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Assessing the Transport of Pollutants by Means of Imaging Methods

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Abstract

Tragic oil spills such as the Exxon Valdez episode in the 1989 are a reminder of such events and their consequences. It is therefore important to have tools capable of detecting and tracking the fate of such spills. This paper presents some imaging-based tools developed to track the evolution of pollutant spills and tested in laboratory environment with two types of pollutants: a liquid and a dust-type pollutant.

Keywords: pollutants, imaging techniques, tracking, rhodamine, coal.

1. INTRODUCTION

Imaging methods have a range of application in many fields of science, and in hydraulics, where imaging-based methods such as PIV and PTV are often used (Muste et al. 2017). Imaging methods offer the possibility of analysing a significant area with enough resolution and so are particularly suited to field applications. In this study, imaging techniques were applied to determine the spill geometry and its evolution, of two different materials: rhodamine (liquid) and coal (dust). To extract the spill geometry a threshold analysis is used. This threshold can be defined in terms of the pixel intensity or pixel color. A trial-and-error test is usually needed to define the threshold value to consider. The goal is to obtain a binary image where the spill is isolated as depicted in Fig. 1. This task is not always trivial when the contrast between the pollutant and

Fig. 1. Identifying the spill by imaging methods. From left to right: raw image, binary image, isolated spill.

the background is low. In the present case, the threshold was adapted to consider dilution and light changes along the flume. With the spill isolated, it is then possible to compute its geometrical characteristics, namely its perimeter and its area. With some assumptions regarding its thickness, it becomes also possible to calculate its volume. By applying this procedure to the whole footage, it is possible to estimate the evolution and fate of the spill.

2. RESULTS

Experiments were carried out in a 15 m long, 1.0 m wide, and 1.5 m deep flume at the School of Ocean Engineering of the University of Valparaíso (Fig. 2). Tests were carried for a flow rate of $Q = 0.0101$ m^{3}s^{-1}, corresponding to a bulk mean velocity of $U \approx 0.050$ m/s. Images of the rhodamine and coal (d_{50} = 0.54 mm) spills were acquired by means of GoPro cameras located above the flume. The obtained results for the tracking of the different spills are depicted in Fig. 2. Mean velocity of the spills was 0.17 and 0.09 m/s for rhodamine and coal, respectively. The heavier fraction of coal deposits, and the lighter is transported in suspension.

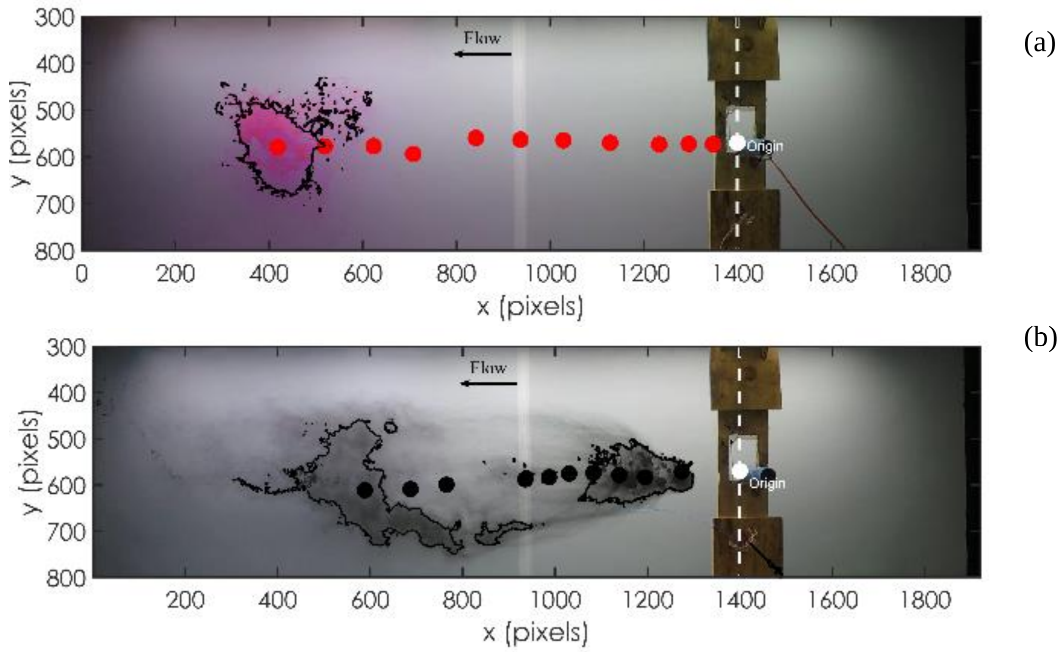

Fig. 2: (a) rhodamine spill tracked, (b) coal spill tracked. Flow is right to left. Dots indicate the center of mass of the spills at regular time intervals (dt = 1.67 s).

3. CONCLUSIONS

A detection and tracking algorithm was applied to spills made of different material at a laboratory scale. It was possible to track the evolution in time and space of the spill, allowing to track its trajectory, and ultimately its fate. It became also possible to determine the area and the velocity of the spill.

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