Potential Sources of Surface and Groundwater Contamination in Tirana- Durres Region

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Abstract

The objective of this paper is to assess and evaluate the conditions of the surface and groundwater resources in the Tirana-Durres region. The most important aquifer is that of Tirana and it supplies with drinkable water (1200 –1300 l/sec) Tirana, Vora, Kamza and the other vicinities. The risk of pollution is very high because the aquifer's cover layer is very thin; the running rivers (Lana, Ishmi and Gjola Rivers) are very polluted due to over urbanization and the high usage of the sand soil for the construction industry. In addition, the groundwater layer in Durres region has high values of Cl-, K+ and Na+ ions, indicating a possible progression of seawater in the coastal aquifer of Durres. The potential for seawater contamination of the freshwater-bearing zones probably will continue to increase in west Durres, as freshwater zones continues to decline. The current situation in the region is evaluated through data from wells and spring and Water budget to evaluate the groundwater characteristics. The distributions of different chemical properties are mapped to identify the most problematic zones by using GIS techniques. The study focuses on problems such as seawater intrusion in the area of Durres and stream water contamination in Tiran region. The effects of these phenomena are studied and some possible remedies are discussed in this paper.

Keywords: *Groundwater contamination, saline intrusion.*

Introduction

Tirane-Durres Region is located in central Albania and it is bounded by the Adriatic Sea in West and Dajti Mountain in the East. During the past 20 years the population of the region has increased rapidly and now it is one of the most densely populated regions in Albania. The demand for fresh water is covered by the Tirana-Durres Aquifer and Fushe-Kruje Aquifer. Fushe Kruje aquifer supplies with drinkable water (600-700l/sec) Shijak, Fushe-Kruje, Preze, Mazhe, Bubq, Thuman, Gramez and other villages. Tirana Durres aquifer is used to supply Tirana,

Kamza, Vore and other vicinities at a rate of 1200 –1300 l/sec. The Potential effects of rapid population growth in Tirana, the agricultural practices and the industrial expansion have rise concerns about water quality in the region.

During 2011, the environmentalists have noticed that the coastline in Kavaja and Durres has advanced significantly toward the land. More than 100 m that used to be the seaside now it is under seawater. This phenomenon combined with effect of high pumping rates in the west plain for irrigation, industrial and domestical supply can cause saline intrusion in the groundwater reserves. The potential of saline intrusion is expected to increase as the population growth places greater demands in fresh water resources. Therefore it is very important to study this phenomenon; to identify the source, cause and extend of saline intrusion.

Purpose and Scope

The aim of this report is: 1) to describe the water quality of Tirana Durres groundwater based on the chemical properties and to identify potential sources of water pollution, discussing the possible remedies; 2) to describe the water quality in Durres-Kavaja region and highlights the areas where the salt water is present, describe the possible sources and discuss some future solutions.

Study Area

Location and Climate

Tirana is situated on Tirana Plain, 110 m above the sea level and surrounded by a mountainous relief. Durres is situated in the center of the West Adriatic Plain of Albania and is surrounded by hilly-lowland relief. The mean height of the region is 89m above sea level and in the city it is 2m above the sea level. This region has a favorable geographic position that links the Adriatic Sea with the eastern Albania and with the inner part of Balkan Peninsula and it poses a fertile plain rich in forests, land for agricultural use and water. It has a maritime Mediterranean climate, with hot, dry summers and mild, wet winters. The annual average temperature is 15°C, in January 7°C and in July 28°C. Generally it ranges from 17-31°C in July, to 2-21°C in January. The average precipitation is 1 247 mm, 70% of it in the cold half part of the year.

Rivers - The main rivers running in the study area are Erzeni, Ishmi and Shkumbini Rivers (Fig.1). All the rivers have the same direction from east to west. In the coastal zone, the rivers run slowly downhill following a winding course until they reach the sea. There are 11 stations that monitor the flowing water.

