Temporal variation of nitrate, chlorine and pH values in surface waters

Funda Dökmen 1* and Cengiz Kurtuluş 2

1 University of Kocaeli, Ihsaniye Vocational School, Campus of Vezirğolu, Vinsan, Izmır-Kocaeli, Turkey.
2 University of Kocaeli, Faculty of Engineering, Department of Geophysics, Campus of Umuttepe, Umuttepe-Kocaeli, Turkey.

* e-mail: f_dokmen@hotmail.com

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Abstract

In this study, eight different surface water resources located in five villages of Gölcük, Kocaeli, were tested between June 1999 and 2000 to determine the NO3-N, Cl and pH values. Temporal variation in these parameters reflects changes in precipitation. The test results showed that the NO3-N, Cl and pH levels varied between 0.65-0.11 mg L−1, 0.54-0.04 mg L−1 and 8.33-5.15, respectively. Data showed a strong relationship between NO3-N, Cl and pH concentrations and amount of precipitation. Based on this fact, water quality of these surface water resources were also examined.

Key words: Chlorine, drinking water, irrigation water, nitrate, pH, rainfall, water quality.

Introduction

The sensitivity of surface water resources’ quality depending on their location is different even for small variations in environmental conditions. Changes in precipitation quality affect surface water resources depending on seasons. The precipitation amount varies temporally and spatially. The rain water is pure water in nature and contains very low effluent. There are nitrite, ammonium nitrate from nitric acid and nitrate as soluble in rain water. The pH is one of the very important factors which fix water quality. Generally, pH of natural waters fix concentrations of soluble carbonate, bicarbonate and carbon dioxide. Nitrate (NO3-N) is an extremely soluble form of nitrogen. Recent research suggests that consistently high levels of nitrate in surface waters can harm some forms of aquatic life, particularly amphibians. The unsound and excessive applications of fertilizers, especially nitrate and phosphate, can damage environment. The highly dissolved nitrate has been leached from the soil into ground water and surface water. There is low or high chlorine concentration in all of natural waters. Chloride salts are supplemented to the soil and water resources from industrial wastes, fertilizers and stable manure. Penetration of chloride salts transported from HCl existed in volcanic gaseous by rain waters and fogs coming from sea to land were detected. The aim of this work was to study the influence of precipitation events and quantity on the surface water resources in terms of NO3-N, Cl and pH.

Material and Methods

In this study, eight different surface water resources located in five different villages in the vicinity of Gölcük-Kocaeli in Turkey were investigated. The content of NO3-N, Cl and pH were examined for the relation to amount of rainfall. This work was accomplished analyzing 8 water samples every month from the sources in Ümmiye, Mamuriye, Ferhadiye, Nüzhetiye and in Yeniköy villages in the period of 1999-2000 years. In the research area, annual mean temperature is 23.6°C and annual mean of precipitation is 808.4 mm year−1. In the long period years (1975-2006), total annual potential evaporation is 540.5 mm water year−1 and total annual real evaporation of research area is 476.9 mm water. Standard sampling methods were used in the work, and the samples were analyzed according to standard methods.

Results and Discussion

The 14 months average values of pH, NO3-N and Cl in the samples taken from 8 different surface water sources in Kocaeli-Gölcük and surrounding villages are given in Table 1. The names, places and characteristics of the water sources are shown in Table 1. The average values of the samples for 14 months were as follows: pH 7.15-7.34, NO3-N 0.21-0.33 mg L−1 and Cl 0.05-2.88 mg L−1.

All the water sources satisfy the first class water quality for pH. The pH values of all the water sources are suitable for drinking water and irrigation water in accordance with TSE 266 (pH 7.0-8.5). The result of 14 months precipitation rate shows that the pH values between June 1999 and January 2000 are 8-8.5 for all the water resources and decreased to 5.5-6 in January 2000 due to precipitation rate of 154.3 kg m−2. The pH values increased to 7.5-8 depending on the precipitation rate of 210 kg m−2 in June 2000 (Fig. 1). The pH values were for all the water resources around 5-6.5 between January and April, 2000. Although the precipitation rate varies between 78 and 113.5 kg m−2 in winter period (December-March), it decreased the pH in acidic way. Kuvel showed that the pH values did not change significantly after the strong rainy days.

The NO3-N values were 0.3-0.5 mg L−1 between August and September, 1999, and increased in winter period proportionally with the precipitation rate for all of the water resources except the...
Conclusions

In this study, results of analysis and variations of parameters’ concentration were related to precipitation. We observed that the rainfall during summer period affects the pH values to increase in alkaline way, and during winter period to decrease in acidic way, although the monthly total amount (kg m\(^{-2}\)) of rainfalls in summer and spring showed some differences. There was no significant change on pH values, and the values were similar for all water resources. The reason of the pH value decrease in acidic way is the existence of different chemical substances and concentrations of sulphide, carbon dioxide and carbon monoxide in winter rainfalls. The variable effects on the pH value and precipitation variations must be taken into consideration in the agricultural fields. The Cl\(^{-}\) concentration increased during summer period (June-July 1999) when the precipitation rate is about 100 kg m\(^{-2}\) depending on the evaporation rate in water resources. The Cl\(^{-}\) carried by foggy weather in the transition of seasons, especially between autumn and winter and spring, can penetrate surface water resources and soil increasing the Cl\(^{-}\) concentration.

