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Comparison of different statistical methods for estimation of extreme sea levels with wave set-up contribution

Xavier Kergadallan (1), Pietro Bernardara (2,3), Michel Benoit (2,3), Marc Andreewsky (2), Jérôme Weiss (2,3)

(1) CETMEF, Plouzané, France (Xavier.Kergadallan@developpement-durable.gouv.fr), (2) EDF R&D, LNHE, Chatou, France, (3) Saint-Venant Laboratory for Hydraulics, Université Paris-Est, ENPC, EDF R&D, CETMEF, Chatou, France

Estimating the probability of occurrence of extreme sea levels is a central issue for the protection of the coast.

Return periods of sea level with wave set-up contribution are estimated here in one site : Cherbourg in France in the English Channel. The methodology follows two steps : the first one is computation of joint probability of simultaneous wave height and still sea level, the second one is interpretation of that joint probabilities to assess a sea level for a given return period.

Two different approaches were evaluated to compute joint probability of simultaneous wave height and still sea level : the first one is multivariate extreme values distributions of logistic type in which all components of the variables become large simultaneously, the second one is conditional approach for multivariate extreme values in which only one component of the variables have to be large.

Two different methods were applied to estimate sea level with wave set-up contribution for a given return period : Monte-Carlo simulation in which estimation is more accurate but needs higher calculation time and classical ocean engineering design contours of type inverse-FORM in which the method is simpler and allows more complex estimation of wave setup part (wave propagation to the coast for example).

We compare results from the two different approaches with the two different methods. To be able to use both Monte-Carlo simulation and design contours methods, wave setup is estimated with an simple empirical formula.

We show advantages of the conditional approach compared to the multivariate extreme values approach when extreme sea-level occurs when either surge or wave height is large. We discuss the validity of the ocean engineering design contours method which is an alternative when computation of sea levels is too complex to use Monte-Carlo simulation method.