

$$\min \left\{ 24c_0 + \sum_{i=1}^{24} \sum_{j=1}^3 c_j |x_{ji}| \right\}$$

$$y_i \geq -(1-h) \left(c_0 + \sum_{j=1}^3 c_j |x_{ji}| \right) + r_0 + \sum_{j=1}^3 r_j x_{ji}, i = 1, 2, \dots, 24$$

$$y_i \leq (1-h) \left(c_0 + \sum_{j=1}^3 c_j |x_{ji}| \right) + r_0 + \sum_{j=1}^3 r_j x_{ji}, i = 1, 2, \dots, 24$$

Finally in this paper we are going to construct with three linguistic variables (low, medium and high) via fuzzy inference system an adaptive. This classification of the independent variables will be done with the most representing classes, due to the amount of statistical data. In this way, they will approach the problem concerning the chl-a prediction by setting as inputs the values of the independent parameters.

III. Results

In Table 1 it can be easily observed the fuzzy numbers of each examined couple of independent and dependent variable. These fuzzy numbers are presenting all the possible values that can be represented by our parameters in this ecosystem.

At this point we can say that the three selected independents variables can predict with safety the parameter of chlorophyll-a. In fig.1, fig.2 and fig.2 it is pictured the fuzzy numbers of every value of chl-a in relation with the independent parameters of water temperature, DO₂ and pH.

TABLE I. FUZZY NUMBERS OF CHLOROPHYLL-A

Independent parameters	Fuzzy numbers
Water Temperature	$y_{temp} = (18.42, 13.23) + (-0.19, 0)x$
DO ₂	$y_{DO_2} = (1.99, 0) + (1.37, 1.18)x$
pH	$y_{pH} = (-24.7, 13.23) + (5.05, 0)x$

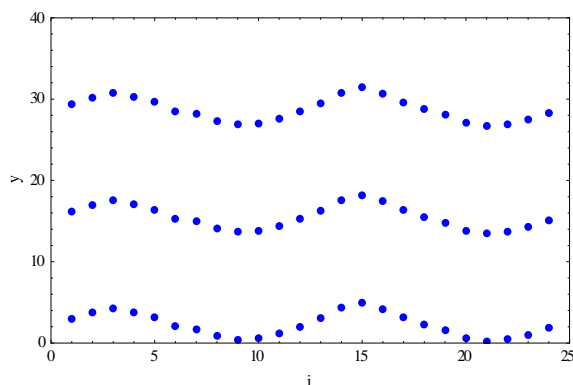


Figure 1. Fuzzy numbers of chl-a computed by water temperature

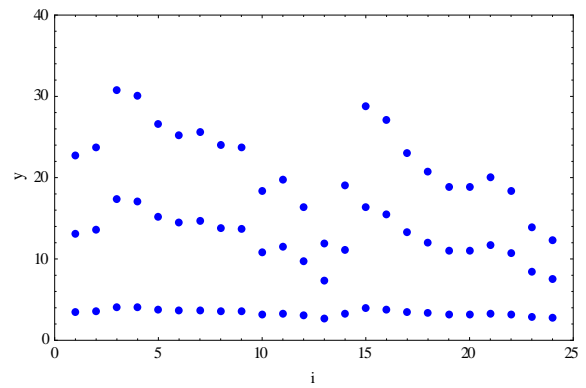


Figure 2. Fuzzy numbers of chl-a computed by DO₂

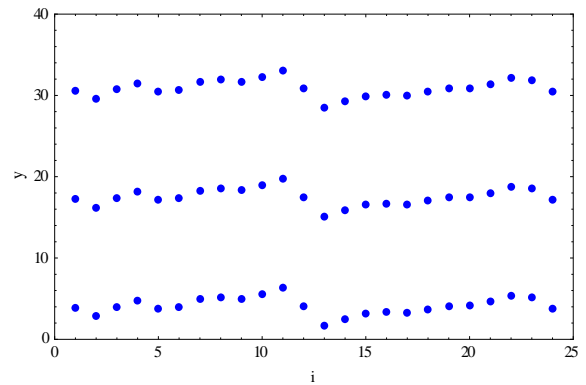


Figure 3. Fuzzy numbers of chl-a computed by pH

Since we noticed that the fuzzy numbers above have a very big range, our next step is to classify all of the independent parameters (temperature, DO₂ and pH) to three linguistic classes, low, medium and high. At this method we will still use triangular fuzzy numbers. So, in figures 4, 5 and 6 these fuzzy numbers can be pictured.

