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## EVALUATION OF CONTAMINATION LEVEL OF GLIWICE CHANNEL AND ITS SIDE STREAMS WITH ORGANIC COMPOUNDS

### OCENA STOPNIA ZANIECZYSZCZENIA ZWIĄZKAMI ORGANICZNYMI KANALU GLIWICKIEGO I JEGO WYBRANYCH DOPŁYWÓW

**Abstract:** The aim of the study was to determine the level of contamination of different side streams of Gliwice Channel basing on analyses of organic compounds concentrations. Surface waters localized near two Silesian cities *ie* Zabrze and Gliwice were analyzed during the study *ie* Mao Stream (Wojtowianka) (1 sampling point), Rokitnica Stream (1 sampling point), Bytomka (1 sampling point), Klodnica River (2 sampling points) and Gliwice Channel (1 sampling point). Water samples were collected twice a month in the winter-spring-summer period, always in the morning. COD analysis was made via dichromate method using NOVA 400 spectrophotometer by Merck. BOD<sub>5</sub> was determined via respirometric method with Oxi Top equipment by WTW and TOC by multi N/C Analytik Jena. Physico-chemical parameters of investigated waters *ie* pH and temperature were measured using Elmetron set equipped with proper electrodes. Obtained results were elaborated according to physico-chemical parameters of investigated waters (pH, suspended solid concentration) and watercourse properties (length, number of side streams, flowing area characteristic).

**Keywords:** natural watercourses, organic compounds, BOD<sub>5</sub>, COD, TOC

## Introduction

Surface waters present at highly industrialized and urban areas like Upper Silesia become seriously contaminated by humans activities. The main sources of contaminants are municipal and industrial wastewaters together with water flows from contaminated areas including industrial ones [1, 2]. One of the most important industry branch which has a great impact on environment is mining [3, 4]. The exemplary river damaged by this activity is Klodnica River, which has been highly contaminated for almost 100 years by now [5].

The study focused on determination of contamination level (basing on organic compounds concentrations measurements) of various water courses which are main side

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streams of Gliwice Channel. As most of the investigated water courses are found to be contaminated or highly contaminated basic wastewater parameters i.e. BOD<sub>5</sub>, COD and TOC were used for their evaluation [5, 6]. Oxidability was not date.

## Methodology of the study

Following streams, rivers and artificial channel localized at Gliwice and Zabrze cities areas were used for the study *ie* Doa Stream (Wojtowianka) (1 sampling point N50°16'45" E18°39'0"), Rokitnicki Stream (1 sampling point N50°21'54" E18°48'8"), Bytomka River (1 sampling point N50°18'32" E18°46'41"), Klodnica River (2 sampling points: N50°18'37" E18°39'0" and weir) and Gliwice Channel (1 sampling point N50°20'25" E18°37'12"). Doa and Rokitnicki Streams, through Ostropka and Bytomka Rivers, are Klodnica River side streams, while Klodnica River is one of the side streams of Gliwice Channel. Water samples were collected twice a month in 2010 during winter-spring-summer period (in the sampling day morning). All samples were collected manually to dark-glass bottles. The quality control of water can be made via analysis of physical parameters and chemical parameters *eg* BOD<sub>5</sub>, COD, TOC, pH, suspended solids [7]. BOD<sub>5</sub> analysis was made via manometric method using Oxi Top system by WTW. Total and suspension free (*ie* filtered samples) COD was determined by means of dichromate method on NOVA 400 spectrometer by Merck. Total and suspension free TOC was analyzed using TN-TC multi N/C analyzer by Analytik Jena. Physical parameters of samples *ie* temperature and pH were measured with the use of Elmetron set equipped with proper electrodes. Dry mass content in the suspension was determined at 105 °C by weight method.

