Environmental impact assessment generated
by ALBANIAN petroleum industry into Gjanica rIVEr

Received for publication, July 02, 2013
Accepted, July 12, 2014

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Abstract
Pollution from the oil production and refining industry in Albania is an economic activity that has a strong impact on the environment. The environmental impact of the oil industry on Gjanica River, which collects the discharges from the main oil industry area in Albania, was assessed using the global pollution index. We applied two different evaluation methods of the global pollution index (\( I^*_\text{PG} \)), concentric circles graphical method and water quality index method. The concentric circles graphical methodology produced a water component value of 4 which is equivalent to \( I^*_\text{PG} \) value of 6.25, corresponding to the situation of “a degraded environment, improper for life forms”. The water quality index methodology produced an index value (EQ\text{water}) of 54.91 which is equivalent to \( I^*_\text{PG} \) of 10.42, and again “an environment improper for life forms”.

Keywords: global pollution index, environmental assessment, oil industry, water pollution

1. Introduction
The sustainable management of natural resources and wastes is promoted at European and global scales, aiming to decouple the links between the environmental impacts of natural resource usage and waste generation on one hand, and economic growth on the other (ZAHARIA & al. [1]). After the 1990s, Albanian has been transforming towards an open market economy which has resulted in significant damages to natural resources and the environment of the country, especially to natural waters sources in, exposed and unprotected areas. The situation is especially dramatic in the western part of Albanian which contains the majority of Albanian rivers. This region has become the most polluted from urban and industrial wastes, discharged directly into the rivers (ÇULLAJ & al. [2]). The monitoring of environmental quality has become one of the most important objectives of Albanian environmental policies and strategies. In the framework of the National Program of Environmental Monitoring, the Ministry of Environment, Forests and Water Administration (MoEFWA), through various scientific institutions is monitoring the environmental state of its main components (MoEFWA [3], [4], [5]; MoE [6]).

Some of the main factors that are causing the environmental degradation of the region include: urban development, unsustainable consumption, lack of economic incentives for environmental conservation, uncontrolled usage of natural resources, existing or historic
pollution, inefficient management practices of discharge, lack of a severe inspection system, and low degree of environmental conscientious of the population and the business community.

Recently, the environmental central authority has been increasing its efforts to formulate and maintain environment quality standards according to the European requirements and methodologies. During the last few years they have approved, a lot of important regulations and legislative acts for the environment.

Environmental Impact Assessment (EIA) is a process that evaluates the environmental consequences, both favorable and undesirable, of a proposed project to ensure that these consequences are considered during the project design phase (GREC & al. [7]). It is a national instrument which shall be undertaken for proposed activities which are likely to have a significant adverse impact on the environment (ABAZA & al. [8]). The EIA is the cluster of systematic studies that evaluates the direct or indirect repercussions of a project to allow for modification in design before the environment is harmed (FERREIRA & al. [9]). EIA leads to improved decision-making by providing better information and controls earlier in the development process (RTPI [10]).

EIA is considered to be a potential multidisciplinary, objective decision-making tool that helps the company management staff, planners and politicians to choose the routes of selection, functioning and developing the process technology, industrial or urban sites as well as other project sites. The EIA method relies on indicators that serve as criteria to evaluate whether the objectives have been attained or not. These indicators take into account the local impacts such as noise, odors, aesthetic effects, and stress on vegetable and animal life forms, regional impacts such as eutrophication, low agricultural production, or global impacts like greenhouse effects and climate changes (ZAHARIA & DÂRTU [11]; ZAHARIA & al. [12]).

In Albania various abiotic attributes of the environment (e.g., water, air, etc.) are analyzed and based on this evaluation, the status of the environment and human health are described along with the source of pollution. Assessment of the environmental status for sites impacted by industrial or urban pollution is accomplished by comparing the measured value of each indicator with the allowed value (MoEFWA [3], [4], [5], MIHO & al. [13], ÇULLAJ & al. [2], ÇULLAJ & al. [14]). This same methodology is also used to evaluate certain agricultural activities (SEITI & al. [15], [16]; BEQIRAJ & al. [17]). Based on the degree to which an abiotic attribute deviates from the allowed value determines the magnitude of the environmental degradation. For example, SEITI & al. ([16], [18]) suggest that: “the values of the pollution indicators for the discharged water from the oil industry into the Gjanica River are relatively high and are polluting the water surface of this river”.

