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# The Assessment of the Eutrophication Degree in Selected Surface Waters of the Poprad Catchment

## 1. Introduction

Eutrophication, according to the Directive 91/271/EEC, referring to the treatment of municipal wastewaters, is defined in the following way:

> Eutrophication means enrichment of water with the compounds of nitrogen and/or phosphorus, causing the accelerated growth of algae and higher plants, which causes undesirable disturbances of biological equilibrium among aquatic organisms and the quality of the discussed waters.

To carry out the analysis of water a test kit – JBL TESTLAB was used to study water parameters. Owing to its small size and, consequently, its portability, water analysis could be done in situ.

The kit consists of nine different water tests of a wide spectrum:

- test GH – general hardness,
- test KH – carbonate hardness,
- test pH 3–10 – general acidity of water,
- test pH 6.7–7.6 – water acidity – more accurate measurement,
- test $NO_2$ – the content nitrites,
- test $NO_3$ – the content nitrates,
- test Fe – the content iron,
- test $NH_4$ – the content of ammonia,
- test $PO_4$ – the content of phosphates,

In the set there are glass burettes, thermometer, syringes, plastic spatulas, scales of colours, and tables to record the results of the analyses (Fig. 1).

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**Fig. 1.** Test kit JBL TESTLAB

## 2. The Methods and Place of Sampling

One of the most important tasks of qualitative water analysis is taking a representative sample, according to certain procedures of sampling, because errors made at the stage of sampling cannot be corrected in the later analyses. Thus, sampling is a process having fundamental meaning for correctness of the obtained results and was carried out according to the following standards:

- Polish Standard PN-EN ISO 5667-1:2008: *Water Quality – Sampling – Part 1*,
- Polish Standard PN-EN ISO 5667-6:2003, *Polish Standard – Sampling – Part 6*.

Figure 2 presents places where samples were taken. In table 1 the sample numbers were put together with the place of sampling and the name of the river/stream the sample was taken from.

**Table 1.** Places of sampling

| Sample No. | Place of Sampling | The Name of the River/Stream |
|---|---|---|
| 1 | Stary Sącz – Stream Gauge Biegonice | Poprad |
| 2 | Below Rytro – Bridge Rzeczanów | |
| 3 | Above Piwniczna | |
| 4 | Wierchomla Wielka – Outlet to Poprad | |
| 5 | Below Żegiestów | |
| 6 | Milki | |
| 7 | Below Muszyna – Waste water Treatment Plant | |
| 8 | Muszyna – Outlet of Szczawnik to the Poprad Rivier | |
| 9 | Muszyna – Outlet of Muszynka to the Poprad River | |
| 10 | Leluchów | |
| 11 | Circ | |

**Table 1.** cont

| Sample No. | Place of Sampling | The Name of the River/Stream |
|---|---|---|
| 12 | Powroźnik – below the Outlet of Kryniczanka | Muszynka |
| 13 | Below Krynica – Czarny Most | Kryniczanka |
| 14 | Below Krynica | |
| 15 | Above Krynica | |
| 16 | Mochnaczka – Outlet to Muszynka | Muszynka |