## Results and discussion

### The indicators of water pollution

Physico-chemical analyses of collected surface water samples revealed that the degree of contamination of investigated waters with organic compounds (BOD<sub>5</sub>, COD and TOC) and suspended solids was different despite all water courses were localized at Upper Silesia (Fig. 1–5). Doa and Rokitnicki Streams characterized with lowest parameters values in the range of: for BOD<sub>5</sub> – up to 5 mgO<sub>2</sub>/dm<sup>3</sup> and up to 10 mgO<sub>2</sub>/dm<sup>3</sup>, for COD from 26.5 to 52 mgO<sub>2</sub>/dm<sup>3</sup> and from 24 to 58 mgO<sub>2</sub>/dm<sup>3</sup>, for TOC from 9 to 10 mg/dm<sup>3</sup> and from 7 to 11 mg/dm<sup>3</sup>, respectively. Bytomka and Klodnica River together with Gliwice Channel were defined as contaminated surface waters [8]. The measured BOD<sub>5</sub> values of those water courses were almost at the same level and in the range of 10 mgO<sub>2</sub>/dm<sup>3</sup> to 30 mgO<sub>2</sub>/dm<sup>3</sup>, 10 mgO<sub>2</sub>/dm<sup>3</sup> to 40 mgO<sub>2</sub>/dm<sup>3</sup> and 5 mgO<sub>2</sub>/dm<sup>3</sup> to 35 mgO<sub>2</sub>/dm<sup>3</sup>, respectively. The greatest impact of anthropogenic activity on investigates surface waters activity was observed at COD parameter. It value was in the range of 48 mgO<sub>2</sub>/dm<sup>3</sup> to 98 mgO<sub>2</sub>/dm<sup>3</sup>, 52 mgO<sub>2</sub>/dm<sup>3</sup> to 174 mgO<sub>2</sub>/dm<sup>3</sup> and 51 mgO<sub>2</sub>/dm<sup>3</sup> to 145 mgO<sub>2</sub>/dm<sup>3</sup> for Bytomka River, Klodnica River and Gliwice Channel respectively. The contamination of investigated waters with organic compounds was accompanied by high suspended solids content (Fig. 4). However,

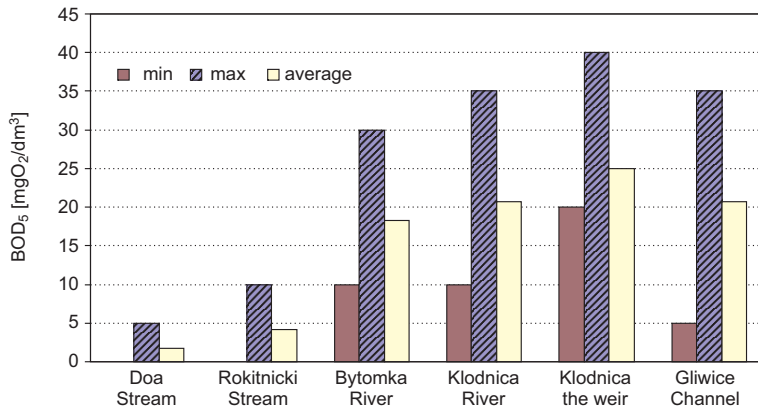
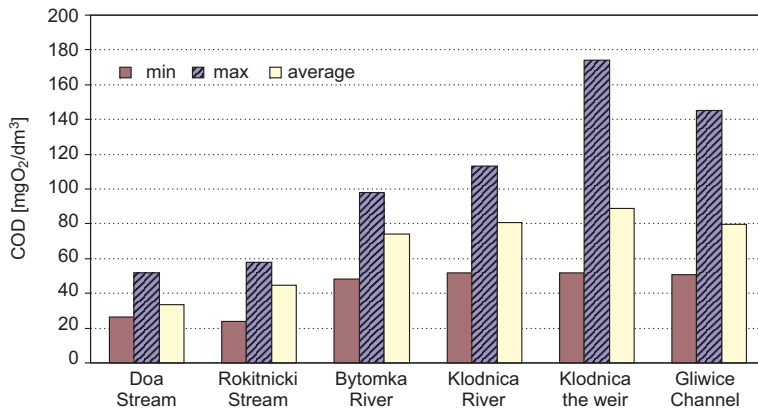
Fig. 1. BOD<sub>5</sub> of investigated waters