Geology - The study area consists of three types of lithological deposits:

a) Quaternary deposits mostly found in the North-West plain of Durres city and center of Tirana city.

b) Terrigenuous Rocks occupying extensively the study area.
c) Limestone situated mainly in the North East of Tirana and East of Kavaja City.

Methods

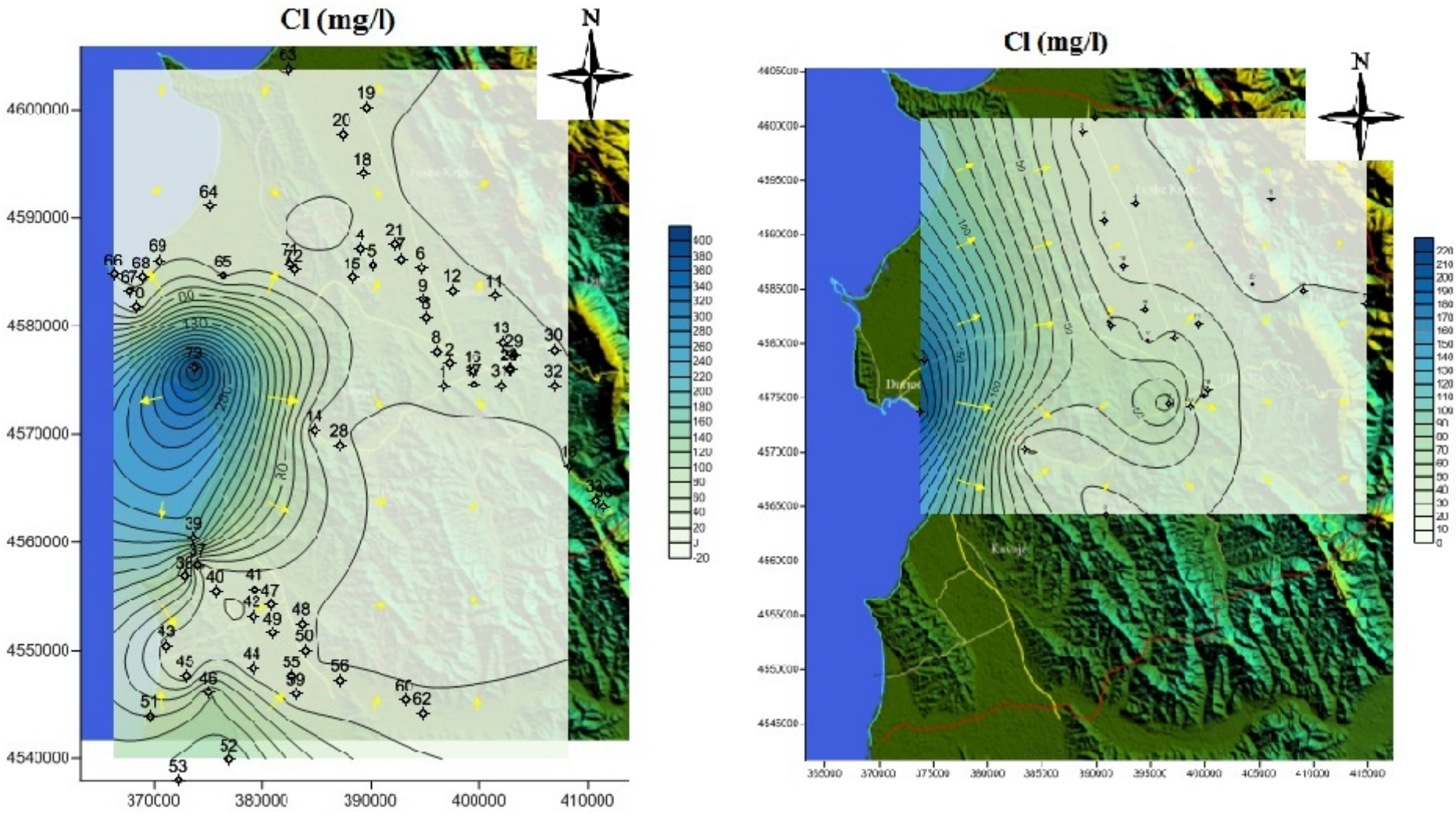
Field Measurements - Groundwater monitoring is performed by the Geological Institute of Albania through drilling logs and pumping stations wells.. For this study there are used two time series of the water sample: a) water monitoring samples from 1982-2001 and water monitoring samples for 2010 for the Durres-Tirana region. At each sample station is determined the static and dynamic level of groundwater table, cover depth and the height of the aquifer layer. Ph, temperature and conductivity were measure in situ.

