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Original Research Article

The use of phytoplankton as an indicator of internal hydrodynamics of a large seaside reservoir – case of the Sasyk Reservoir, Ukraine

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ABSTRACT

The Sasyk Reservoir, one of the largest seaside reservoirs on the northwest shore of the Black Sea, the former river delta currently detached from the sea with a narrow bar of sediments, was investigated for spatial distribution of water quality characteristics with the use of bioindication method. A three day preliminary sampling campaign of phytoplankton held in the summer 2013 revealed that the reservoir's dominating species belonged to moderate temperature, freshwater, low acidic and low alkaline indicative groups. They suggest standing to slow-moving hydrodynamics of water masses, that contain a medium amount of oxygen. The indices of ecosystem status, such as index of organic pollution according to Watanabe, modification of Sládeček, water quality classes based on saprobity, trophic state indicator groups, nitrogen metabolism indicator groups, as well as Shannon index coincided, showing medium polluted Class III (saprobity) eutrophic water with prevailing moderate concentrations of organically bounded nitrogen. Environmentally homogeneous water masses were dominated with local anomalies on the locations of inflows of waters of different physicochemical characteristics from rivers and the Danube-Sasyk Canal, saline waters from the sea, and nitrogen enriched groundwater from intensive agricultural area. Two types of ecosystems were identified, the one connected with the main water body and the other with the shallows. The sampling was performed in the condition of no outflow, but the wind direction and the wind driven internal dynamics of the reservoir were the major influencing factors for phytoplankton distribution. A gradient of water pollution in the direction of the north–south section of the receiving water from the Danube-Sasyk Canal was revealed. Although the reservoir ecological processes seems to be effective enough in metabolizing the incoming pollution, the symptoms of progressing deterioration of water quality (small-cell forms of organisms) indicate the need for further monitoring and proper management. The bioindicative method appeared to be in some cases more sensitive in ecosystem and abiotic factors analysis then a standard physicochemical analysis, which creates a ground for further developing of its predictive potential.

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1. Introduction

The lack of water supply is of high importance in the world. Public awareness in the aspect of large water reserves being situated in marine areas focused mainly on desalination for their use for agricultural needs. Specific water management of this territories and examples of such experience in Romania and Singapore should help the societies to solve problems of water shortage (Alexandrov et al., 2004; Dealing… 2006). Scientific investigation of such waterbodies is of great value all over the word and considering them separately for each climatic zone is quite necessary (Janssen et al., 2014). Undoubtedly, ecology of these waterbodies should be investigated carefully to address many environmental and human induced problems, such as the impact of farms, domestic and livestock waste water utilization, etc. (Jeppesen, 1998; Henderson-Sellers and Markland, 1987).

Ukraine faced water shortages and the issue of preserving the existing water resources become of serious concern, which was addressed for the Odessa region in the previous century when the Sasyk liman (name from that period) was transformed into a freshwater reservoir. Moreover, the upper Sasyk is included into the Danube Biosphere Reserve and protected as a wetland of international importance under the Ramsar convention (Tamburelli, 2007; Sasyk Lake 2013). That is the reason why the issue of intensive anthropogenic impact on modern ecological state of the Sasyk Reservoir is of high importance. Significant changes of the physicochemical and ecological characteristics of this water body are observed from the moment of its formation (end of 1970s to beginning of 80s).

The desalination effect may be assessed not only by physicochemical analysis of the water but also through investigation of the distribution of indicator organisms over the area. The main hydrobiological investigations of the Sasyk Reservoir were presented for the period from its formation to the 1990s in a monograph of Kharchenko et al. (1990). Relatively new research works focused on defining contemporary ecological state by virtue of saprobiological characteristics, macrozoobenthos, and bacteriobenthos (Meteletskaya, 1999; Oleynik et al., 1999; Lyashenko et al., 2010).

The first element in the food chain is phytoplankton, which responds rapidly to changes in environmental conditions and accounts for the high importance in studies of environmental monitoring of water bodies. Monitoring approach, serving as ecological characteristic of water body, is phytoplankton dynamics revealing changes over all investigated area (Elliott et al., 2010). Investigations based on this characteristic were conducted mainly in the period of formation of the Sasyk Reservoir. Though phytoplankton is a biological indicator of the ecological state of a water body, at the same time, it is the subject of influence of hydrological factors, and quickly reacts to local temperature and long-term changes of the habitat and therefore can be applied to all types of water bodies.

It was up to now no attempts to evaluate ecological situation in Sasyk Reservoir with the help of bioindication, despite the fact that this method is recommended in the EU (Water Framework Directive, WFD The Directive (2000)). It is worth to mention that in the time after a transformation of the reservoir from estuary into a closed water body there was no research conducted, neither with the help of indication methods, nor any basic investigations of plankton have been held since that time.

It is important to investigate the ecosystem response of the Sasyk Reservoir to the change of its physicochemical parameters. However, only initial attempts to combine some hydrological characteristics and aquatic communities in selected water bodies of Ukraine were made (Timchenko, 2006; Protasov, 2011; Romanenko et al., 2012). We hypothesized that bioindication methods which have long been used in Europe, may also reflect changes of the Sasyk water characteristics. The response of the ecosystem is likely to occur and may be investigated by the use of indicative phytoplankton species. Therefore, the aim of our study is analyze the bioindicative potential of phytoplankton as an indicator of the areas with homogeneous environmental conditions, formed under the influence of internal dynamics in the Sasyk Reservoir. The abiotic factors, such as wind that disturbs the water surface, input of the ground waters from the Kogylnik, and influence of the Danube-Sasyk Canal as well as uneven heating of water, were taken into consideration, and during the summer time there were no more hydrological external impacts.

2. Materials and methods

2.1. Description of study site

The Sasyk Reservoir is one of the largest seaside aquatic object on the northwest shore of the Black Sea and is categorized as a shallow lake (Sasyk Lake 2013). This water body is characterized by absence of significant differences in trophic structure and interactions, and is also featured as a fully mixed lake (Jeppesen, 1998).

It is situated on the far southwest of Danube-Dniester interfluves close to the Kiliyskaya delta of the Danube River. It has a pear asymmetric form and spreads from the north to the south for 35 km. The width of the water body is from 3 to 12 km and a maximal depth – from 3.2–3.6 m (Shvebs, 1988). The water surface is approximately 200–215 km^2, and average volume is about 500 mln. m^3.

In its natural state the Sasyk was marine water body, which formed as a result of the Black Sea transgression, which intruded deeply into the lower reaches of the Kogylnik and the Sarata rivers (Shuyskyy and Vykhovanets, 2011). According the origin of this water body, it belongs to the closed estuaries (Timchenko, 1990) and until 1978 was separated from the Black Sea with the help of a sand bar with a length of 10.1 km, which reached heights of 2.2–3.4 m. But unlike other closed estuaries, a peculiarity of this water body was its unstable connection with the sea. It was carried through the outlets and breaches as a result of sea waters rushing in. Basically, the Kunduk outlet was operative with a width of about 100–200 m, which was located in the central part of the mound. The Small Kunduk outlet could have additionally been formed after a particularly strong northerly wind and as a result of intense water exchange between the sea and estuary. In 1978, the estuary separated from the sea with the help of