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Modification of the temperature condition of the basin-cooler in the energy object coverage

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Abstract. In the context of the growing interest to urban ecology, in particular the forces of human impacts on aquatic ecosystems, and the inevitable need for electricity generation for the life of the townspeople, becoming especially topical study thermal effects on basin-coolers. In article is described modification of the temperature condition of the basin-cooler within range of the Kazan CHPP-1, namely the process of cooling water during open offtake (in the dynamics of years). Demonstrated the lowering of water temperature (average of the season) in open offtake and in the basin-cooler – the Sredniy Kaban lake.

Introduction

Currently, aquatic ecosystems are objects of multi-purpose industrial and/or agricultural uses. Particularly relevant for research become reservoirs located within major cities experiencing increased anthropogenic impact. In Kazan, a city with over a million dwellers, is located the system of Kaban lakes (from 1902 onwards), attracting the attention of researchers. Special interest is the Srednyi Kaban lake which is the basin-cooler of the Kazan CHPP-1 from the year 1931.

Characteristics of the object of research

Total water surface of the Srednyi Kaban lake, taking into account open offtake of the Kazan CHPP-1, is 131.8 hectare. Since the use of the lake as a basin-cooler the 23% of its water area not covered by ice during winter time, which opens the possibility of using a reservoir for aquaculture. Length of the open offtake and the object of our detailed research are 760 meters. From 1931 year warmed water waste were cooling directly on the CHPP and next on open offtake and entered to the Srednyi Kaban lake. According to 2010/2011 for the full length of open offtake the water cooled to 3.5 °C [1, 2]. In March 2011 the dam was built to reduce the heat warmed waters of CHPP on reservoir. This dam bearing open offtake from the Srednyi Kaban lake (Figure 1). Circulation in the lake was maintained by pipes running under the dam.

The results of the research

Based on the results of data which collected from 2010 to 2017 were built charts of temperature modification (average of the season) of water surface layer in the process of moving from the beginning of the open offtake to the open plot of basin-cooler (100 meters from the dam) (Figure 2).



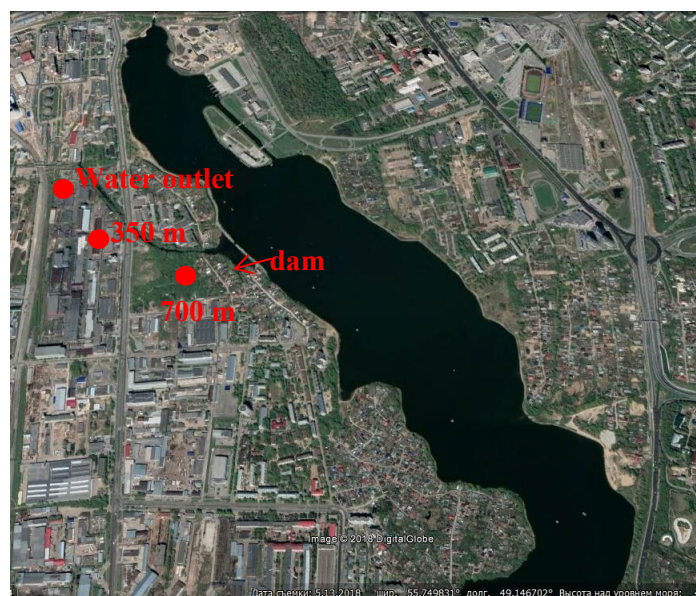


Figure 1. The location of the dam, separating the open offtake of the Kazan CHPP-1 from the basin-cooler the Srednyi Kaban lake.