In reviewing published studies assessing the environmental impact of abiotic factors on the quality of water, soil and air in, we did not find any study in Albania that addressed the potential synergetic effects of potential pollutants or that used an objective index approach to evaluate the various factors, as it is cited in many studies (GREC & al. [7]; ROBU & al., [19], [20], [21], [22]; ZAHARIA & DÂRTU [11]; ZAHARIA & al. [1], [12], [23]; ZAHARIA & SURPATEANU [24]; ZAHARIA & MURĂRAȘU [25]; PETRUC & al. [26], CÂRLIG & al. [27], CIOBANU & al. [28], etc.)

This paper describes using the Romanian EIA methodology of global pollution index proposed by Rojanschi (1991) and improved by POPA & al. ([29]) (as alternative method of global pollution index) to assess the impact of pollutants on the Gjanica River (tributary of Seman River) (Fig. 1). These rivers directly receive discharges of oil industry effluents and urban wastewaters (ÇULLAJ & al. [2], [14]; SEITI & al. [18]; BEQIRAJ & al. [17]). The EIA methodology was chosen because it provides a broad overview of the environmental state and quality of the river. It also allows qualitative approach for comparing the environmental
quality of several regions (ZAHARIA & al. [1]; ZAHARIA & SURPATEANU [24]; POPA & al. [29]). Furthermore, this method can be used to evaluate individual or a suite of variables (e.g., surface water, air, soil etc.) at a global pollution level (ZAHARIA & MURĂRAȘU [25]).

2. Methods and Results

The global pollution index ($I_{PG}$) is applied in two different evaluation procedures: one is the concentric circles graphical methodology (ZAHARIA & al. [1]; ROBU & al. [19], [20]; ZAHARIA & MURĂRAȘU [25]; PETRUC & al. [26]), and the other is the environmental component quality index methodology (GREC & al. [7]; (ZAHARIA & DÂRTU [11]; ZAHARIA & al. [12]; CIOBANU & al. [28]).

2.1. Site characteristics and location

The oil industry in Albania is about 80 years old. It utilizes very old techniques and technologies, and the strategies and politics of the environmental management are non-existent (SEITI & al. [15]; BEQIRAJ & al. [17]). The intensive extraction, development and utilization of oil during the past years have caused environmental problems to the ecosystem (SEITI & al. [18]) and the industry has not consistently acted in an environmentally responsible manner (BEQIRAJ & al. [17]).

![Figure 1](image_url)
Sources of oil and gas and the industrial infrastructure to extract and utilize these resources are found mostly in the southeast to the southern part of Albania. The maximal gross production of oil in Albania reached approximately 2.5 million tonnes in 1974 and dropped to about 1.1 million tonnes by 1990. Today, around 600 thousand tonnes are produced each year (SEITI & al. [15], [18]). The Oil Refining Plant in Ballsh, which produces an array of petroleum products including lubricants, is the primary production facility base in Albania and remains a considerable source of pollution (SEITI & al. [15]).

The major part of the oil industry is concentrated on both sides of the Gjanica River (Fig. 1), which is the most polluted river in the region (SEITI & al. [19]). The Gjanica River runs a distance of 70 km and covers a water basin of 234 km². Its flow varies greatly between seasons and from year to year ranging between 0.146 and 124 m³/sec. Seventy-five percent of the river passes through the oil industrial area. In its lower part the river runs in the center of Fier city joining with Seman River. In this river are discharged all the water effluents of two decanting plants, the Usoja and Visoka,) and the Ballsh Oil Refining Plant (BEQIRAJ &. al. [17], [30]). This river receives waters from many other channels in the surrounding area, which during the rainy season contains high quantities of crude oil originating mainly from well pools or crude oil spills in the territory (BEQIRAJ & al. [30]).