Fig. 2. Total COD of investigated waters

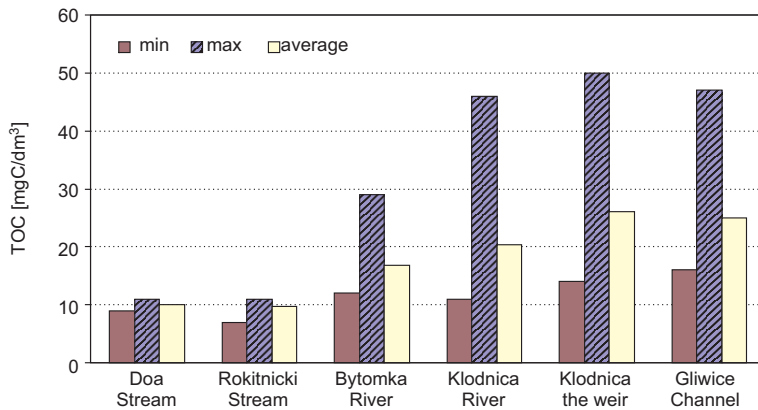


Fig. 3. TOC of investigated waters

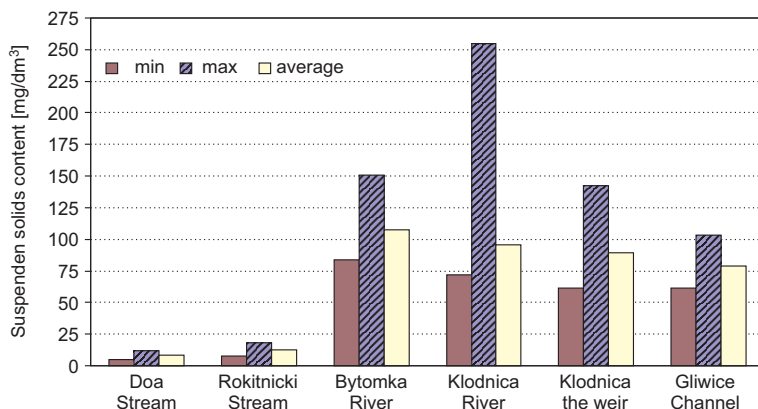


Fig. 4. Suspension of investigated waters

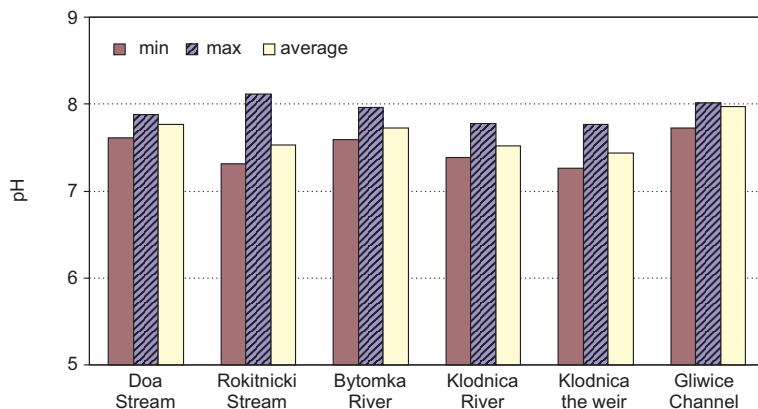


Fig. 5. pH of investigated waters

measured value of pH parameter did not indicate on such a high contamination as they were in the range of 7.26 to 8.12 (Fig. 5).

Mean values of water contamination parameters with organic compounds are presented in Fig. 6. Doa Stream (periodically dry stream of length 4 km) was found to be the least contaminated water course. It flows through agricultural areas and has an estuary in Ostropka, which is Klodnica River side stream. Similarly low parameters values were obtained for Rokitnicki Stream for which the sampling place was localized at low population density area (between two districts of Zabrze *ie* Helenka and Rokitnica). Moreover, up to the sampling place Rokitnicki Stream flows mainly through fields. However, after passing Zabrze city center at the estuary to Bytomka River (Gliwice city area) Rokitnicki Stream becomes highly contaminated surface water.

