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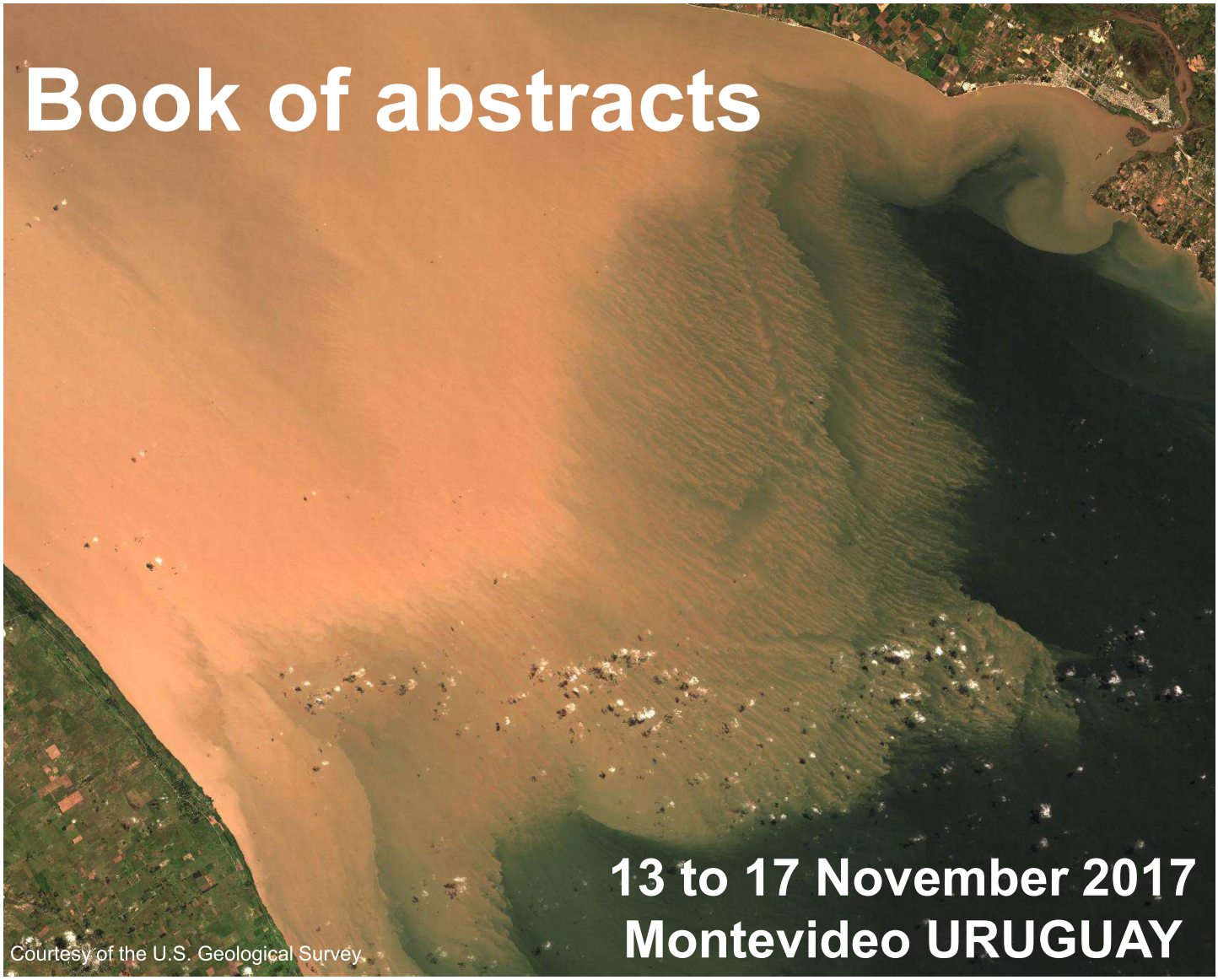

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Wave attenuation by brushwood dams in a mud-mangrove coast

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During recent decades, mangrove forests have experienced severe degradation due to unsustainable land use. Restoration of mangrove ecosystems requires the recovery of their habitat, considering ecology, hydrology, hydrodynamics, and sediment transport. In a first pilot in 2013, brushwood dams were built on the eroding coast of Demak, Indonesia, in order to emulate the function of mangrove roots and provide the physical conditions for natural colonization. However, at present there is little research on how soft structures affect the local hydrodynamics. The present study aims to improve the understanding of wave attenuation by permeable brushwood dams in Demak, combining field observations and hydrodynamic modelling using Delft3D. The findings of the study will be used to develop a landscape bio-morphodynamic model, which will be applied for planning future mangrove restoration efforts.