The highest potential polluters of the region are the decanting plants, as the amount of the polluted water discharged from them is very high. The quantity of the polluted water that is discharged from the oil decanting plants to the Gjanica River, and after to the Seman River and at the end to the Adriatic sea, is evaluated to be 0.5 million m³/year (BEQIRAJ & al. [17]). The determination of the amount of environmental pollution generated by the oil processing and production industry was based on the physicochemical analysis of specific indicators of water quality: organic matters expressed as chemical oxygen demand (COD) and biochemical oxygen demand (BOD₅), suspended solids, oily products, phenols, total nitrogen, ammonium, total phosphorus, sulphides and H₂S, total iron, all of which have significant impact on river water quality.

2.2. Sampling

Environmental pollution from the production and oil refining plants impacts soil, water and air. The Gjanica River, together with Roskovec – Hoxhar canal, receive and eventually discharge waste from 2,837 active oil wells, 18 active natural gas wells, 6 treatment plants, 6 decanting station, 10 pumping station, and 2 refining plants (BEQIRAJ & al. [17]). Although there are many other pollutants that are discharged into this system, we have restricted our analysis to include only the water component.

Water samples were taken monthly on the Gjanica River year round, between Visoka and industrial complex of Fier, before discharges of production water and wastes from Fier Oil Refinery on Gjanica River. All the data in the tables below are given as annual average for each pollutant.

2.3. Assessment of environmental impact

2.3.1. The concentric circles graphical methodology

The concentric circles graphical methodology (ZAHARIA & DÂRTU [11]; ZAHARIA & al. [12]; POPA & al. [29]), takes into account the ideal state and the actual state of the environment, based on the evaluation of selected representative quality indicators. The assessment method is based on a synthetic evaluation of the quality indicators for each environmental component (e.g., air, water resource, soil, etc.). This approach uses a graphical approach to compare the various components in a graphical presentation from which a global
pollution index can be calculated as a function of the ratio of ideal surface area and actual surface area (ZAHARIA & al [1], ZAHARIA & MURĂRAȘU [25]). Each environmental component is assigned an evaluation score that quantifies the pollution caused by that component relative to an evaluation scale (ROBU & al. [19], [20]; ZAHARIA [1], [23], ZAHARIA & MURĂRAȘU [25]; PETRUC & al. [26]).

The evaluation scale consists of different variation intervals for the evaluation score that corresponds to the specific pollution situation. The evaluation scale ranges from 1 to 10 with 10 representing a non-affected natural state of the environment and 1 representing an irreversible and major degradation of the studied environmental components (ZAHARIA & al. [1]; ROBU & al. [19]; ZAHARIA & MURĂRAȘU [25]).

The evaluation scale for the various surface water quality indicators evaluated in this study is presented in Table 1 (ZAHARIA & al. [1], [23]; ROBU & al. [19], [20]; ZAHARIA & MURĂRAȘU [25]; PETRUC & al. [26]). An alternative method, the global pollution index, can be used to assess the global pollution state of a certain site if there is existing information for one or two environmental components (ZAHARIA & MURĂRAȘU [25]).

The calculation of the global pollution index ($I_{PG}$) for the water components in this study was made according to equation (1) (ZAHARIA & DÂRTU [11]; ZAHARIA & al. [12]; ROBU & al. [20]; ZAHARIA & SURPATEANU [24]; ZAHARIA & MURĂRAȘU [25]; PETRUC & al. [26]):

$$I_{PG}^* = \frac{S_i}{S_r} = \frac{100}{b^2}$$

where, $S_i$ – geometrical surface corresponding to the non-affected natural state (ideal state of water component with a radius of 10); $S_r$ – geometrical surface corresponding to the actual pollution state of the water (actual state is the radius equal to $(\bar{b}^2)^{1/2}$, where $\bar{b}^2$ is the arithmetic mean of the total evaluation score for each analyzed water quality indicator based on the evaluation scale in Table 2 (Fig. 2).