In case of other investigated waters sampling places were localized at high population density areas. Besides, before reaching the sampling point those water courses flow through urban and industrial areas. The sampling place for Bytomka River

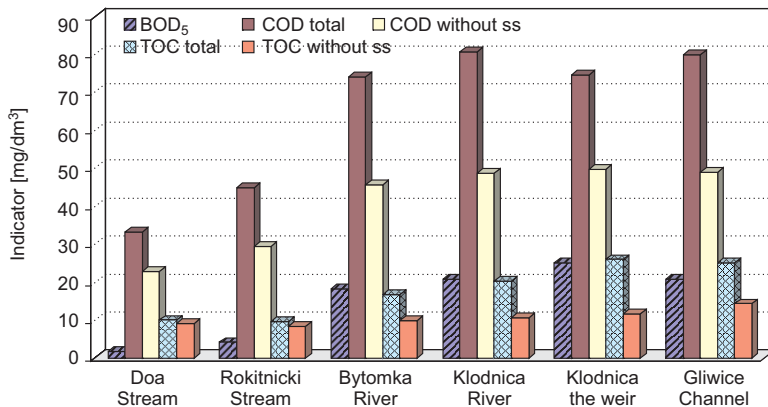


Fig. 6. Average values of indicators of water pollution

was localized at Zabrze city center after its flow through Bytom and Ruda Slaska. In case of Klodnica River, two sampling places were chosen *ie* before Central Municipal Wastewater Treatment Plant and at the weir after the Plant at which it already flowed through Katowice, Ruda Slaska, Zabrze and Gliwice. Samples of Bytomka and Klodnica Rivers and Gliwice Channel waters indicated on their high contamination considering both, chemical (BOD<sub>5</sub>) and industrial (COD-Cr) parameters of water quality (Fig. 6). According to the literature the side streams of Klodnica River *ie* contaminated Bytomka and Kochlowka had an unfavorable impact on its BOD<sub>5</sub> parameter value, while its COD was mainly affected by Bytomka, Bielszowicki Stream and Czarniawka waters incomes [6, 11]. Similar dependences were obtained in case of total suspended solid content analysis [5]. Thus, Klodnica River has negative impacts on other surface waters [12].

### Nowadays anthropogenic pollutants as the indicators of water pollution

The recent papers show the improvement of Polish surface water quality in refer to one observed in seventies of XX century caused by both, the collapse of large part of industrial plants but also by the increase of ecological consciousness [12, 13]. Nevertheless, the detailed analysis of surface water quality establishing the level of organic macro- and micropollutants is needed. On the one hand the concentration of macropollutants is quite easy to be monitored and their load to the environment is limited by regulations on wastewater treatment. On the other hand, the concentration micropollutants still increases [14]. The development in chemical analysis enables the simultaneous monitoring of wide range of compounds in aqueous samples [2, 15]. In the previous century the main groups of compounds were PAHs, surfactants, pesticides and chlorinated organic compounds [16, 17]. Nowadays among anthropogenic pollutants pharmaceuticals are of the highest interest, while among natural ones mycoestrogens [14, 18, 19].

The characteristic of surface waters based on BOD<sub>5</sub>, COD and TOC parameters values enabled to determine the degree of their contamination. Those are general water parameters thus their evaluation allows only to conclude, that water contamination is caused by humans activities [20]. In order to determine exact contamination sources more detail analyses of number of chemical compounds must be performed. The main indicator of water contamination with untreated municipal wastewater is the presence of the long-chain fatty acids (as components of eatable oils and fats). In case of water contamination with industrial wastewaters characteristic organic compounds *eg* phenols are said to be so-called industrial indicators [6].

Moreover it can be show that the water pollution is caused by municipal wastewater deposition as biological indicators *ie* *Streptococcus Faecalis* or *Clostridia* resting spores [21] can be determined.

The total content of the three long-chain fatty acids for surface water as the proposed indicators at highly industrialized and urban areas shown in Fig. 7. The relationship

