A new method of testing groundwater inflow to the seabed, Puck Bay, South Baltic

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ABSTRACT

Submarine Groundwater Discharge (SGD) is a hydrogeological process which commonly occurs in coastal areas. Groundwater discharge is controlled by several geological forcing mechanisms, which result in a hydraulic gradient between land and sea. SGD plays an important role in coastal biogeochemical processes and hydrological cycles (Burnett 2003). The Southern Baltic Sea coastal zone represents an interesting object of study as bottom deposits show seepages of fresh groundwater (Jankowska - Piekarek 1994). This study involved Puck Bay and the adjacent coastal belt of the Kashubian Coast plateau in the Baltic Sea. Multi-year research at the Institute of Oceanography University of Gdansk (Jankowska - Piekarek 1994) were carried out to investigate groundwater discharge into the bottom of Puck Bay in the southern Baltic. Data from this research mainly focused on water chemistry and salinity changes, therefore the study is to provide additional details concerning in situ measurements. Research of potential outflows of fresh groundwater was done through a thermal imaging study of the area. Aerial photographs made in summer 2015 using a thermographic camera feature dark blue spots, which represent regions with cooler waters (<15°C), and yellow, orange or red spots, which represent regions with warmer water (>18°C). Areas where intensive seepage of fresh water into Puck Bay takes place are cooler relative to adjacent areas. An articulate thermal anomaly allows determination of the location research points and verify them by in situ measurements of the direction and intensity of water flow in the bottom sediments of the bay. The flow of both fresh and sea water is primarily controlled by hydraulic gradients between land and sea and differences in the densities between both waters and the permeability of the sediments. The direct measurement of the submarine groundwater discharge required designing and constructing two new devices – the gradientmeter, which measures the direction of water flow, and the filtrometer, which determines the intensity of water flow (Chudziak 2014). The equipment was extended in a way that groundwater drain intensity measurements were possible in the aquifer. To substantiate the results, water from the research area was sampled at two depths: near the bottom of the bay and at the surface. The low salinity of deeper water confirmed the presence of submarine groundwater seepage into Puck Bay. The research conducted by our team allowed to create maps of hydraulic gradient variability, groundwater seepage intensity and the spatial distribution of hydraulic conductivity of bottom sediments. As a result of the research, the new tools were deployed, which allows for the measurement of direct hydraulic parameters at the sea's bottom and other water reservoirs has been developed. This research revealed a high correlation between thermal imaging interpretation data and results of in situ measurements of submarine groundwater seepage. It can be hypothesized that thermal imaging can accurately characterize such seepage once the seepage intensity is properly calibrated based on measurements of the hydraulic gradient and the intensity of water flow in bottom sediments.

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