial association between two images. The proposal is a variant of a structural similarity (SSIM) coefficient and introduces a codispersion coefficient to capture the hidden spatial association between two images in a particular direction on a plane. The novel contribution of this article is the inclusion of the codispersion coefficient instead of the sample correlation coefficient The difference between the codispersion and correlation coefficients is illustrated through two examples. We then show that this modified measure is a valid distance metric and has several useful properties, including quasi-convexity, which is established under very precise conditions. In addition, we introduce another variant of the SSIM with a contrast function that depends on the spatial lag on the space. This proposal trivially recovers the optimization properties of the SSIM. We characterize the practical advantages and drawbacks of the SSIM variants. Various computational experiments with real datasets support our proposals and findings.

ENVIRONMENTAL SUSTAINABLE MANAGEMENT OF URBAN NETWORKS WITH THE USE OF ICT: URBANETS PROJECT. THE CASE OF GALLIPOLI

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This paper is part of a wider work developed in the context of the "Urbanets project - Sustainable Management of Urban Networks with the Use of ICT" on traffic and environmental requirements for Brindisi and Gallipoli. The paper considers different aspects, having as an objective the satisfaction of transport and environmental knowledge needs with particular regard to Gallipoli (Apulia). The aim is to supply policy indications in the light of population, economic operators and stakeholders exigencies. The paper contains a transport and an environmental analysis referred to the Gallipoli area and results, stemming from a consultation process of transport operators, citizens, tourists, public employees and stakeholders, are presented. Statistical data analysis describes the nature of the data, explores the relation of the data to the underlying population, creates a model and proves its validity and provides several insights on needs of specific user categories, as gender issues and social equity that are key issues in urban policies. In addition, the potential willingness to pay of users to obtain a general improvement in bus service quality and in environmental conditions is investigated through discrete choice modelling. The idea behind this study is to overcome the crucial impediment in understanding urban travel patterns and the key forces behind user attitudes which normally characterise city surveys. Therefore, attitudinal and behavioural variables are considered to evaluate the propensity of using buses and changing habits for modal choices, more environmental sustainable, through a random utility model. Finally, indications on perspectives and final conclusions are supplied. This paper can represent a useful tool for those who operate in the transport and environmental sectors and for policy-makers as well.

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