**Figure 2.** Graphical representation of the concentric circles graphical methodology of $I_{PG}^*$ corresponding to ideal state ($S_i$) (circle with the radius of 10) and real situation ($S_r$) (circle with the radius equal with the value of $(\bar{b}^2)^{1/2}$) (ZAHARIA & DÂRTU [11]; ZAHARIA & al. [12], ZAHARIA & MURĂRAȘU [25]).
Table 1. Evaluation scale for the environmental component surface waters

<table>
<thead>
<tr>
<th>Eval. scale</th>
<th>Water category</th>
<th>COD (mg/L)</th>
<th>BOD$_5$ (mg/L)</th>
<th>Total N (mg/L)</th>
<th>Ammonium (mg/L)</th>
<th>H$_2$S (mg/L)</th>
<th>Phenols (μg/L)</th>
<th>Oily products (μg/L)</th>
<th>Total P (mg/L)</th>
<th>Total Fe (mg/L)</th>
<th>Susp. solids (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Drinking water</td>
<td>&lt; 5</td>
<td>&lt; 3</td>
<td>&lt; 4</td>
<td>&lt; 0.05</td>
<td>&lt; 0.1</td>
<td>fond*</td>
<td>&lt;10</td>
<td>&lt;1</td>
<td>fond*</td>
<td>&lt;10</td>
</tr>
<tr>
<td>9</td>
<td>Category I</td>
<td>5 - 10</td>
<td>3 - 5</td>
<td>4 - 13</td>
<td>0.05 - 0.25</td>
<td>0.14 - 0.3</td>
<td>&lt; 1</td>
<td>10 - 100</td>
<td>1 - 3</td>
<td>fond*</td>
<td>1 - 35</td>
</tr>
<tr>
<td>8</td>
<td>Category II</td>
<td>5 - 10</td>
<td>3 - 5</td>
<td>4 - 13</td>
<td>0.25 - 0.35</td>
<td>0.34 - 0.5</td>
<td>1 - 20</td>
<td>100 - 200</td>
<td>3 - 5</td>
<td>&lt; 0.1</td>
<td>35 - 70</td>
</tr>
<tr>
<td>7</td>
<td>Category III</td>
<td>10 - 20</td>
<td>5 - 10</td>
<td>13 - 26</td>
<td>0.35 - 0.7</td>
<td>0.5 - 0.75</td>
<td>20 - 50</td>
<td>200 - 500</td>
<td>5 - 10</td>
<td>0.1 - 0.3</td>
<td>70 - 150</td>
</tr>
<tr>
<td>6</td>
<td>Category IV</td>
<td>20 - 50</td>
<td>10 - 25</td>
<td>26 - 66</td>
<td>0.7 - 1.9</td>
<td>0.75 - 1.0</td>
<td>50 - 100</td>
<td>500 - 1000</td>
<td>10 - 15</td>
<td>0.31 - 1.0</td>
<td>150 - 350</td>
</tr>
<tr>
<td>5</td>
<td>Category V</td>
<td>50 - 100</td>
<td>25 - 30</td>
<td>66 - 75</td>
<td>1.9 - 2.2</td>
<td>1.0 - 1.25</td>
<td>100 - 500</td>
<td>1000 - 5000</td>
<td>15 - 20</td>
<td>1.1 - 2.5</td>
<td>350 - 500</td>
</tr>
<tr>
<td>4</td>
<td>Degraded stage 1</td>
<td>100 - 150</td>
<td>30 - 50</td>
<td>75 - 85</td>
<td>2.2 - 2.5</td>
<td>1.25 - 1.5</td>
<td>500 - 1000</td>
<td>5000 - 7500</td>
<td>20 - 25</td>
<td>2.51 - 3.75</td>
<td>500 - 700</td>
</tr>
<tr>
<td>3</td>
<td>Degraded stage 2</td>
<td>150 - 300</td>
<td>50 - 100</td>
<td>85 - 95</td>
<td>2.5 - 3</td>
<td>1.5 - 1.75</td>
<td>1000 - 3000</td>
<td>7500 - 10000</td>
<td>25 - 30</td>
<td>3.76 - 4.5</td>
<td>700 - 850</td>
</tr>
<tr>
<td>2</td>
<td>Waste water stage 1</td>
<td>300 - 400</td>
<td>100 - 500</td>
<td>95 - 100</td>
<td>3.0 - 5</td>
<td>1.75 - 2.0</td>
<td>3000 - 5000</td>
<td>10000 - 12500</td>
<td>30 - 35</td>
<td>4.51 - 5</td>
<td>850 - 1000</td>
</tr>
<tr>
<td>1</td>
<td>Waste water stage 2</td>
<td>&gt; 400</td>
<td>&gt; 500</td>
<td>&gt; 100</td>
<td>&gt; 5</td>
<td>&gt; 2.0</td>
<td>&gt; 5000</td>
<td>&gt; 12500</td>
<td>&gt; 35</td>
<td>&gt; 5</td>
<td>&gt; 1000</td>
</tr>
</tbody>
</table>