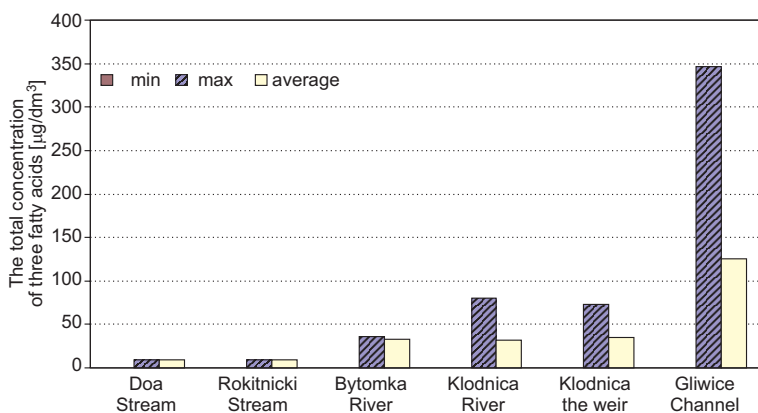


Fig. 7. The total content of the three long-chain fatty acids for surface waters

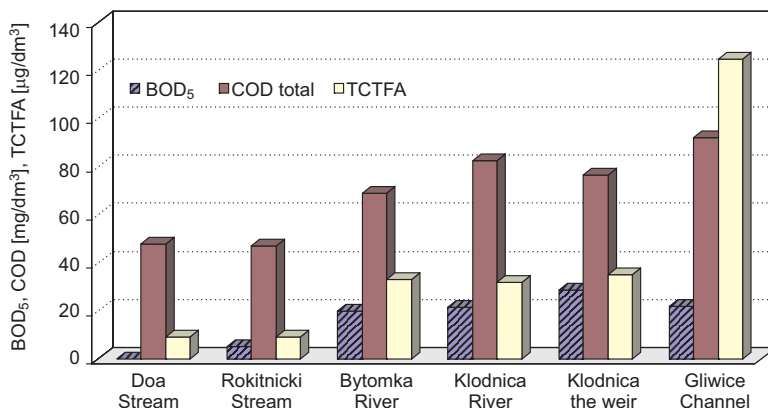


Fig. 8. Average values of BOD<sub>5</sub>, COD and total content of the three long-chain fatty acids for surface waters

between indicators is given in Fig. 8. Natural waters which characterized with high BOD<sub>5</sub> and COD values revealed also the highest concentration of fatty acids concentration of which was the most unstable.

## Conclusion

1. The study of various water courses which are main side streams of Gliwice Channel showed the influence of the human activity on the natural environment.

2. Doa Stream flows through agricultural areas as Ostropka River side streams. It characterized with lowest organic pollutants (BOD<sub>5</sub>, COD). Similarly, low parameters values were obtained for Rokitnicki Stream for which the sampling place was localized at low population density area.

3. Rokitnicki Stream (after passing Zabrze city center), Bytomka River and Klodnica River became highly contaminated surface waters. The influence of the anthropogenic pollutants was confirmed both using COD as well as long-chain fatty acids. The water quality of side streams influences on the water quality of the Gliwice Channel.

4. The characteristic of surface waters based on BOD<sub>5</sub>, COD and TOC parameters values enabled to determine the degree of their contamination. In order to determine exact contamination sources more detail analyses of number of chemical compounds must be performed. Determination of the nowadays anthropogenic organic pollutants is very important and necessary. The main indicator of water contamination with untreated municipal wastewater or wastewater from food industry can be the presence of the long-chain fatty acids

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## OCENA STOPNIA ZANIECZYSZCZENIA ZWIĄZKAMI ORGANICZNYMI KANALU GLIWICKIEGO I JEGO WYBRANYCH DOPŁYWÓW

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**Abstrakt:** Badania miały na celu określenie stopnia zanieczyszczenia różnych cieków wodnych zasilających Kanał Gliwicki na podstawie oznaczenia związków organicznych. Do badań wybrano wody powierzchniowe znajdujące się na terenie Gliwic i Zabrze: Doa (Wójtowiankę), Potok Rokitnicki, Bytomkę, Kłodnicę oraz Kanał Gliwicki. Próby pobierano dwa razy w miesiącu w okresie od zimowo-wiosenno-letnim w godzinach porannych w ciągu jednego dnia. Oznaczenie ChZT wykonano metodą dwuchromianową przy użyciu spektrofotometru NOVA 400 Merck; BZT<sub>5</sub> metodą manometryczną, przy użyciu buteleczek Oxi Top firmy WTW, OWO na analizatorze TN-TC multi N/C firmy Analytik Jena. Suchą masę zawiesiny oznaczano metodą wagową. Uzyskane wyniki opracowano w zależności od parametrów fizykochemicznych badanych cieków (pH, stężenia zawiesiny) oraz ich charakterystyki (długości, ilości dopływów, charakteru terenów przez które płyną).

**Słowa kluczowe:** naturalne ciek, zanieczyszczenia organiczne, ChZT, BZT<sub>5</sub>, OWO