WATER CIRCULATION IN POLYMICTIC FLOW-THROUGH LAKES ON THE EXAMPLE OF SWARZĘDZKIE AND WOLSZTYŃSKIE LAKES

This doctoral thesis examined functioning of lakes in the context of water dynamics caused by wind and river flow. An eutrophic lakes restoration has received much attention in recent years to restore them recreational and economic function. Recognition of water dynamic can be helpful in planning this kind of operation. Investigation tasks concern to characterize the intensity of water mixing by calculating horizontal range of circulation and vertical range of waving. This study also tries to correlate water dynamics with spatial variability of physical and chemical parameters. Another important task, which has an applicable character, is recognition of possibilities of using acoustic method to measure water turbidity.

Two lakes were selected to investigation. These are eutrophic, urban lakes. First of them, Swarzędzkie Lake, is located in Swarzędz commune in central part of Wielkopolska, and it is located close to residential buildings. The second, Wolsztyńskie Lake, is located in Wolsztyn commune in western part of Wielkopolska, and it is also located close to residential buildings. Both two lakes are shallow polymictic reservoir and because of this they are sensitive to wind actions. They are also flow through lakes and they are exposed to negative influence of the rivers. The Cybina river flows through the Swarzędzkie Lake but The Dojca river through Wolsztyńskie Lake. They are small rivers with low flow rate. Mean depth of Swarzędzkie Lake is 2,3 meters and its area is about 90 hectares. Mean depth of Wolsztyńskie Lake is 2 meters and its area is about 120 hectares.

For each of the lakes eight measurement points on the lake surface and one on the river were chosen to investigation. Several research methods were used in this study. Acoustic Doppler current profiler was used to measure water movement. It was also used to measure water turbidity. Moreover turbidity was measured in taken samples of water to calibrate the acoustic method. Physical parameters were measured with multiparametric instrument Hanna. Ion chromatography and optical spectrometry were used to calculated the concentration of chemical parameters in taken samples.

During the analyses the way of water movement was first characterised. It is determined that particles in water move in circular or elliptical orbit. Moreover the smaller depth, the more elliptical the orbit is and the movement becomes more linear. The movement is also oscillating, with frequently changing direction.

Next, the vertical range of waving were analysed. It was calculated by measuring variability of vertical velocity in measurement profile. It was determined that the velocity value decreases with depth up to some specific limit, which was defined at 0,002 m/s. The range of

waving mostly depends on run-up of waves in given measurement point, but not directly on wind speed. Mean range of waving is higher in Wolsztyńskie Lake compared to Swarzędzkie Lake. It can be caused by higher exposure index, that shows higher sensitivity on external factor, like wind, insolation, temperature.

Next subject of investigation in the doctoral thesis were wind-driven current. It has been shown, that macrofits have significant impact on lowering velocity of water circulation. The highest velocity of wind-driven current occurs in the surface layer and it decreases with depth. In the scale of whole reservoir the highest velocity occurs in the most shallow areas of the lakes – near the islands and shore. The direction of current in the surface layer is commonly compatible with direction of the wind. Velocity of the circulation depends on mean velocity of the wind for whole reservoir. The analyses and calculations has shown, that character of circulation depends on existing even small difference of water temperature (1-2˚C) between the surface and bottom layer. When this difference exists, the current direction in surface layer is the same for almost whole of lake surface and the compensation current with opposite direction appears near the bottom. When the temperature is homogeneous for whole lake, circular currents can be observed and islands have strong impact on them.

It has been shown with several measurement method, that the flowing currents are not noticeable in the inflow area and water dynamic is specific for lake water. It is surely due to very low values of flows in investigated rivers.

The spatial variability of physical parameters and chemical elements concentration was investigated. The investigation focused on turbidity, because of using new measuring method with acoustic Doppler current profiler. The measurement and calculations confirmed advantages of using this method to analyse turbidity in lakes with great spatial resolution. Moreover, the investigation has shown that wind action compare with morphometry of lakes has significant influence on water lake turbidity. Run-up of the waves and small depth causes sediment resuspention and increases turbidity. Intensive horizontal circulation wides this effect on whole lake. Any significant variability of physical parameters and chemical elements wasn’t observed in whole the lake, but high concentration of phosphorus was noticed in autumn near the inflow area. It was caused by functioning of fish ponds over the lake.

The functioning of lake ecosystem strongly depends on intensity of water mixing. This study has shown that wind action connected with lakes morphometry has significant impact on this functioning especially for shallow polimictic reservoirs. The recognition and understanding of these processes can be useful in planning lakes restoration.