*concentration in natural conditions, no emissions

Reviewed literature (ZAHARIA & al. [1], [12], [23]; ROBU & al. [20]; ZAHARIA & SURPATEANU [24]; ZAHARIA & MURĂREŞU [25]; PETRUC & al. [26]; POPA & al. [29]) proposes for different values of $I_{PG}^*$ the following characterization of global environmental impact (Table 2). According to Table 1, when $I_{PG}^* = 1$ the environment is not polluted; when $I_{PG}^* > 1$ the environment is being modified to an increasing degree up to essentially total degradation at $I_{PG}^* > 6$.

Table 2. Correlation between arithmetic mean of evaluation degrees and global state of the environment

<table>
<thead>
<tr>
<th>Values of $b$</th>
<th>Value of $I_{PG}^*$</th>
<th>Real situation of environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>$I_{PG}^* = 1$</td>
<td>Natural environment, not affected by industrial/human activities</td>
</tr>
<tr>
<td>9.999 – 7.072</td>
<td>1 $&lt; I_{PG}^* &lt; 2$</td>
<td>Environment modified by industrial activities within admissible limits</td>
</tr>
<tr>
<td>7.071 – 5.774</td>
<td>2 $&lt; I_{PG}^* &lt; 3$</td>
<td>Environment modified by industrial activities causing discomfort conditions</td>
</tr>
<tr>
<td>5.773 – 5.001</td>
<td>3 $&lt; I_{PG}^* &lt; 4$</td>
<td>Environment modified by industrial activities causing distress to life forms</td>
</tr>
<tr>
<td>5 – 4.083</td>
<td>4 $&lt; I_{PG}^* &lt; 6$</td>
<td>Environment modified by industrial activities, dangerous for life forms</td>
</tr>
<tr>
<td>$&lt; 4.082$</td>
<td>$I_{PG}^* \geq 6$</td>
<td>Degraded environment, not proper for life forms</td>
</tr>
</tbody>
</table>

2.3.2. Methodology using individual environmental components to derive a quality index

The environmental component quality index approach (e.g., for water component) uses a correlation scale of grades from 1 to 10. The correlation scale, presented in Table 3 (GREC & al. [7]; ZAHARIA & DÂRTU [11]; ZAHARIA & al. [12]; CIOBANU & al. [28]), accords the 10th grade to the natural unaffected state and the first grade to the maximum pollution state. The specific evaluation score (ES) for a measured component is assessed by comparing the measured value for the component to the currently accepted normative value (GREC & al. 10156).
Environmental impact assessment generated by ALBANIAN petroleum industry into Gjanica River

For example, the concentrations of different pollutants ($C_i$) are determined by laboratory analysis and then compared with the maximum allowed concentrations ($MAC_i$) based on national environmental standards. The degree to which the measured component (e.g., water) differs from the MAC$_i$ determines the index ($EQ_i$) value (GREC & al. [7]; ZAHARIA & DĂRTU [11]; ZAHARIA & al. [12]; CIOBANU & al. [28]):

$$EQ_i = \frac{C_{i, measured}}{MAC_i}$$

For each pollutant, the EQ$_i$ is determined and the potential synergetic effect of all the pollutants are summed and averaged to derive an average arithmetic value which, for water would be expressed as EQ$_{water}$.

