COASTAL EROSION RISKS – BEACHES

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Abstract

Introduction

The coastal area constitutes a very narrow strip between land and sea, but it is of great significance as a link in the transport of mass, momentum, and energy. Most of the energy transferred from the atmosphere to the ocean surface is dissipated in these areas generating strong forcing that may cause severe impacts. Waves and currents resulting from this forcing induce sediment transport and beach change with consequences for infrastructure, buildings, and human activities in the coastal areas.

The forcing in the coastal areas and the associated response occur at many different scales in time and space. Thus, in engineering projects it is necessary to identify the coastal processes of importance for the particular problem under study and its characteristic scale. In addition, the great variability and random properties of the forcing make it logical to adopt a risk-based approach when performing analysis, design, or impact assessment in such projects.

This presentation focuses on different types of coastal erosion and how to develop a risk-based approach to characterize and manage the problems associated with the erosion. Coastal erosion associated with three different time scales is discussed, namely (1) storm erosion occurring over several days at most; (2) erosion due to man-made structures or activities taking place over several years up to decades; and (3) erosion caused by sea-level rise over centuries.

Objectives

The main objectives of the presentation are:

- To briefly introduce coastal processes governing sediment transport and beach change
- To discuss coastal erosion, including its main causes and effects, associated with storms, man-made structures and activities, and sea-level rise
- To review approaches to model the different types of coastal erosion with a risk-based perspective
- To examine different methods for employing risk-based estimates of coastal erosion in integrated coastal zone planning and management

Overview of Lecture

A brief introduction is made of the main coastal processes governing sediment transport and beach change. Nearshore waves and currents, and their influence on the sediment transport are reviewed together with some basic information on beach morphology and its evolution.

The first mechanism for coastal erosion to be discussed is storms, which typically induce large waves and increased water levels over half a day to several days. Storms may cause dune erosion, overwash, and breaching of barrier islands besides eroding the upper part of the profile and depositing the material in

deeper water, often as a longshore sand bar. A wide range of models have been developed to predict erosion during storms, typically focusing on the profile response assuming that longshore gradients are negligible. Both analytical and numerical models are available and a few of the most commonly used models are presented. Probabilistic methods, including the transformation of a specified probability density function or a Monte-Carlo simulation technique, are utilized in risk-based approaches to assess coastal erosion during storms. A few examples of such methods are discussed.

The second mechanism for coastal erosion to be reviewed is gradients in the longshore sediment transport induced by man-made structures or activities. Such erosion occurs over several years up to decades and is caused by blocking of the longshore sediment transport. Typical structures that have this effect are groins, jetties, detached breakwaters, and seawalls. Although the structures might have been designed for shore protection purposes, side effects are common, including downdrift erosion. Man-made activities that could have similar effects are dredging of navigation channels or shoal areas. Shoreline evolution models to simulate erosion due to gradients in the longshore sediment transport were the first type of coastal evolution models to be developed. These models may also be operated using Monte-Carlo simulation techniques to arrive at probabilities of erosion, which are then used in risk assessment. A few of the most common models to simulate shoreline evolution are discussed.

The third mechanism for erosion is sea level rise, which is commonly occurring along many coasts and is predicted to exhibit an increased rate in the near future because of an expected change in the climate. The rise in sea level occurs at a time scale of centuries with little feedback from morphological change, which implies that existing models to estimate erosion associated with this rise involve little dynamics. Instead various types of geometric rules are applied. A summary of such methods will be presented and put into a probabilistic context.

Finally, different methods are examined to employ the risk-based estimates of coastal erosion in integrated coastal zone planning and management with regard to the different mechanisms investigated.