A TOOL FOR THE DESIGN OPTIMIZATION AND MANAGEMENT OF SUBMARINE OUTFALL PROJECTS: APPLICATION TO A PORTUGUESE CASE-STUDY

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Paper topic: Coastal risks and management, including climate changes

Summary

The use of submarine outfalls has been increasing rapidly (Grace, 2009) and their good working conditions are of mandatory importance to the environment, welfare of populations and economy. These structures are subject to the action of several climate and usage exploitations agents, which must fulfill overall safety and operational criteria.

Despite the fact that high-cost projects of outfalls are a complex task that relies on many disciplines, the risk management is still applied instinctively, with risks remaining implicit.

This work aims to create a consistent methodology for the risk management of the project of submarine outfalls following the procedure of the Spanish Recommendations for Maritime Structures, ROM, that is restricted essentially to harbor and coastal protection structures (Puertos del Estado, 2002). This methodology is expected to evaluate safety and operationality, as well as some aspects of the performance of the submarine outfall.

The first step of the engineering procedure specifies the requirements and target design levels of these structures in the project phase and is described in Mendonça et al. (2013), together with failure modes and corresponding limit states. The risk assessment procedure proposed in Mendonça et al. (2012) is applied for operational limit states (environmental failure modes) focusing on the environmental legislative framework, climate agents on the coastline and effluent fate and distribution.

The developed methodology analyses the plume behavior in each time interval (yearly) with the objective to:

- Calculate the probability of exceeding a representative threshold value whose occurrence may be significant to the operationality of the structure (e.g. faecal coliform concentration);
- Calculate the persistence of the exceedance of that threshold value;
- Calculate the frequency and seasonality;
- Identify the areas with high probability of exceedance of that threshold value;
- Establish a relation between wind forcing and surface currents, finding out if the spatial variability of plumes is primarily determined by atmospheric forcing;
- Quantify the physical forcing mechanisms that govern the variability of plumes in the studied coastal system; and
- Define the plume distribution function and its lower and upper characteristic levels.

The numerical modeling process uses TELEMAC (Galland et al., 1991): (i) to simulate 1000 statistically independent event (yearly) scenarios in feasible computation times, using Monte Carlo simulated wind time series as boundary conditions, while (ii) representing the typical annual current conditions.

Project design alternatives for submarine outfalls should be drawn based on these result analyses

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with solutions flexible enough to be constantly upgraded and improved in order to fulfill expected environment protection requirements as the Marine Strategy Framework Directive and established target design levels of operationality.

Empirical orthogonal functions (EOFs) to find ways to reduce the dimensionality of the system and find the most important patterns explaining the variations will be applied to TELEMAC results.

To illustrate the procedure, an application to the submarine outfall of Vale de Faro, situated in Praia do Inatel, Albufeira, in the south coast of Portugal is analysed (Figure 1).

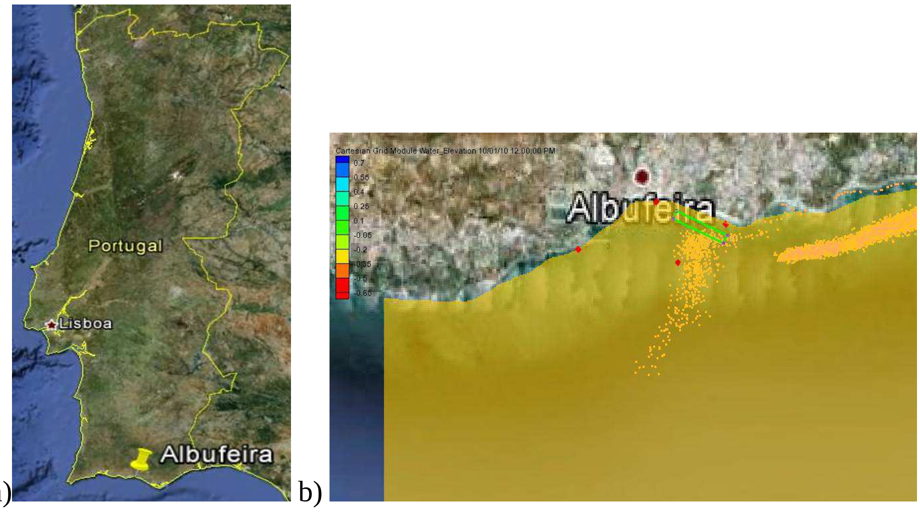
a) b)


Figure 1. Vale de Faro submarine outfall, Portugal: a) location; b) effluent transport near the coastline.

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References

Galland, J.C., Goutal, N., Hervouet, J.M., 1991. TELEMAC: A New Numerical Model for Solving Shallow Water Equations. Advances in Water Resources AWREDI, Vol. 14, No. 3, pp. 138-148.

Grace, R.A., 2009. Marine Outfall Construction Background, Techniques, and Case Studies. American Society of Civil Engineers. ISBN-10: 0784409846 (1991).

Mendonça, A., Losada, M.A., Neves, M.G., Reis, M.T., 2012. Operational forecast methodology for submarine outfall management: application to a Portuguese case study. MWWD & IEMES 2012 7th International Conference on Marine Wastewater Discharges and Coastal Environment, Montenegro, 21-16 October.

Mendonça, A., Losada, M.A., Reis, M.T.; Neves, M.G., 2013. Risk Assessment in Submarine Outfall Projects: the Case of Portugal. Journal of Environmental Management, Vol. 116, pp. 186-195.

Puertos del Estado, 2002. General Procedure and Requirements in the Design of Harbor and Maritime Structures. Part I: Recommendations for Maritime Structures, Ministerio de Fomento, Puertos del Estado, Spain. ISBN 84-88975-30-9.