Introduction

Mangrove ecosystems are present along intertidal areas of tropical regions and provide multiple ecosystem services. They are natural habitats for numerous species, provide food and fuel wood, sequester carbon and act as a natural flood protection against hazards (Giesen et al., 2007, McIvor, 2012).

During recent decades mangrove forests have experienced severe degradation due to unsustainable land use (Winterwerp et al., 2013). In the province of Demak, Indonesia, mangrove removal for the construction of aquaculture ponds altered the sediment balance and produced high erosion rates at the coast. The measured retreat rates are over 100 m/year at some locations of the coastline, and around 6000 villages are at risk of being swallowed by the sea.

Restoration of mangrove ecosystems requires recovering their habitat, considering the ecology, hydrology, hydrodynamics and sediment transport. A first pilot was carried out in Demak in 2013, where permeable brushwood dams were built to emulate the function of mangrove roots. The dams attenuated waves in the areas that they confined, favouring sedimentation behind them and providing the physical conditions for vegetation to grow. After the stormy season of 2015 (November-February), 0.5 m of accretion was measured behind the dams and natural recruitment of *Avicennia marina* was observed to occur in the area.

In 2015 a large-scale project started with a consortium of Dutch companies (Ecoshape) in cooperation with the Indonesian Ministry of Marine Affairs and Fisheries (MMAF). The purpose of the project is to protect 20 km of coastline by a buffering mangrove belt. The BioManCO research project builds further on this initiative. It aims to expand the scientific knowledge on mud-mangrove coastlines and to develop a bio-morphodynamic landscape model that can be used to plan future restoration efforts.

Studying and quantifying wave damping by brushwood dams is a necessary step for the development of the landscape model. Substantial literature exists on the effect of permeable granular structures on incident waves (e.g. Sollit and Cross, 1976; Losada et al., 1995; Ting et al., 2004 among others). A number of authors have represented the effect of the structures in terms of reflection and transmission coefficients, empirically related to wave properties (wave height, wave steepness, wave number) and to the characteristics of the structure (geometry, porosity). However, little research has been done with soft structures such as brushwood dams.

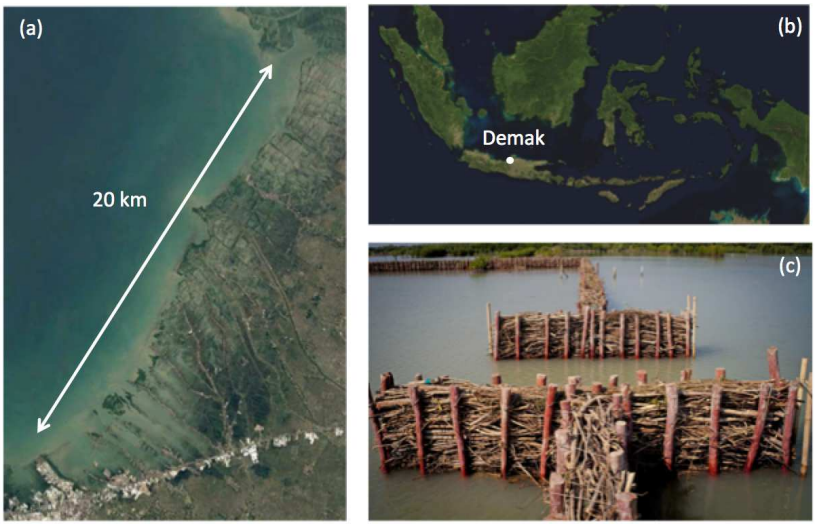

Figure 1. (a) Stretch to be protected by a mangrove belt (b) Location of Demak (c) Picture of one of the permeable dams.

Methodology

In order to improve the understanding of wave attenuation by permeable dams in the area of Demak, a combination of field observations and hydrodynamic modelling are being performed. Field measurements are conducted in order to quantify wave attenuation over the existing dams, and to characterize the soil properties at their location. The effect of the dams on flow and waves is parameterized in a submodel, included in a larger-scale Delft3D model of hydrodynamics and morphodynamics along the coast of Demak. The findings of this study will allow further development of the landscape model. This model will be applied in selecting suitable sites for the use of the permeable dams as a means to foster natural mangrove colonization and subsequent restoration of degraded mangrove ecosystems.

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