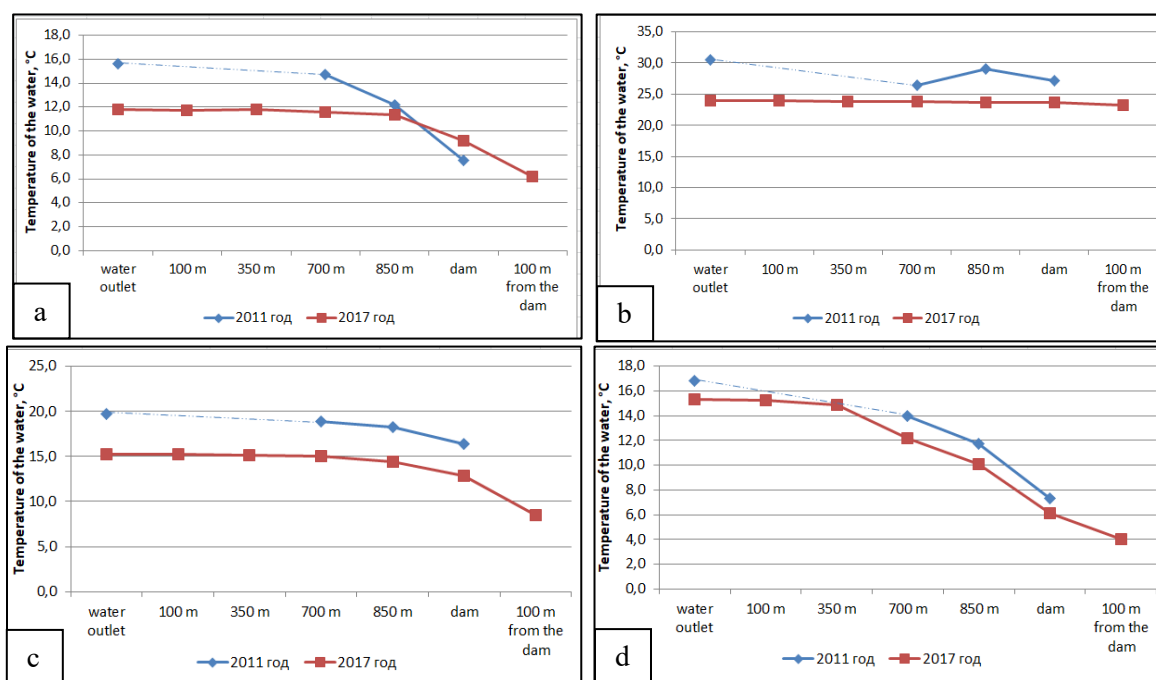


Figure 2. The temperature modification of the water surface from the beginning of the open offtake to the open plot of basin-cooler: a – spring; b – summer; c – autumn; d – winter.

Figure 2 shows that in 2017 year the water temperature in the beginning of the open offtake lower an average at 4.1 ± 1.02 °C: in spring at 3.8 °C, in summer at 6.5 °C, in autumn at 4.4 °C, in winter at 1.5 °C. Perhaps this is due to the improvement of the cooling system of the Kazan CHPP-1.

According to the data on Figure 2 we can note that the water, moving through the territory of the open offtake (760 meters), cooled in spring at 0.2 °C, in summer at 0.1 °C, in autumn at 0.3 °C and in winter at 3.2 °C in 2017 (in 2011: at 0.9 °C; at 4°C; at 0.8 °C; at 2.9 °C accordingly). Thus, in 2017

the maximum is observed in winter period, which is associated with low air temperature, and the minimum in summer, when the temperature of the waste water and the temperature of the reservoir varies by 0.7 °C.

It should take into account that the air temperature in the summer time in the year 2017 is lower than in the year 2011: the temperature of the warmest month – July – is declined by 4.2 °C. If in the 2011 year the maximum temperature was observed only in July, in 2017 year the average monthly air temperature for 23° C continues 2 months – July and August (Figure 3).

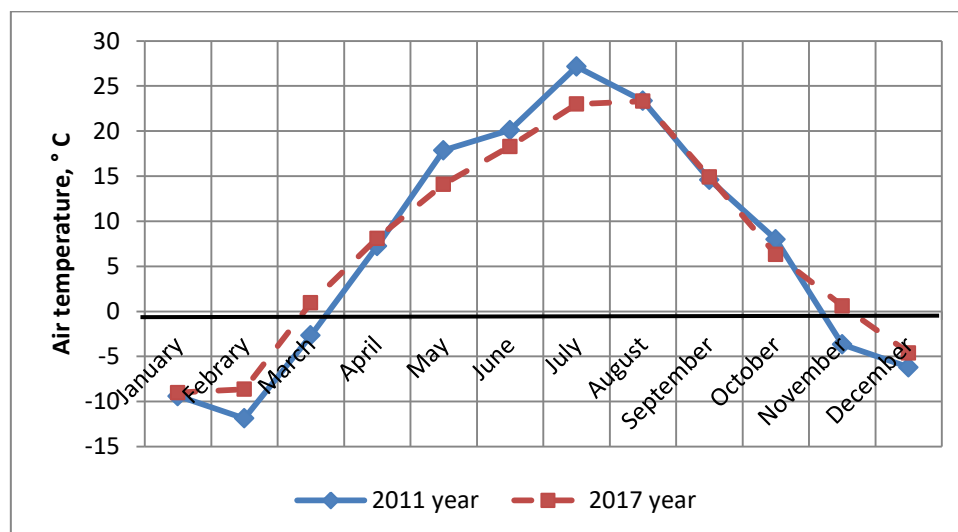


Figure 3. Air temperature modification in different time intervals [3].

In General, we can point out that built in 2011 year dam changes the water temperature to a level similar to its construction (Figure 3). Maximum cooling of water is carried out by mixing with the water of the lake, but not at the expense of the separation barrier. It is clearly visible in Figure 2 a – spring period, where is observed in the 2011 year the sharp decrease of the water temperature after 700 meters of open offtake, where has been an increasing of offtake and mixing water of open offtake with the water of the Srednyi Kaban lake.

Construction of the dam has a reverse side. Construction has led to slow circulation and as a consequence to the eutrophication the plot which fenced by dam (Figure 4): obliteration of higher aquatic vegetation, increased algal mass, flock of birds in the territory. Besides, near the dam began to accumulate trash polluting the aquatic ecosystem (Figure 4).



Figure 4. The plot of the Srednyi Kaban lake fenced by dam.

As a result of heavy precipitation in summer of 2017 the dam was almost completely flooded, causing the water of the open offtake mixed with the water of the lake by the underground pipes and ground mixing (Figure 5).



Figure 5. Flooding the dam as a result of the heavy rainfall in the summer time.

Thus, it is need to do the design revision of the dam as a way to reduce the heat influence to the basin-cooler in order to improve the environmental condition of the plot which flooded by the dam.

References

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