Chemical Analyses - The water samples collected in situ where analyzed in the Laboratory of Geological Science in Tirana. For each sample a chemical analyses was conducted to find out the concentration of different chemical substances like: Ca+, Na+, K+, Mg+, HCO3-, Cl-, SiO2, O2, Fe+, CO3, NH4, NO3, NO2, Total Dissolved Solids (TDS) and hardness. The chemical properties of water are in 2 time series: for the period 1982-2001 and for 2010.

Map Generation - The results of the chemical analyses are used to generate the map distribution of the different chemical substances in the study area. The mapping of the chemical properties was performed with *Surfer 10* software. The coordinates of the water samples are converted from ALB87 coordinate system to UTM coordinate system. The chemical concentrations are expressed as mg/l. The maps of the same chemical properties for the two time series 1982-2001 and 2010 will be compared together and the progress or regress will be analyzed. Based on these mappings the hot spots will be identified.

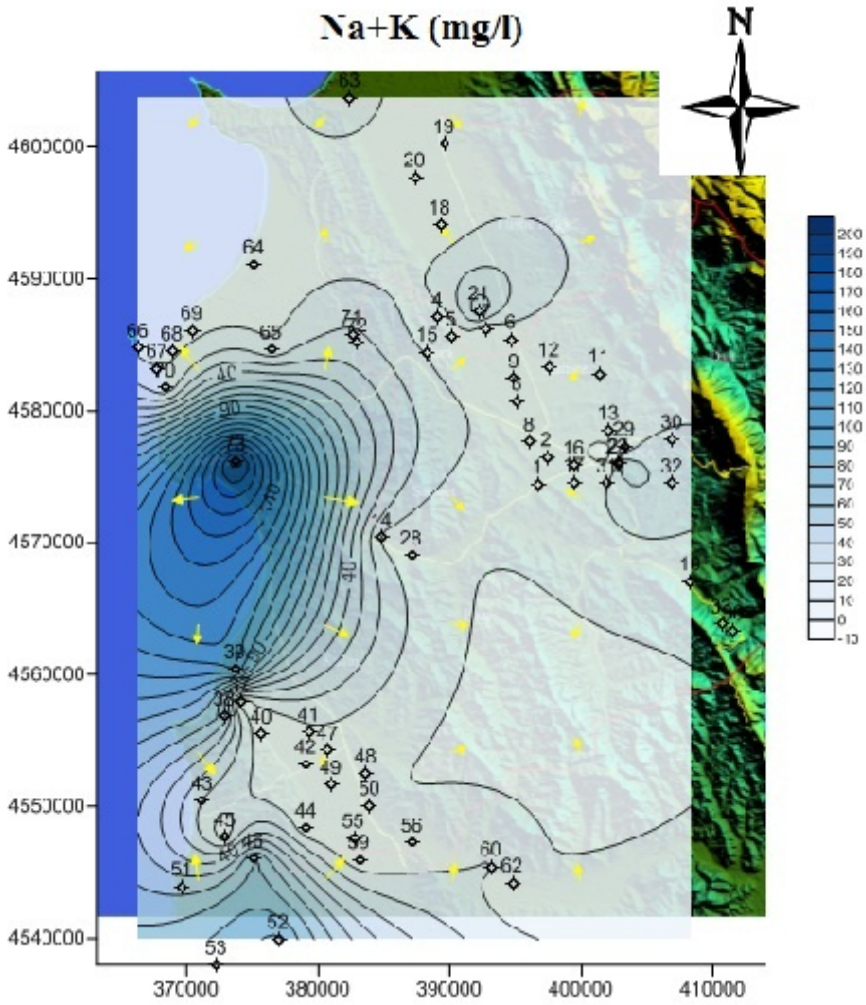
Results

Wells - The most problematic chemical parameters are plotted individually for both time series for the Tirana-Durres Region in Figures 4-10. The guideline properties for drinkable water are based to EPA (USA Environmental Protection Agency), WHO (World Health Organization), European and Albanian Standards (Table 5). The concentrations of the high concentration hydro-chemical property for the 2010 samplings are plotted together with the permitted values indicated from EPA and WHO and are shown in Figures 1-3.

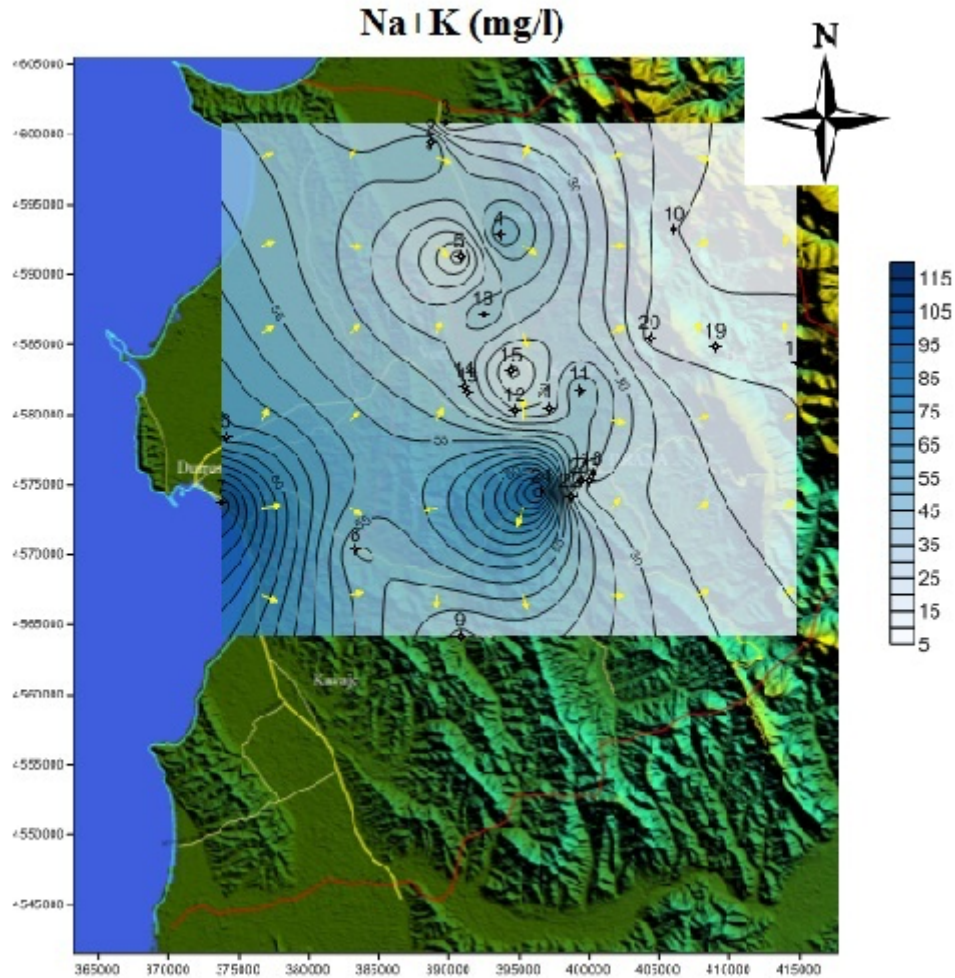


a) b)