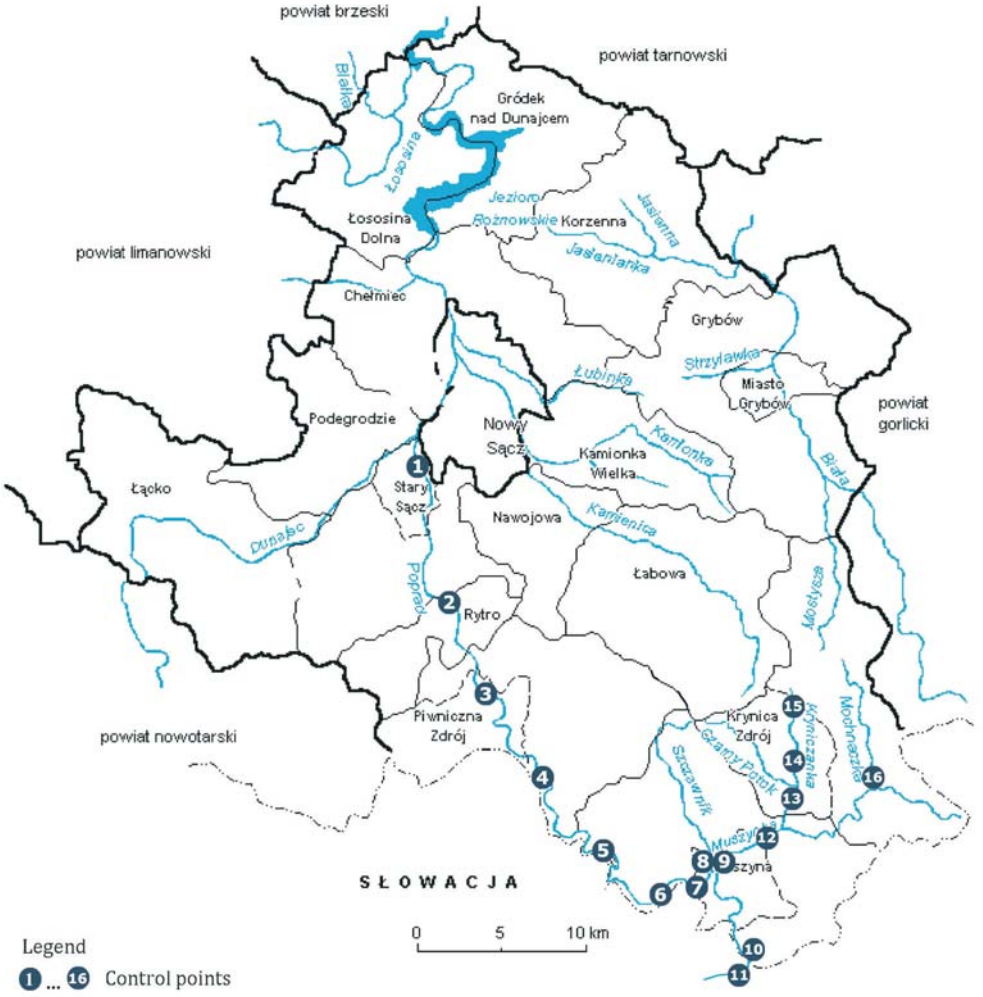


**Fig. 2.** Sampling points

## 3. Results

Four sampling series were done (two in the spring – in April and May and two others in the autumn – in October and November). The results of the carried out series of measurements were put together in tables, each series was put in as separate table (Tabs 2–5).

Additionally, for the sake of more accurate analysis, the results of 2 series were presented in a graph for each season (Figs 3–6).

**Table 2.** The results of the measurements of the contents of nitrates and phosphates – April 2011

| Sample No. | Reaction | Nitrates [mg/dm$^3$] | Phosphates [mg/dm$^3$] |
|---|---|---|---|
| 1 | 8.6 | 5.00 | 0.10 |
| 2 | 8.8 | 7.50 | 0.30 |
| 3 | 8.8 | 5.00 | 0.05* |
| 4 | 8.2 | 7.50 | 0.25 |
| 5 | 8.2 | 8.50 | 0.25 |
| 6 | 8.2 | 8.50 | 0.20 |
| 7 | 8.2 | 8.50 | 0.30 |
| 8 | 8.0 | 7.50 | 0.25 |
| 9 | 7.9 | 7.50 | 0.20 |
| 10 | 8.5 | 7.00 | 0.05* |
| 11 | 8.6 | 7.50 | 0.05* |
| 12 | 8.1 | 7.50 | 0.25 |
| 13 | 7.4 | 7.50 | 0.20 |
| 14 | 7.8 | 7.50 | 0.30 |
| 15 | 8.1 | 7.50 | 0.05* |
| 16 | 7.4 | 4.00 | 0.05* |

* Slight colouration was detected.

