Statistical modelling of environmental extremes

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1 Motivation

The statistical modelling of extreme events provides a framework for developing techniques and models to answer questions related to very high or low values in sequences of random variables and stochastic processes. As you will learn in the courses on **Regular Variation** and **Risk Analytics**, extreme value theory has a rich mathematical background with a rapidly growing range of applications. Indeed, over the last decades, numerous authors have contributed to the applications of extremes in various areas, such as insurance, finance and environmental impact assessment.

This course will focus on common challenges when modelling environmental extremes. Using different datasets, we will illustrate classical and emergent modelling techniques and their implementation in R. The course will take the form of a guided tutorial. Please see below for computational requirements.

2 Course content

Practical 1 [09:00-10:30 – 9 March 22] Introduction to the statistical modelling of environmental extremes. Recap of some classical modelling techniques that will be used in the course, such as generalised linear models, generalised additive models and generalised additive mixed models. Gentle introduction to the integrated nested Laplace approximation (INLA) for Bayesian inference. **Keywords: GLMs, GAMs, GAMMs, INLA.**

Practical 2 [11:00-12:30 – 9 March 22] Facing common issues in environmental extremes: trends and seasonality in block-maxima data. **Keywords: GEV, ML-based inference (ML: maximum likelihood).**

Practical 3 [09:00-10:30 – 15 March 22] Facing common issues in environmental extremes: non-stationary exceedances. **Keywords: GPD, ML-based inference, GAMs.**

Practical 4 [11:00-12:30 – 15 March 22] Environmental extremes observed over space: modelling spatial extremes using latent Gaussian models. **Keywords: GPD, Bayesian modelling, INLA.**

Practical 5 [11:00-12:30 – 17 March 22] Modelling (joint) extremes of two environmental variables: measures of asymptotic dependence and independence and (parametric) bivariate extreme-value models. **Keywords: bivariate extreme-value models, ML-based inference.**

3 Requirements

Attendants are expected to be familiar with GLMs, GAMs and GAMMs. For Practical 4, they are adviced (not mandatory) to read Rue *et al.* (2017)[1] to familiarise themselves with latent Gaussian models (LGMs) in the context of the integrated nested Laplace approximation (INLA).

To actively participate in the course, attendants are welcomed to bring their laptops with `R/RStudio` previously installed. The following libraries should also be installed in advance: `evd`, `ismev`, `evgam`, `INLA` an `tidyverse`. Note that INLA is not available from CRAN but can be easily downloaded from the INLA website. Codes and data to run the examples will be available from dcastrocamilo.com.

[1] Rue, H., Riebler, A., Sørbye, S., Illian, J., Simpson, D. P. and0 Lindgren, F. K. (2017) Bayesian computing with INLA: a review. *Annual Review of Statistics and Its Application* **4**, 395–421.