Figure 1 Distribution Maps of Cl- ions in the Tirana-Durres Region for the period a) 1982-2001 b) 2010

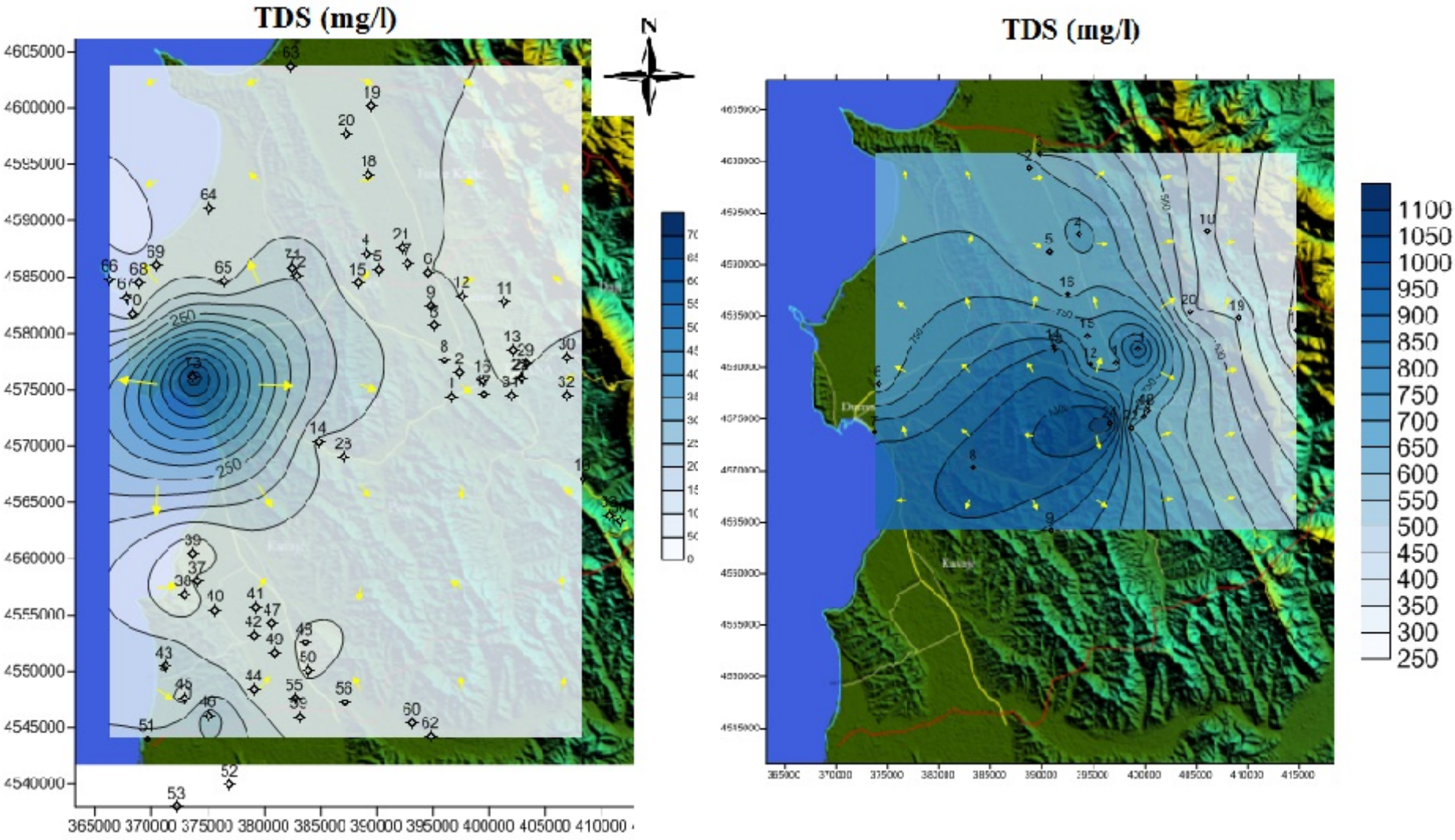


a)



b)