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Name of the spring</th>
<th>Flow (m s(^{-1}))</th>
<th>Soil characteristic</th>
<th>pH</th>
<th>NO(_3)-N (mg L(^{-1}))</th>
<th>Cl(^{-}) (mg L(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ümmiyi</td>
<td>Şelale</td>
<td>0.5</td>
<td>Sandy-Lime</td>
<td>7.34</td>
<td>0.28</td>
<td>0.09</td>
</tr>
<tr>
<td>2</td>
<td>Mamuriye</td>
<td>Altınoluk</td>
<td>1.0</td>
<td>Sandy-Lime</td>
<td>7.31</td>
<td>0.25</td>
<td>0.05</td>
</tr>
<tr>
<td>3</td>
<td>Febradiye</td>
<td>Çıtırıkbayır</td>
<td>0.5</td>
<td>Clayish-Lime</td>
<td>7.15</td>
<td>0.24</td>
<td>0.15</td>
</tr>
<tr>
<td>4</td>
<td>Nüzhetiy Hananlıkdere</td>
<td>0.3</td>
<td>Lime</td>
<td>7.21</td>
<td>0.27</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Nüzhetiy Değirmendere</td>
<td>0.9</td>
<td>Lime-Sandy</td>
<td>7.29</td>
<td>0.21</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Nüzhetiy Sakarboğazı 1</td>
<td>0.5</td>
<td>Sandy-Lime</td>
<td>7.23</td>
<td>0.24</td>
<td>2.88</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Nüzhetiy Sakarboğazı 2</td>
<td>0.5</td>
<td>Clayish-Lime</td>
<td>7.28</td>
<td>0.27</td>
<td>0.12</td>
<td></td>
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<tr>
<td>8</td>
<td>Yeniköy</td>
<td>Havuzlubâşe</td>
<td>0.9</td>
<td>Clayish-Lime</td>
<td>7.27</td>
<td>0.33</td>
<td>0.11</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean 0.6 7.26 0.26 0.44

The NO\(_3\)-N value was 0 mg L\(^{-1}\) in rainy months and 0.2 mg L\(^{-1}\) in less rainy months. The NO\(_3\)-N value was acquired 0 mg L\(^{-1}\) in July 1999-2000 in whole water resources (Fig. 2). Concentrations of NO\(_3\)-N in rainy months are related to the leaching of N (nitrogen) applied for the agricultural purpose through the formation and surface water resources, and erosion occurred by the effect of precipitation. The value of NO\(_3\)-N measured in less rainy months is related to the disaggregation of NO\(_3\)-N depending on the temperature elevation in water and hence the decrease of concentration.

An increase of 0.05-0.15 mg L\(^{-1}\) was detected in Cl\(^{-}\) concentration in the water resources in autumn and spring depending on rainfall as depicted in Fig. 3. The Cl\(^{-}\) concentration decreased when the amount of rainfall was 210 kg m\(^{-2}\) in June 2000, whereas it became 0 mg L\(^{-1}\) when the amount of rainfall was between 7.4 and 78.0 kg m\(^{-2}\) in September and December, 1999. The elevation in temperature and rainfall caused lessening in Cl\(^{-}\) concentration until 0 mg L\(^{-1}\). No significant temperature and rainfall during winter period prevent the active concentration of Cl\(^{-}\). The Cl\(^{-}\) concentration increased during summer period (June-July 1999) when the precipitation rate is about 100 kg m\(^{-2}\) depending on the evaporation rate in water resources. The Cl\(^{-}\) carried by foggy weather in the transition of seasons, especially between autumn and winter and spring, can penetrate surface water resources and soil increasing the Cl\(^{-}\) concentration.

The NO\(_3\)-N concentration was-related to precipitation. We observed that the rainfall during summer period affects the pH values to increase in alkaline way, and during winter period to decrease in acidic way, although the monthly total amount (kg m\(^{-2}\)) of rainfalls in summer and spring showed some differences. There was no significant change on pH values, and the values were similar for all water resources. The reason of the pH value decrease in acidic way is the existence of different chemical substances and concentrations of sulphide, carbon dioxide and carbon monoxide in winter rainfalls. The variable effects on the pH value and precipitation variations must be taken into consideration in the agricultural fields. The NO\(_3\)-N concentration was considered in the usage of irrigation water including NO\(_3\)-N fertilizers in the agricultural purpose. The Cl\(^{-}\) concentration in the water resources used for irrigation in arid summer periods must be taken into consideration because the lowest amount of Cl\(^{-}\) can cause a greater risk on economic crop specimens. Kelly\(^{9}\) and Eaton\(^{10}\) indicate the limits of Cl\(^{-}\) below 62 and 71 mg L\(^{-1}\), respectively, for the allowable Cl\(^{-}\) concentrations for the safe crops productivity. The allowable limits\(^{9}\) for spring water is 20 mg L\(^{-1}\) and for city drinking water 200 mg L\(^{-1}\). The Cl\(^{-}\) concentrations in the surface water resources were below the respective TSE health based guideline values.

References


\(^{13}\)Anonymous 2007. Kocaeli Meteoroloji İstasyonları Kayıtları Recorders of Kocaeli Weather Station), Kocaeli.


Figure 1. The change of pH values from the water source depending on rainfall.

Figure 2. The change of NO₃-N values from the water source depending on rainfall.

Figure 3. The change of Cl⁻ values from the water source depending on rainfall.