For quantification of the global pollution of environment on Gjanica River, the global pollution index ($I_{PG}$) is used by the above mentioned alternative methodology. The calculation of geometrical surface is performed using the index value to express the water quality that corresponds to a specific evaluation score (compliance degree) (Table 3). The $I_{PG}$ assessment can be made by considering the correlation presented in table 2.

### Table 3. Correlation scale for the pollution level of water component (water quality scale)

<table>
<thead>
<tr>
<th>Compliance degree ($ES_i$)</th>
<th>Values of $EQ_i$</th>
<th>The effect on the environment and human health</th>
</tr>
</thead>
</table>
| 10                          | 0                | The environment is not affected by the human activity  
Environment state: natural |
| 9                           | 0.0-0.2          | The environment is affected by the human activity  
The effect cannot be quantified |
| 8                           | 0.2-0.7          | The environment is affected under the maximum allowed limits – level 1.  
Alert level: potential effects |
| 7                           | 0.7–1.0          | The environment is affected, but in the maximum allowed limits–level 2.  
Intervention level: potential effects |
| 6                           | 1.0–2.0          | The environment is affected over the maximum allowed limits – level 1.  
The effects are pronounced |
| 5                           | 2.0-4.0          | The environment is affected over the maximum allowed limits – level 2.  
The effects are harmful |
| 4                           | 4.0–8.0          | The environment is affected over the maximum allowed limits – level 3.  
The harmful effects are pronounced |
| 3                           | 8.0–12.0         | Degraded environment – level 1  
The effects are lethal to the average exposure |
| 2                           | 12.0–20.0        | Degraded environment – level 2  
The effects are lethal at short durations of exposure |
| 1                           | >20.0            | The environment is improper for life |

### 3. Results and discussion

#### 3.1. The alternative method of global pollution index

The measured individual pollutants in the water from the Gjanica River are presented in Table 4. Comparing these measured values to the evaluation scale (Table 1) results in the following level of pollution for each component COD - 3; BOD$_5$ – 3, total N – 7, ammonium – 1, sulphides and H$_2$S - 1, phenols - 2, oily products – 1, total P - 8, total Fe – 7; suspended
solids -7 and an average score of 3.9. The measured values that appear to be causing the most pollution are oily products, sulphides and H₂S, phenols, and also organic matter expressed by COD and BOD.

Table 4. Chemical composition of Gjanica River water

<table>
<thead>
<tr>
<th>Physicochemical indicators</th>
<th>Measured (average annual) values (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>157.00</td>
</tr>
<tr>
<td>BOD₅</td>
<td>54.50</td>
</tr>
<tr>
<td>Ammonium</td>
<td>10.00</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>14.87</td>
</tr>
<tr>
<td>Sulphides and H₂S</td>
<td>2.50</td>
</tr>
<tr>
<td>Phenols</td>
<td>3.70</td>
</tr>
<tr>
<td>Oily products</td>
<td>363.00</td>
</tr>
<tr>
<td>Total Fe</td>
<td>0.25</td>
</tr>
<tr>
<td>Total P</td>
<td>1.45</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>91.00</td>
</tr>
</tbody>
</table>

Applying this arithmetic mean to the global pollution index approach results in a $\bar{b}$ or approximately 16 resulting in $I_{PG}^{*}$ value of 6.25, which corresponds to “a degraded environment, not proper for life forms”.

3.2. The quality index of the water component

The individually measured results of analyzed physicochemical indicators for water quality to the investigated river and the allowed maximal concentration according the normative are shown in table 5.