Figure 2 Distribution Maps of Na+K ions in the Tirana-Durres Region for the period a) K 2010 b) Na 2010 c) Na+K 1982-2001



a) b)

Figure 3 Distribution Maps of TDS in the Tirana-Durres Region for the period a) 1982-2001 b) 2010

a) *Fe Concentration* - The maximum concentration of iron is registered in the well No.7 near Adriatic shoreline in Durres city. This value exceeds the recommended value of iron concentration according to EPA and WHO standards (0.3 mg/l). Iron is not hazardous to health, but it is considered a secondary or aesthetic contaminant. Higher ferrous iron gives water a disagreeable metallic taste.

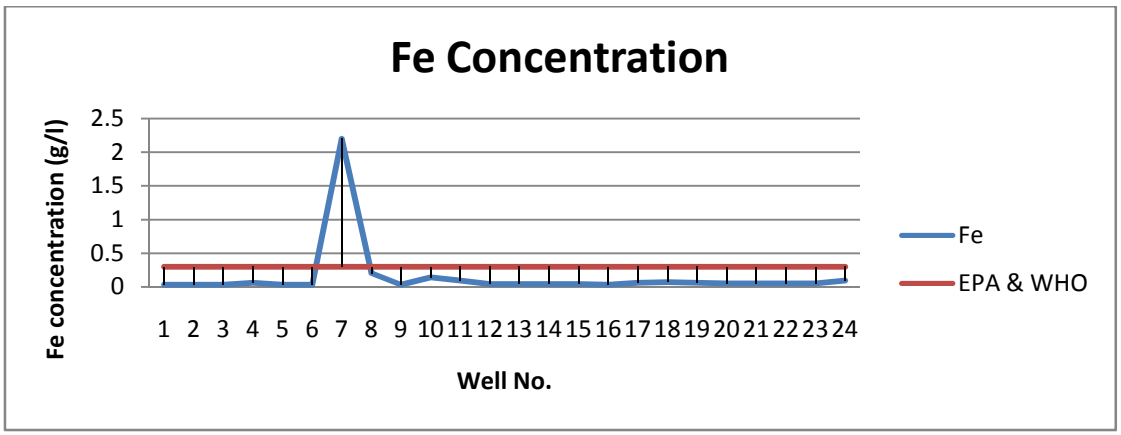


Figure4 **Iron Concentration in water samples (well 2010 – Tirana Durres region)**

b) *TDS Concentration* - Generally the concentrations of TDS are of high values and the maximum value is registered in well No. 24 as 1089.28 mg/l. Most of the wells exceed the recommended value from WHO (600 mg/l) but are below the maximum allowable value (1200 mg/l) stated by STASHR (Albanian Standards for Drinkable Water). High TDS, greater than 1000 mg/L, is commonly objectionable or offensive to taste.

