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DERIVATION BACKGROUND CONCENTRATIONS OF HYDROCHEMICAL PARAMETERS USING PROBABILITY DISTRIBUTION STATISTICS (LAKE SEVAN BASIN, ARMENIA)

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The determination of background concentration values of hydrochemical parameters in surface waters, to distinguish between natural concentration and anthropogenically-influenced concentrations, is a difficult task, but a most important one because of the definition of water quality standards (Hovhannisyan, Shahnazaryan, 2016; Minasyan, 2015; Pekarova, 2008).

Prior to determining the site-specific objectives for any river basin, the determination of background concentration (BGC) is necessary. In the literature, there are different methods to define the BGCs of hydrochemical parameters. For example, mean value plus two standard deviations, 90th percentile value, the median value, geochemical, statistical, combined methods. In the presented work BGCs are calculated using the statistical method with the theoretical distribution function. This method is quite simple, and for its calculation long-term data of water quality are not required (Hovhannisyan, Shahnazaryan, 2016).

The aim of this study is the calculation of BGCs, the application of BGCs in the derivation of water quality assessment system for the Rivers of the Lake Sevan Basin. BGCs were calculated for 8 main rivers of the Sevan Lake Basin: Dzknaget, Gavaraget, Martuni, Masrik, Vardenis, Karchaghbyur, Argichi, Sotq.

Since, in the nature the processes mainly are described by normal distribution function, and in mathematical statistics logarithmic variables ranks, regardless of their distribution law, seeking to normality, it is accepted as a theoretical distribution function observed the logarithmic normal distribution function (Pekarova, 2008).

Logarithmic normal density function is given as follows:

$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} exp\left(-\frac{1}{2}\frac{(ln(x) - \mu)^2}{\sigma^2}\right),\ x > 0$$

where μ and σ are the location and scale parameters respectively, which can be estimated as follows:

$$\hat{\mu} = \frac{\sum_{i=1}^{n} ln(x_i)}{n}, \qquad \hat{\sigma}^2 = \frac{\sum_{i=1}^{n} (ln(x_i) - \mu)^2}{n}.$$

The lognormal distribution function percentile is calculated as follows:

$x_p = F^{-1}\left(\frac{p}{100}\right)$, where $F(x)$ is the lognormal cumulative distribution function.

First of all, for each river, the locations with natural or minimal anthropogenic influence, where water quality data are available, was chosen. For the calculation of BGCs water monitoring data of eight sampling sites in the rivers for the period 2014–2019 were used. The sequence of steps in the implementation of the BGCs calculations is presented below:

- the hydrochemical monitoring data are aggregated,
- the μ and σ parameters are calculated;
- the percentile is calculated in the range of 50–90%;
- the logarithmic normal distribution curve then the trend is built;
- the BGCs values are estimatedfrom the lognormal probability curve, as percentile, where sudden concentrations arisen appeared.

The estimated background concentrations for 2 parameters are presented in Table 1.

Table 1. Background concentration values of Cadmium andLead in Sevan Bassin Rivers

Parameters	Dzknaget	Masrik	Sotq	Karchaghbyur	Vardenis	Martuni	Argichi	Gavaraget
	Concentration, µg/L							
Cadmium	0.0105	0.0083	0.0086	0.0115	0.0071	0.0107	0.0089	0.0099
Lead	0.187	0.098	0.211	0.097	0.434	0.090	0.122	0.147

Lognormal distribution function is an effective tool for the assessment of background concentrations. Application of background concentrations on the assessment of the river water quality has made it possible to estimate the pollution and the real impact on water quality.

References

Hovhannisyan A.S., Shahnazaryan G.A. Determination of background concentrations of hydrochemical parameters and water quality assessment in the Akhuryan River Basin (Armenia). J. Physics and Chemistry of the Earth, 2016, V 94, pp. 2–9.

Minasyan S.H. The new water quality standards for the rivers of Armenia. UNESCO-IHP European Regional Consultation Meeting “Water Quality in Europe: Challenges and Best Practice”, Book of Abstracts, Koblenz, Germany, 2015, pp.1–4.

Pekarova P. Development of the background concentrations for heavy metals in surface waters in Slovak Republic / et al., Part 4. SHMI, Bratislava, 2008.

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