The index expressing the water quality is assessed for each pollutant and at the end was found through the correlation and different degree of compliance ($ES_i$). Compliance degree for the water component is evaluated as mean of the degree. The data shows that the most important pollutants of water are oily products, phenols, ammonium ions and sulphides, which contributes to increase the mean value of the index that expresses the water quality to $EQ_{water} = 54.91$, which according to data from table 3, reflects the fact that "the environment is improper for life".

Table 5. Measured and allowed values for physicochemical indicators

<table>
<thead>
<tr>
<th>Physicochemical indicators</th>
<th>MACi (mg/l)</th>
<th>$C_{measured}$</th>
<th>$EQ_i$ (water)</th>
<th>$ES_i$ (water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>COD</td>
<td>10.00</td>
<td>157.00</td>
<td>15.70</td>
<td>2</td>
</tr>
<tr>
<td>BOD₅</td>
<td>5.00</td>
<td>54.50</td>
<td>10.90</td>
<td>3</td>
</tr>
<tr>
<td>Ammonium</td>
<td>0.20</td>
<td>10.00</td>
<td>50.00</td>
<td>1</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>20.00</td>
<td>14.87</td>
<td>0.74</td>
<td>7</td>
</tr>
<tr>
<td>H₂S</td>
<td>0.10</td>
<td>2.50</td>
<td>25.00</td>
<td>1</td>
</tr>
<tr>
<td>Phenols</td>
<td>0.05</td>
<td>3.70</td>
<td>74.00</td>
<td>1</td>
</tr>
<tr>
<td>Oily products</td>
<td>1.00</td>
<td>363.00</td>
<td>363.00</td>
<td>1</td>
</tr>
<tr>
<td>Total Fe</td>
<td>0.10</td>
<td>0.25</td>
<td>2.50</td>
<td>5</td>
</tr>
<tr>
<td>Total P</td>
<td>0.40</td>
<td>1.45</td>
<td>3.63</td>
<td>5</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>25.00</td>
<td>91.00</td>
<td>3.64</td>
<td>5</td>
</tr>
</tbody>
</table>

$EQ_{water} = 54.91$

$ES_{water} = 3.10$
As it was described, \( I_{PG}^* \) represents the global pollution degree of the analyzed area and EQi is the quality or the pollution degree for each environmental factor (e.g., for water is noted EQ\(_{water}\)). The index \( I_{PG}^* \) is calculated as the arithmetic average of the pollution degree for each indicator examined from the environmental factors. Since the study takes into consideration only one environmental factor (the water) the value of \( \bar{b} \) is 3.10 (\( \bar{b}^2 = 9.61 \)), and \( I_{PG}^* \) is 10.42, corresponding to the situation of “degraded environment, not proper for life forms”.

As the index expresses the quality of water component (EQ\(_{water}\)), even the global pollution index (\( I_{PG}^* \)) reflects the same picture of the studied environment. In this case-study the assessment of quality of only one environment component is sufficient to evaluate it only by EQ index.

4. Conclusions

The oil industry in Albania is a powerful polluter of the environment. The assessment of its environmental impact to the water of Gjanica River was done with the method of global pollution index. The \( I_{PG}^* \) value calculated using the concentric circles graphical methodology is 6.25 and value calculated using methodology of water quality index is 10.42, which indicates a “degraded environment, not proper for life forms”.

Hence, the computed \( I_{PG}^* \) values clearly indicate degraded state of environment and different management programs are recommended in order to reduce the pollution sources: to stop the discharge of the petroleum industry directly to the river without being pre-treated, also, it is necessary to take measures for the rehabilitation of the Gjanica River and its surrounding environment.

The method of global pollution index can be successfully used in Albania to assess the environmental impact of private and industrial project and their activity. It has to be noted the fact that concentric circles graphical procedures is mainly based on subjective assessments and therefore the experience of evaluators is very important (ROBU & al. [19]; ZAHARIA & SURPATEANU [24]), it is more appropriate to assess the environmental impact according to the water quality index method.

References


