THE LINEAR MODELS (ARIMA) IN THE INVESTIGATION OF LONG-TERM SESTON DYNAMICS

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The Naroch lakes are the system that consists of three different trophic water bodies with a common catchment area and are the object of long-term hydro-ecological monitoring observations. The hydro-ecological observations conducted at various stages of the evolution of Naroch lakes ecosystem (1978–2012) including harsh external influences (the implementation of environmental rehabilitation program and the invasion of mass-scale reproduction of the Ponto-Caspian water-filtering mollusk, the zebra mussel *Dreissena polymorpha* Pallas) allow estimating the dynamics of seston concentration as one of the key components of water ecosystem. The dynamics obtained could be used for the evaluation of the occurred changes. It could be also used as the basis for prediction of numerical parameters of ecosystem functioning.

To determine the pattern of seston concentration dynamics and for the prediction of seston concentration an autoregressive integrated moving average model (ARIMA) was used. Fourier analysis was applied to determine the seasonal component.

The results of the calculation of mean absolute relative error (mean absolute value of relative error) for different time periods enable us to determine the best fitted linear models. It turned out that for 1990 – 2012 and for 1985 – 1999 forecast for Lake Batorino and Lake Myastro the models with intervention at 1990 have the least error values and, thus, appear to be the best. Similar analysis for Lake Naroch shows that for 1990/91 – 2012 and for 1985 – 1999 forecast the best model is also the model with intervention, and besides, the year of intervention (1990/1991) does not matter.

The advantage of models with intervention in 1990 for Lake Maystro practically vanishes when only the data for the last ten years are taken into account. For this time period the models that contain only seasonal component are as effective as the models with seasonal component and intervention. The models that assume the existence of a trend are characterized by significantly less predictive power because they give higher errors.

The data also show that for the last ten years all models are of equal effectiveness for Lake Naroch. In this way, to describe the dynamics of seston concentration in Lake Naroch it is equally plausible to use models only with seasonal component and models with seasonal component and intervention.

Only for Lake Batorino for the mentioned above period (from 2003 till 2012) the models with intervention appeared to be the best. The models that assume only seasonal component give greater errors. This could be interpreted as the evidence of continuing influence of harsh intervention the main response to which occurred in 1991. This could be also interpreted as the evidence that different ecosystems have different response time to interventions. Lake Batorino is the first lake in the system and, therefore, was affected earlier than the other lakes by nutrient load decrease and *Dreissena* invasion. Since Lake Batorino is the smallest lake among all three Naroch lakes and has the shortest period of water exchange it may be supposed that its long-lasting reaction to intervention is connected with its initially observed eutrophic status, and, as a result, a longer period of stabilization after the intervention.

In such a way, the results of time series analysis show that the intervention characterizes each of the Naroch lakes: besides the natural seasonal fluctuations there was relatively strong disturbance that led to quick decrease not only in seston concentration but in seston fluctuation variance as well. The main response to this event occurred in 1991 for Lake Batorino and Lake Myastro, and in 1990 and 1991 for Lake Naroch.

Sufficiently high error values for all models even for short time intervals (2003–2012) and additional analysis of multiple-step ahead forecast show that even the best linear model could not give the prediction with acceptable accuracy even for one step ahead. This allows us to conclude that ARIMA models give a opportunity to characterize changes the lake functioning but they are ineffective for prediction purposes.