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Smart Control of the Climate Resilience in European Coastal Cities

Preparing modelling scenarios through statistical analysis

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Extreme value analysis (EVA)

- Extreme value analysis (EVA) or Extreme Value Theory (EVT) aim to develop mathematical models and methods able to predict the occurrence of rare phenomena i.e., to estimate the likelihood of the occurrence of extreme values based on a few basic assumptions and observed/measured data (Benstock & Cegla, 2017).

- Although the extreme values are not frequent, the impact of these values on humans is huge. Studying such extreme values provides an overview of the parameter, for instance the rareness of such extreme data.

- EVA typically involves the following steps:
  - ➢ Data Preprocessing
  - ➢ Identifying and extracting the extreme events
  - ➢ Modell fitting

Figure 3 shows the maximum and mean values of each month for the historical time-period data, and there is an increase trend observed from the pattern as well (blue line).

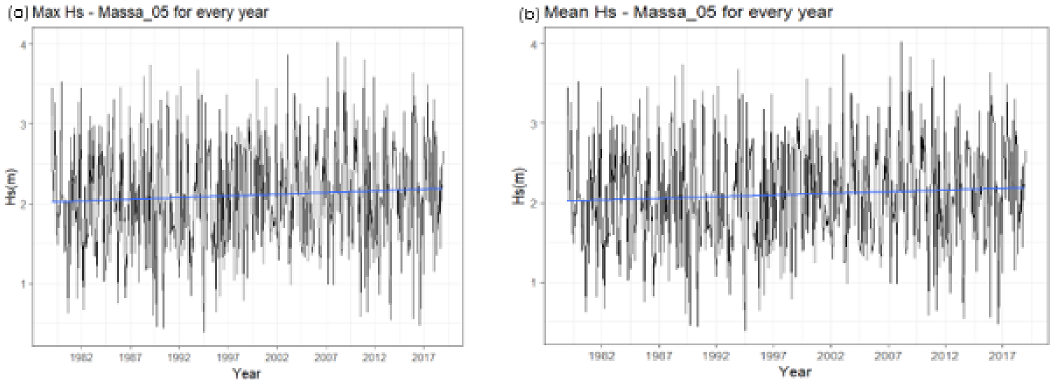


Figure 3: Monthly (a) maximum and (b) mean values of the time-series data

The figure below, Figure 4 shows the increasing trend of the $H_s(m)$ (blue line) as well for the RCP 4.5 and RCP 8.5 scenarios over the 2006-2100 time period.

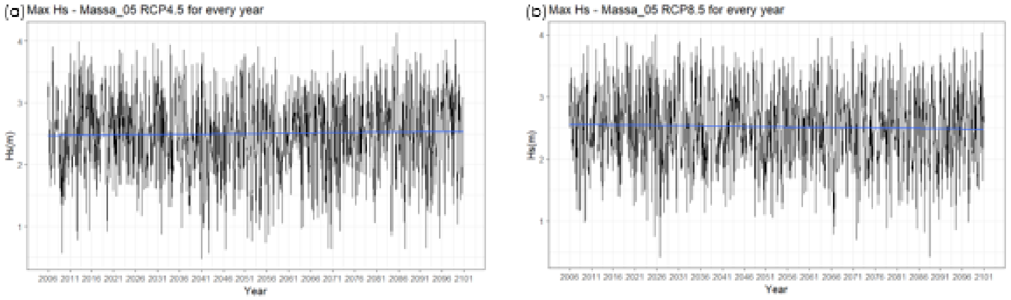


Figure 4: Monthly maximum values of the time-series data for (a) RCP4.5 and (b) RCP8.5

The most usual methods used to calculate the return levels

1

Block Maxima (BM) which focuses only on the maximum observation during each non-overlapping, equal-sized interval of the observation period. Gumbel distribution was the most appropriate for the SSH, wave height and river discharge

2

Peak over Threshold (POT) which works by specifying a certain high threshold and considering all observations above the threshold point in the analysis. It includes different methods to choose the threshold.

3

Point Process approach, which analyses extremes by unifying and extending the EVT based on the BM and POT approaches.

Peak Over Threshold method – selecting the threshold

- Graphical method (Coles, 2001; Smith, 2002);
- Thompson method (Thompson et al., 2009, “Tea” R package (Ossberger, 2022);
- EVA R package, Anderson-Darlin test (Bader et al., 2018);
- Solari Method (Solari et al., 2017).
- 98% percentile.