It should be mentioned that, this method is a useful tool for the prediction of the levels of our dependent parameter chl-a. The error derived from this is 0.00189. This leads us to a hopeful result that, our prediction will be almost a hundred percent accurate.

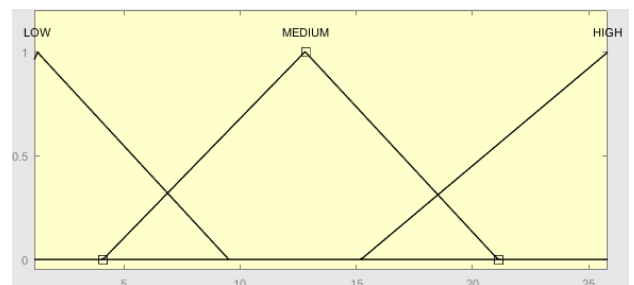


Figure 4. Classification of temperature as triangular fuzzy numbers

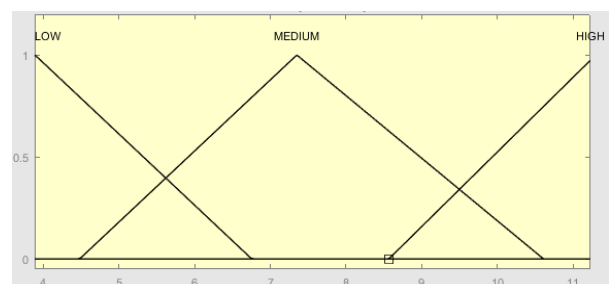


Figure 5. Classification of DO₂ as triangular fuzzy numbers

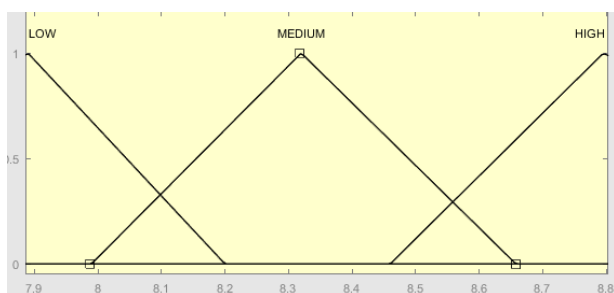


Figure 6. Classification of pH as triangular fuzzy numbers

IV. Discussion and Conclusion

Primary production models in water bodies involve the quantification and estimation of chlorophyll-a concentrations, based on empirical relationships, dynamic models and the fuzzy logic approach [2]. In this study we applied the fuzzy linear regression using data that have a strong relation with the phenomenon of the eutrophication. The selected water body in this study is the Orestiada lake and it is characterized as hypertrophic lake. Using the linguistic variables we succeeded to minimize the error of prediction. Since the “ageing” of a reservoir is a complicated process lasting several years [3] the estimation of parameters which express this process such as the chlorophyll a as a proxy of primary production is considered of high importance [4]. The results of this study can help us understand better the mechanisms of this ecosystem. In a previous paper [1], studying another Mediterranean lake and using less data sets, we found a stronger relation between the parameter of water temperature and chl-a instead of the others.

Orestiada lake is a site of Community interest of the Pan-European Ecological Network Natura 2000 (GR1320001-BioGreece99). According to Directive 92/43 / EEC, a special management plan should be established for this area. This will identify specific actions and management measures that will aim and should ensure the good ecological status of conservation of the types of vegetation and flora species and fauna that occur in the region and have been the main reasons for accession of the area on the Network.

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