Direct measurements of submarine seepage of groundwater into Puck Bay, Poland

M. Marciniak
Adam Mickiewicz University in Poznan, Poland
L. Łęczyński, E. Bublijewska
University of Gdansk, Poland
Ł. Chudziak
Adam Mickiewicz University in Poznan, Poland

ABSTRACT
Many long-term studies 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 Sea. These studies usually focused on the changes in water chemistry and salinity. In many cases, data from submarine and coastal drillings were also analyzed. In August 2015, thermal imaging was applied to seek regions of groundwater seepage into the bay. Aerial photographs made in summer using a thermographic camera feature dark blue spots, which represent regions with cooler waters (<15^{o}C), and yellow, orange or red spots, which represent regions with waters that are warmer (>18^{o}C). Areas where intensive seepage of water into Puck Bay takes place are cooler relative to adjacent areas.
The results of thermal imaging were verified by in situ measurements of the direction and intensity of water flow in the bottom sediments of the bay. These measurements required designing and constructing two new devices - the gradientmeter, which measures the direction of water flow, and the filtrometer, which allows determining the intensity of this flow. Both devices are briefly presented in this paper. Moreover, in areas where such measurements were performed, water 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.
Maps of hydraulic gradient variability, groundwater seepage intensity and the spatial distribution of hydraulic conductivity of bottom sediments were developed. The research revealed a high correlation between the results of thermal imaging interpretation and the 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.