PROBABILISTIC ASSESSMENT OF PORT OPERABILITY UNDER CLIMATE CHANGE

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INTRODUCTION

Harbors are strategic infrastructures within the local, regional and global economy. The objective of a harbor is to guarantee the safety, serviceability and exploitation of all activities, for each element, and in all project phases. Within this context, Level III Verification Method is recommended for the probabilistic evaluation of failure modes and operational stoppage modes (downtime) of maritime structures; and the Spanish Recommendations for Maritime Structures (ROM) proposes a simulation method based on the Monte Carlo technique. On the other hand, ports are susceptible to impacts from climate change driven processes, like sea level rise (SLR) or changes in waves and storm surges. These impacts could reduce the functionality of ports and therefore negatively affect the effectiveness of supply chain network.

In this work, we focus on a very long-term probabilistic assessment of the port operability due to wave agitation inside the port including the potential effects of climate change.

METHODOLOGY

Port agitation is determined by wave penetration into the harbor arising from the combination of different variables: significant wave height, wave period, wave direction, astronomical tide and storm surge outside the port. The probabilistic verification comprises the fitting of a statistical model which considers the dependence between the variables and then Monte Carlo approximation to stochastically simulate a large (1000´s) samples of hourly sea conditions.

The natural boundary condition for undertaking multivariate analysis for port operability is defined in deep water, prior to the complex nearshore wave penetration into the harbor. A meta-model is used to increase the computational efficiency associated with the physical modelling of wave agitation. This meta-model propagates a number of representative sea states using a elliptic mild slope model (MSP) and reconstructs the time series nearshore using an interpolation technique (Camus et al., 2011).

Two multivariate statistical approaches are applied to generate synthetic hourly sea conditions. One model is based on a copula-based method including the climate variability through a weather-type approach (Rueda et al., 2016), extended to the hourly conditions. The other approach is based on a vector autoregressive model able to reproduce the structure of the multivariate time series (Solari et al., 2012). IPCC SLR projections under RCP scenarios are considered. Changes in reflection coefficients inside the harbor due to SLR are implemented in wave propagation.

RESULTS

The methodological framework is applied to a local port located in the northern coast of Spain. Different abilities of the two statistical approaches to verify probabilistically the port operability including climate change impact due to SLR and even changes in storminess are identified. Figure 1 shows the configuration of the studied port. As an example, Figure 2 shows changes in port operability due to SLR in the area marked in Figure 1.

Figure 1 – Case study: local port in the northern Spain.

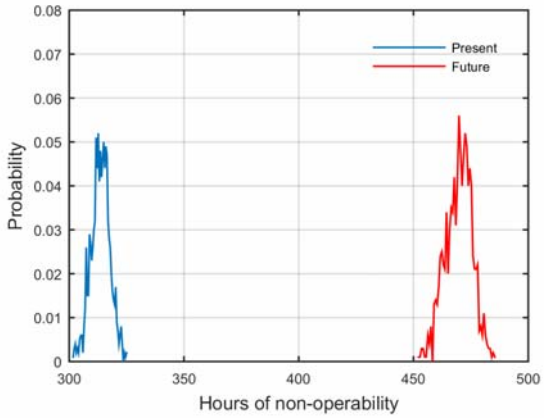

Figure 2 – Changes in port operability.

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