Waterdunen: field monitoring and numerical modeling of tidal flow

MSc Graduation project

Introduction

The Waterdunen is an artificial intertidal area in Zeeuws Vlaanderen which is situated landward of the primary sea dike (fig. 1). It is connected to the Western Scheldt by means of an adjustable culvert (fig. 2) whose operation is controlled to optimize the tidal conditions within the basin. The velocities at both sides of the culvert can become very high (>7 m/s) with supercritical flow at normative conditions. To protect the bed near the culvert from erosion by these high velocities a bed protection layer has been constructed. However, the data necessary to design it are largely uncertain. Furthermore, recent studies have revealed a possible feed back mechanism between the flow field and the resulting scour that may further enhance erosion, which is not accounted for in design methods for bed protection. To obtain accurate data of the flow and turbulence characteristics around the culvert, a large scale monitoring program will be carried out during September-November 2019. This involves ADCP measurements of the flow velocities, and water surface tracking by shore based high-speed cameras. The horizontal flow field can be deduced from the latter by using particle imaging velocimetry (PIV). Application of this technique in field situations is relatively new and particularly promising for environmental flows with high velocities where air entrainment obscures the ADCP sensors. The data will be used to validate advanced 3-dimensional numerical flow models to further analyze these types of flow. This will become increasingly important as climatological changes impose new operational limits on new and existing hydraulic structures.

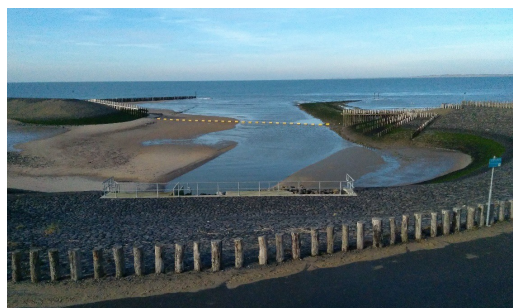

Figure 1. Impression of Waterdunen

Figure 2. Culvert and inlet channel

Scope

The project aims to understand the phenomenon of jet-outflow at culverts in order to reduce uncertainties in the modeling for bed protection design purposes. This involves ADCP and remote camera measurements, field data analysis, and 3-dimensional numerical flow modeling.

Planning

In view of the field measurements campaign the project will start October 2019, or earlier, depending on the student's availability. Part of the work will be carried out at Svasek Hydraulics, Rotterdam.

Requirements

It is recommended to pass/study the courses on turbulence and numerical modeling of flow and transport. Affinity with modeling and programming, in particular using Python, is an advantage. Regarding the third parties that are involved (province, waterboard) proficiency of the Dutch language is necessary.

Committee

The graduation committee will consist of Anna Kroon, Wim Uijttewaal, Robert Jan Labeur, and various members representing the Province of Zeeland and the Waterboard Scheldestromen.

Information

Anna Kroon (room 3.95, j.kroon@tudelft.nl) or Robert Jan Labeur (room 2.90, r.j.labeur@tudelft.nl)