Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2020-80-RC1, 2020

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Trivariate copula to design coastal structures" *by* Olivier Orcel et al.

Anonymous Referee #1

Received and published: 1 April 2020

This paper demonstrates the disparity in the contours of equal joint exceedance probability of wave height and storm surge associated with several bivariate copulas and those obtained using an existing method at two sites in northern France. Two selection criterion are adopted in collaboration with tail dependence coefficients to determine the best fitting among the ten tested copulas. The superiority of (trivariate) nested hierarchical construction over standard trivariate Archimedean copulas for modelling the dependence between wave height, wave period and storm surge is also exemplified at one of the sites.

A significant proportion of the current manuscript is composed of material that can be found elsewhere, while the absence of any discussion on the latest modelling of the joint distribution of the variables comprising an extreme sea state is a glaring omission. Moreover, in parts of the manuscript individual sentences are listed rather than crafted into paragraphs, many figures and tables are poorly explained and there is a lack of ref-

Printer-friendly version

Discussion paper

erencing throughout. From a technical perspective, although the bivariate results are interesting the trivariate analysis only considers two approaches both of which have been shown to be inferior to pair copula construction for higher dimensional modelling. This reviewer therefore believes that the manuscript will require very significant revisions to be worthy of publication in this special issue of Natural Hazards and Earth System Science.

General comments:

The introduction fails to place the work into the wider context of copula modelling in the field of hydrology or multivariate modeling of extreme sea states carried out to date. The latter discussion should concern work where the dependence between pairs of the wave height H, wave period T and storm surge S or all three are considered (e.g. Gouldby et al. 2014). There is a general lack of referencing throughout the paper.

A coherent and sufficiently detailed explanation of the limitation(s) of the Defra method is also lacking. For instance, does the methods limitations stem from a poor fit of the Gaussian copula from which the dependence factor is derived or the spatial extent covered by each dependence factor a combination of both or other factors.

The word “accuracy” is used repeatedly throughout the paper, however the true shape of the dependence is unknown. Consider replacing “accuracy” with “robustness” or similar. The colloquial [e.g. “variables taken separately” (P1 L31) and “even though this is a complicated exercise” (P2 L42)] and occasionally subjective [e.g. “relatively innovative” (P1 L32)] language used in the manuscript needs remedying.

The “Data Used” subsection feels out of place in the “Theoretical approach” section. Please consider moving the “Data use” subsection to the start of the “Results for bivariate copulas” section. Furthermore, Figure 1 should appear immediately after the first introduction of Le Harve and Saint-Malo in the main body of the manuscript. Perhaps refer to the two sites as two ports in northern France in the introduction so Figure 1 can be placed after the body of text comprising section “2.1 Data Used” in the submitted

manuscript.

The Tables in the results section are often more difficult to interpret than they need to be. To aid interpretation the columns could first be grouped by site i.e., the first half of the columns represent Saint Malo and the second half corresponding to Le Harve.

Sections 2.2 to 2.4 contain material that can be sourced from a multitude of other books/papers. Consider removing or moving to the appendix.

Aas and Berg (2009) show that pair copula construction is less restrictive in terms of the class of copulas that can be mixed and parameter constraints than nested Archimedean construction and are thus more suitable for higher dimensional modeling. The quality of the paper would be elevated substantially if a form of pair copula construction were also fitted in section 4.

The results for trivariate copulas (Section 4) requires more detailed explanation as to the significance of the results. For example, currently Section "4.4 Contours of equal joint exceedance probability with a trivariate copula" is completely devoid of any meaningful discussion of the results.

Often technical concepts or methods e.g., iso-values (P2 L46) or the Chakak and Koehler procedure (P2 L42) are introduced without any or very little introduction.

Specific comments:

P1 L7-8: "The Defra method that is currently used ...". Please detail where the method is currently used.

P1 L9-10: "These schematic correlations do not, however, represent all the complexity of the reality and may lead to damaging errors in coastal structure design." Vague.

P1 L18: Replace "fittest" with "best fitting".

P1 L25-26: "We must therefore address the lack of accuracy of the dependencies between the different variables characterizing the sea state (Sergent et al., 2014; Hawkes,

2005) such as wave height H, wave period T and storm surge S." Please make clear that the "lack of accuracy" refers to the modeling procedure.

P1 26-27: "The design of coastal structures is based in particular on the return periods of wave overtopping or of armour damage.". Reference required.

P1 L35: "Its use in environmental science especially concerns hydrology." Reference required.

P1 L39: "The bivariate return period can be generalized to the multivariate case." Additional explanation or reference required.

P1 L40: "Copulas generally only allow two parameters." Inaccurate.

P2 L46 & P2 L49: "isovalues" or "iso-values". Inconsistent spelling.

P3 L84: "Defra method [2005] . . .". Reference not listed in References Section.

P2 L66– P5 L150: I suggest most of this text is move to an appendix.

Table 2: The Student copula does not appear in Table 3 but is mentioned in the text below. P10 L293: "If the sample does not have a tail dependence, then the use of Gaussian copula or Student copula or other copula with the same tail dependence characteristics is recommended." The Student copula possesses tail dependence.

P11 L309 "Until now the simplified Defra method has been quite popular among coastal engineers". Rephrase, too colloquial, also a reference is required. Figure 2: Caption needs more detail. For instance, which site(s) is being considered and which of the methods corresponds to the black line and blue crosses?

Table 3: Typo. "041" in the final row of the table.

Table 3: Caption needs improvement. 'Parameter" column labels needs defining.

Figures 3,4, 5, 6 & 7: Sub-figures need (a) and (b) to explicitly denote correspondence between the plots and the sites.

P12 L350: “The value of the log likelihood of the Gumbel survival copula is large.”. Large with respect to what?

P13 L364: “We note Emin the minimum of the error e . . . ”. Add “mean” before error.

Table 4: The Emin numbers in the Table do not match the minimum of the mean errors shown in Figure 4. Please check results and, if they should not match the minimums shown in Figure 4 please explain why.

Table 5: Information in Table 5 is recycled from Tables 3 and 4, thus it presents no new information. Remove.

P14 L381: “. . . we show the observed and calculated joint frequencies for the Le Havre sample . . .”. Need to add reference to Figure 5(a) here.

P16 L414-415: I believe Figure 6 only contains the results for one rather than both sites.

Figure 6: Adjust Figure to detail the location to which the results refer.

P19 L474-479: Data sources are normally described when the case study site is first introduced.

P19 L480-481: “The copula parameters were calibrated from samples where wave height values less than one meter were excluded, thus reducing the sample size to about 3.000 values”. Are the copulas fitted to all pairs/triplets of observations where the wave height exceeded 1 meter? If not, please alter text to clarify.

Figures 8-11: Amalgamate these four Figures into a single Figure.

P20 L490-495 Remove as text already explained in the captions.

References:

Aas, K., and Berg, D.: Models for construction of multivariate dependence – a comparison study, The European Journal of Finance, 15, 7-8, 639-659, 2009.

Gouldby, B., Méndez, F.J., Guanche, Y., Rueda, A. and Mínguez, R., 2014. A methodology for deriving extreme nearshore sea conditions for structural design and flood risk analysis. Coastal Engineering, 88, pp.15-26

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2020-80, 2020.

Printer-friendly version

Discussion paper