BIVARIATE EXTREME ANALYSIS OF ATMOSPHERIC PRESSURE IN THE AEGEAN SEA

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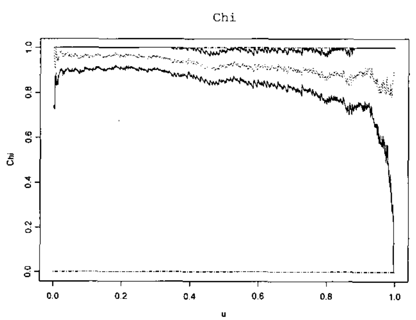
In the present paper bivariate analysis is carried out in order to investigate dependence in the spatial process of atmospheric pressure at five locations in the Aegean Sea (Thessaloniki (622), Kavala (624), Alexandroupolis (627), Chios (706), Heraklio (754)). Four of these locations are situated in the North Aegean Sea, where storm surge events are larger and one is in the South. The station of Thessaloniki, due to its geographical position, is used as a central station for the implementation of bivariate methodologies concerning extreme events. The tendency of atmospheric pressure minima at different locations to occur simultaneously is apparent.

Coles et al (1999) introduced two measures of extremal dependence χ and $\bar{\chi}$, the complete pair of which, gives a summary that is informative for both asymptotically independent and dependent variables. The pair ($\chi>0$, $\bar{\chi}=1$) indicates asymptotic dependence and the value of χ determines the strength of dependence. For two stations that are next to each other (622-624), the plots of χ, $\bar{\chi}$ are respectively:

(a) Thessaloniki (622)-Kavala (624) Stations **(b)** Thessaloniki (622)-Kavala (624) Stations



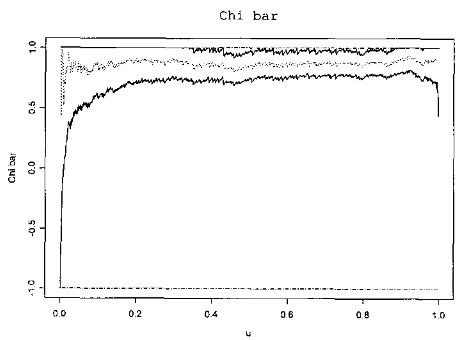


Fig. 1 Variation of (a) χ and (b) $\bar{\chi}$ with u

Plots of χ and $\bar{\chi}$ for all pairs of stations show an increased degree of dependence for the pairs 622-624 (Figure 1) and 622-627 and weaker for the pairs 622-706 and 622-754.

Extremal behavior is well described by using general point process characterizations (Coles et al, 1999). The joint tail behavior of a random vector (X, Y) can be characterized by a sequence of point processes on R_+^2 : $P_n = \{(\frac{X_i}{n}, \frac{Y_i}{n}) : i = 1,2,...,n\}$. As $n \to \infty$, $P_n \to P$ on $R_+^2 / \{0\}$, where P is a Poisson process. Components X and Y are transformed to radial and angular components: R=(X+Y)/n and W=X/(X+Y). The format of the atmospheric pressure data is suitable for the implementation of the point process model. In Figure 2, estimates of the conditional density of W/R>r for the pair of stations 622-624 are given, for a range of values of r corresponding to the 0.5, 0.6, 0.7, 0.8, 0.9 quantile of the variable R and a parametric logistic model is fitted to the pair of pressure data of stations 622-624:

(a) he estimated conditional density of W / R>r, dH(w)/dw

(b) The estimated limiting density dH(w)/dw

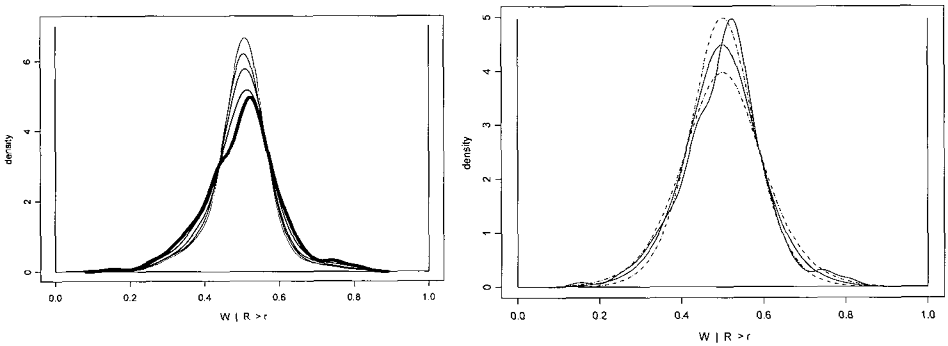


Fig. 2 The estimated conditional density dH(w)/dw and a comparison of the fitted parametric model and the kernel density corresponding to r=0.9R for stations 622-624. Points correspond to 95% confidence intervals for the fitted logistic model.

For all pairs of stations and especially for those of stations 622-624, 622-627, 622-706, the distribution of W values is relatively stable as r increases. The stability of the estimates of W referring to the variable quantities, confirms the previous suggestion of strong dependence. The fitting of the parametric logistic model to the kernel density estimates of the values of W exceeding the 0.9 quantile of the variable R is good, especially for the pairs for which dependence is evident.

Finally, p-quantiles from 0.01 to 0.1 are produced for the fitted Gumbel-McFadden bivariate distribution using GP margins.

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