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Article

Investigation of the Spatio-Temporal Behaviour of Submarine Groundwater Discharge Using a Low-Cost Multi-Sensor-Platform

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Abstract: Submarine groundwater discharge (SGD) is an important pathway of nutrients into coastal areas. During the last decades, interest of researchers in SGDs has grown continuously. However, methods applied for SGD research usually focus on the aquifer or on the mixing processes on larger scales. The distribution of discharged water within the water column is not well investigated. Small remotely operated vehicles (ROV) equipped with environmental sensors can be used to investigate the spatial distribution of environmental parameters in the water column. Herein, a low-cost multi-sensor platform designed to investigate the spatial distribution of water quality properties is presented. The platform is based on an off-the-shelf underwater vehicle carrying various environmental sensors and a short-baseline localisation system. This contribution presents the results of SGD investigations in the area of Woodman Point (Western Australia). Various potential SGD plumes were detected using a skiff equipped with a recreational echo sounder. It was demonstrated that this inexpensive equipment could be used to detect and investigate SGDs in coastal areas. In addition, the low-cost multi-sensor platform was deployed to investigate the spatial distribution of environmental parameters including temperature (T), electric conductivity (EC), dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, and dissolved organic matter fluorescence (FDOM). Three ROV surveys were conducted from different skiff locations. Analyses of the spatial distribution of the environmental parameters allowed the identification of nine potential SGD plumes. At the same locations, plumes were identified during the sonar surveys. In addition, fuzzy logic was used for the fusion of salinity, DO, and FDOM readings in order to enhance SGD detection capability of the designed multi-sensor system. The fuzzy logic approach identified 293 data points as potential within a SGD plume. Average minimum-distance between these points and the identified SGD plumes was 0.5 m and 0.42 m smaller than the minimum-distance average of the remaining data points of survey one and three respectively. It was shown that low-cost ROVs, equipped with environmental sensors, could be an important tool for the investigation of the spatio-temporal behaviour of SGD sites. This method allows continuous mapping of environmental parameters with a high spatial and temporal resolution. However, to obtain deeper insights into the influence of SGDs on the nearshore areas, this method should be combined with other well-established methods for SGD investigation, such as pore water sampling, remote sensing, or groundwater monitoring.

Keywords: submarine groundwater discharge; remotely operated multi sensor platform; low-cost; fuzzy logic

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