**Table 3.** The results of the measurements of the contents of nitrates and phosphates – May 2011

| Sample No. | Reaction | Nitrates [mg/dm$^3$] | Phosphates [mg/dm$^3$] |
|---|---|---|---|
| 1 | 7.6 | 5.00 | 0.20 |
| 2 | 7.8 | 7.50 | 0.20 |
| 3 | 8.7 | 4.00 | 0.10 |
| 4 | 8.4 | 7.00 | 0.20 |
| 5 | 8.3 | 7.00 | 0.20 |
| 6 | 8.3 | 8.00 | 0.25 |
| 7 | 7.8 | 8.00 | 0.20 |
| 8 | 8.2 | 8.00 | 0.10 |
| 9 | 8.2 | 8.00 | 0.10 |
| 10 | 8.8 | 7.00 | 0.05* |
| 11 | 8.9 | 6.00 | 0.20 |
| 12 | 8.1 | 7.50 | 0.30 |
| 13 | 7.8 | 7.00 | 0.05* |
| 14 | 7.6 | 5.00 | 0.10 |
| 15 | 8.1 | 5.50 | 0.10 |
| 16 | 7.9 | 4.00 | 0.05* |

* Slight coloration was noticed.

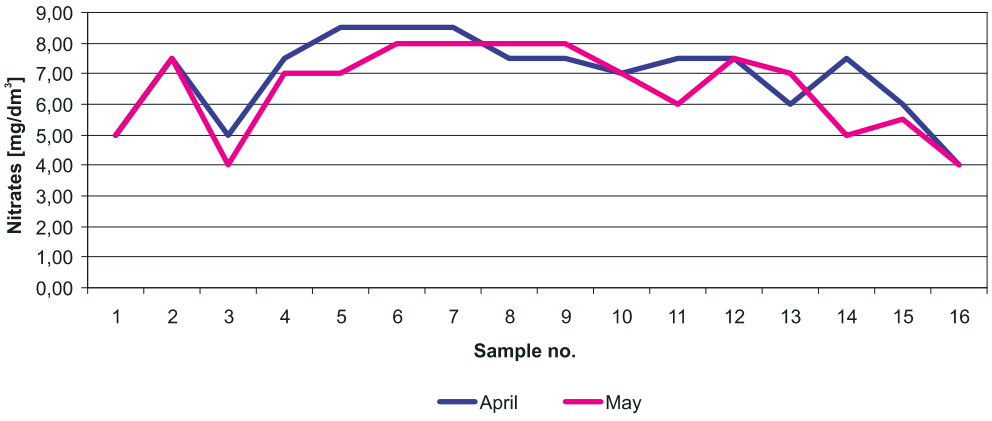


**Fig. 3.** The level of nitrates – spring

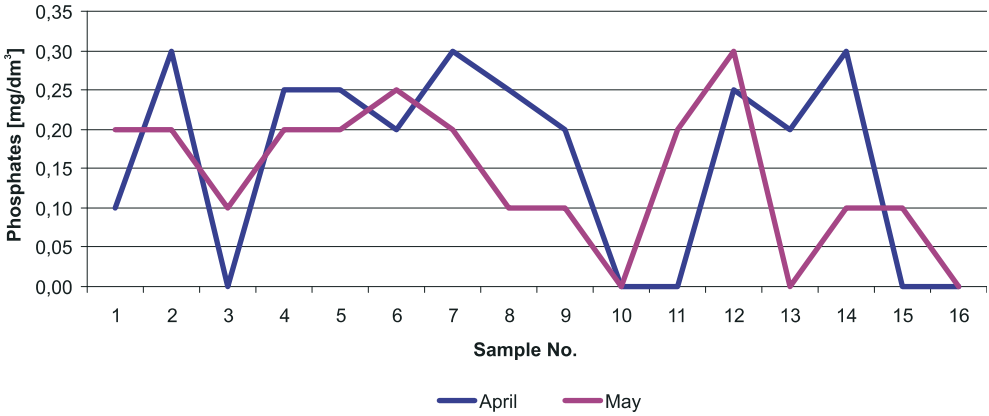


**Fig. 4.** The level of phosphates – spring

**Table 4.** The results of the measurements of the contents of nitrates and phosphates – October 2011

| Sample No. | Reaction | Nitrates [mg/dm³] | Phosphates [mg/dm³] |
|---|---|---|---|
| 1 | 8.7 | 5.00 | 0.05* |
| 2 | 8.3 | 8.50 | 0.25 |
| 3 | 8.5 | 5.00 | 0.10 |
| 4 | 8.5 | 5.00 | 0.05* |
| 5 | 8.4 | 8.00 | 0.20 |
| 6 | 8.3 | 8.00 | 0.20 |
| 7 | 8.4 | 8.50 | 0.30 |
| 8 | 8.0 | 9.50 | 0.80 |
| 9 | 7.7 | 9.50 | 0.20 |
| 10 | 8.3 | 5.50 | 0.10 |
| 11 | 8.3 | 8.00 | 0.50 |
| 12 | 8.2 | 5.50 | 0.20 |
| 13 | 7.6 | 7.00 | 0.10 |
| 14 | 7.9 | 7.00 | 0.80 |
| 15 | 8.2 | 5.50 | 0.10 |
| 16 | 8.0 | 4.00 | 0.05* |

* Slight coloration was noticed.