Threshold selection

File name: hs_eval_massa_05.nc

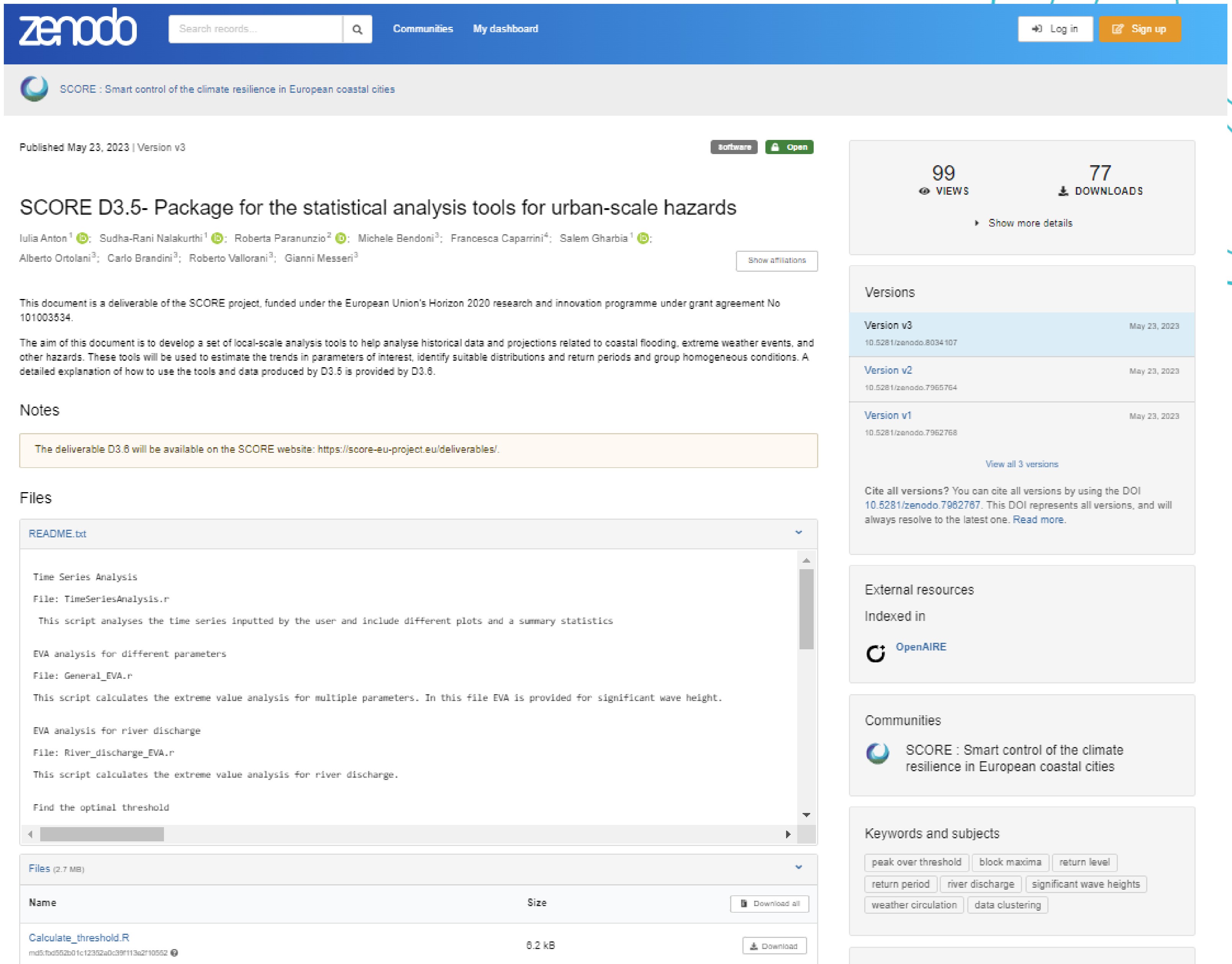
Method	Threshold	20yRL	50yRL	100yRL	200yRL
Graphical	1.5	3.105	3.41	3.588	3.732
Thompson	0.292	3.17	3.742	4.145	4.524
Anderson-Darling test	1.629	3.115	3.417	3.591	3.728
Solari	2.117	3.78	3.884	3.945	3.993

Return period for ssh_runup(m) - Villanova

Peak Over Threshold Method (GPD) - 98% percentile

Parameters	Hist (1956-2005)	Eval (1980-2018)	RCP45 (2015-2064)	RCP45 (2045-2094)	RCP85 (2015-2064)	RCP85 (2045-2094)
Sample size	438312	341880	438312	438288	438312	438288
No of years	50	39	50	50	50	50
Threshold	0.827	0.736	0.834	0.831	0.82	0.819
Location	NA	NA	NA	NA	NA	NA
Scale	0.28	0.23	0.314	0.312	0.25	0.294
Shape	-0.389	-0.261	-0.512	-0.499	-0.29	-0.417
Negative log-likehood	-216.514	-180.826	-200.536	-195.825	-207.269	-176.84
AIC	-429.027	-357.651	-397.072	-387.649	-410.539	-349.68
BIC	-421.447	-350.625	-389.671	-380.275	-403.085	-342.44
RL_5years	0.908	0.798	0.899	0.892	0.879	0.859
CI_5y_Lower	0.873	0.766	0.858	0.852	0.848	0.822
CI_5y_Upper	0.944	0.831	0.94	0.933	0.91	0.896
RL_25years	1.205	1.08	1.207	1.204	1.179	1.184
CI_25y_Lower	1.136	1.022	1.112	1.112	1.122	1.106
CI_25y_Upper	1.275	1.137	1.301	1.296	1.236	1.262
RL_50years	1.286	1.169	1.278	1.278	1.271	1.269
CI_50y_Lower	1.197	1.101	1.147	1.151	1.203	1.169
CI_50y_Upper	1.374	1.237	1.41	1.405	1.338	1.37
RL_100years	1.348	1.243	1.329	1.33	1.346	1.333
CI_100y_Lower	1.234	1.161	1.143	1.152	1.265	1.202
CI_100y_Upper	1.461	1.326	1.515	1.508	1.426	1.465
RL_200years	1.395	1.306	1.364	1.367	1.407	1.381
CI_200y_Lower	1.248	1.205	1.1	1.117	1.311	1.207
CI_200y_Upper	1.542	1.406	1.628	1.617	1.503	1.555
RL_500years	1.44	1.372	1.395	1.4	1.472	1.427
CI_500y_Lower	1.232	1.242	0.974	1.005	1.349	1.173
CI_500y_Upper	1.648	1.503	1.816	1.794	1.594	1.68

For the SCORE CCLLs we used all of these methods and we proceed a package that is freely available on ZENODO



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Thank you!

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