**Table 5.** The results of the measurements of the contents of nitrates and phosphates – November 2011

| Sample No. | Reaction | Nitrates [g/dm$^3$] | Phosphates [g/dm$^3$] |
|---|---|---|---|
| 1 | 8.7 | 5.50 | 0.05* |
| 2 | 8.9 | 8.00 | 0.20 |
| 3 | 8.5 | 5.00 | 0.60 |
| 4 | 8.2 | 8.50 | 0.20 |
| 5 | 8.4 | 8.50 | 0.20 |
| 6 | 8.3 | 7.00 | 0.20 |
| 7 | 8.7 | 7.50 | 0.20 |
| 8 | 7.9 | 9.50 | 0.60 |
| 9 | 7.9 | 9.50 | 0.60 |
| 10 | 8.3 | 4.00 | 0.60 |
| 11 | 8.4 | 7.50 | 0.30 |
| 12 | 8.1 | 5.50 | 0.30 |
| 13 | 7.8 | 5.50 | 0.20 |
| 14 | 7.8 | 6.50 | 0.60 |
| 15 | 8.2 | 5.50 | 0.05* |
| 16 | 8.1 | 4.00 | 0.05* |

* Slight coloration was noticed.

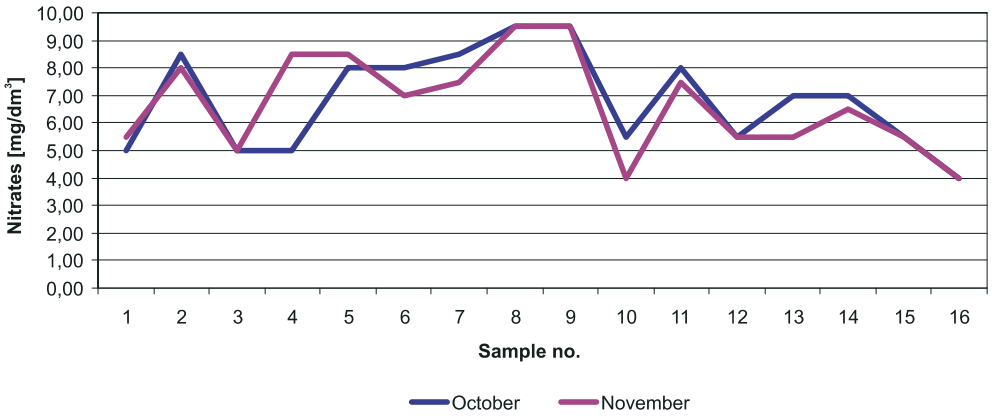


**Fig. 5.** The level of nitrates – autumn

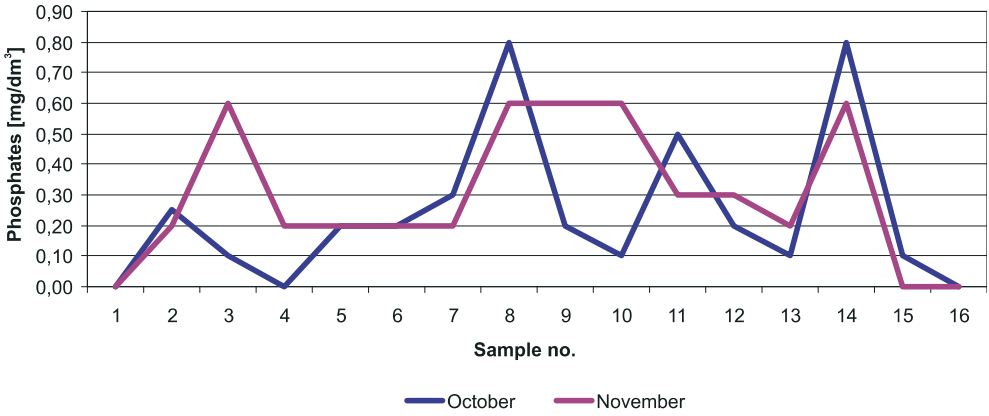


**Fig. 6.** The level of phosphates – autumn

## 4. Statistical Analysis of the Results

The results of statistic analysis of measurements are shown in tables 6 and 7.

**Table 6.** Selected statistical parameters for spring samples

| Statistic Parameter | Spring | | |
|---|---|---|---|
| | reaction | nitrates [mg/dm$^3$] | phosphates [mg/dm$^3$] |
| Mean | 8.2 | 6.73 | 0.20 |
| Maximum | 8.9 | 8.50 | 0.30 |
| Minimum | 7.4 | 4.00 | 0.10 |
| Median | 8.2 | 7.25 | 0.20 |
| Standard Deviation | 0.4 | 1.38 | 0.07 |

**Table 7.** Selected statistical parameters for autumn samples

| Statistic Parameter | Autumn | | |
|---|---|---|---|
| | reaction | nitrates [mg/dm$^3$] | phosphates [mg/dm$^3$] |
| Mean | 8.2 | 6.78 | 0.33 |
| Maximum | 8.9 | 9.50 | 0.80 |
| Minimum | 7.6 | 4.00 | 0.10 |
| Median | 8.3 | 7.00 | 0.20 |
| Standard Deviation | 0.3 | 1.76 | 0.22 |

The goal of this paper was to define the degree of eutrophication for selected surface streams and rivers of the Poprad Catchment, caused by the released agricultural pollutants in the Nowy Sącz District. The studies lasted 12 months. During that period – in 16 points distributed on 3 rivers/streams, in four measurement series, 64 water samples were collected, following standard procedures and analysed. The content of nitrates, phosphates, and the reaction were defined by the portable test kit JBL TESTLAB.

In the studied places the main sources of the pollution of rivers and streams with nutrients include the non-point sources, i.e. the areas of agricultural outflows. They contain nutrients from artificial fertilizers, pesticides, as well as animal production. The identification of non-point pollution sources, coming from agricultural land use as well as animal production is difficult, and so is the control of the inflow.

The carried out analysis of water, based on the *Enactment of the Minister of Environment of 23rd December 2002 on the criteria of the determination of waters sensitive to the pollution of nitrogen from agricultural sources* (Dz. U. 2002 No. 241, position 2093) showed that in the Poprad Catchment, covering the area of the Nowy Sącz District, there are no waters polluted or threatened with pollution with nitrogen compound from agricultural sources, where the content of nitrates would be 40–50 mg $NO_3/dm^3$ or above 50 mg $NO_3/dm^3$. The waters of the Poprad and its tributaries do not indicate the features of the eutrophication originating from farming and agriculture. The concentrations of indexes applied during the assessment of the eutrophication of surface waters such as: nitrates and phosphates did not exceed limit values, above which the eutrophication of waters occur. The mean content of nitrates and phosphates in the spring was 6.73 $mg/dm^3$ and 0.20 $mg/dm^3$, respectively and in the autumn 6.78 $mg/dm^3$ and 0.33 $mg/dm^3$. The level of nitrates for these two seasons was more or less equal, the only difference was in the level of phosphates, which was clearly higher in the autumn – by as much as 0.13, which makes 65%.

There are many ways to limit the process of the eutrophication of waters. One is the management of the catchment, so that the load of nutrients to waters is limited. This action it to (among others) form the agricultural landscape with the use of tree stands between fields, as well as carrying out water management, according to the rules of good practice in agriculture. Good practice in agriculture is understood as: not using artificial fertilizers in the periods when fertilization is not recommended; the application of fertilizers according to the fertilizing plan; following the rules of fertilizing soils situated near waters, as well as on steep slopes; management of grounds and the organization of production, regarding such things as crop rotation; not to fertilize soils that are muddy, flooded with water, covered with snow or frozen; storing natural fertilizers, such as manure and slurry

allowing the preservation of periods when fertilization is not recommended. Following these rules will limit the transfer of nutrients and facilitate marking and controlling the places of the inflow of these elements to waters.

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