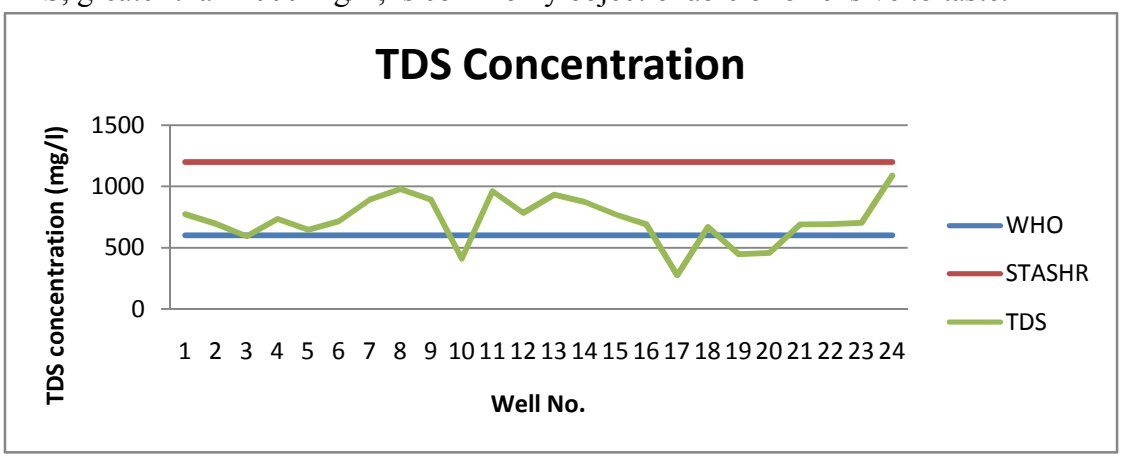


Figure 5 **TDS Concentration in water samples (well 2010 – Tirana Durres region)**

c) *Nitrite Concentration* - There are only two wells that exceed the maximum values for the nitrite concentration recommended from STASHR (0.05 mg/l), EPA and European Standards (0.1 mg/l). The maximum value is registered in No.1 and 11 (both wells are in Kamza city) as 0.4 mg/l. The primary health hazard from drinking water with nitrate-nitrogen occurs when nitrate is transformed to nitrite in the digestive system. The nitrite

oxidizes iron in the hemoglobin of the red blood cells to form methemoglobin, which lacks the oxygen-carrying ability of hemoglobin. This creates the condition known as methemoglobinemia (sometimes referred to as "blue baby syndrome"), in which blood lacks the ability to carry sufficient oxygen to the individual body cells causing the veins and skin to appear blue.

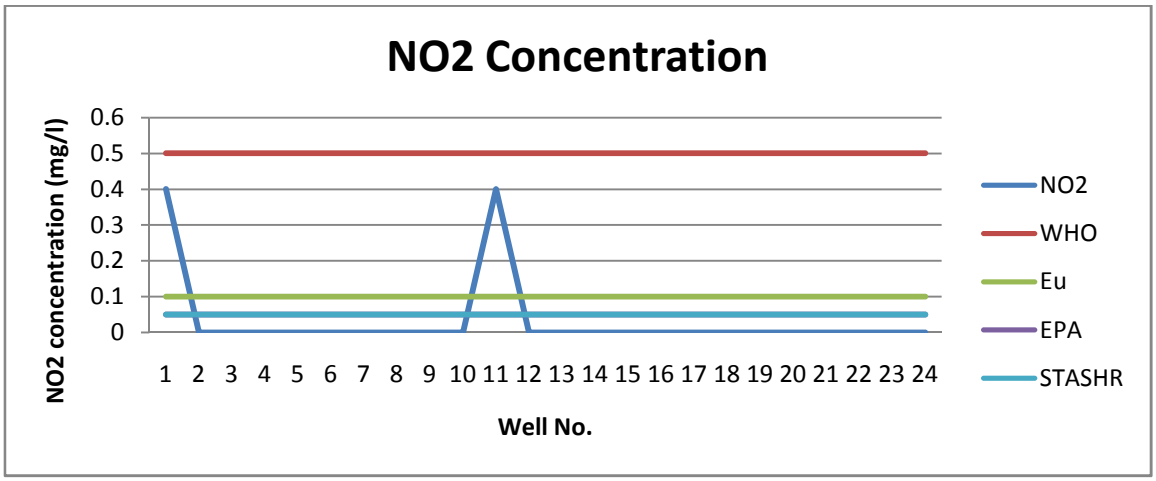


Figure 1 *NO2 Concentration in water samples (well 2010 – Tirana Durres region)*

Rivers - The river parameters are analyzed based on the recommendation of European Union Standards for Albania. The chemical parameters for every station are plotted together and compared with the guideline valued from the European Union.

Dissolved Oxygen- In the region Ishmi, Gjola and Lana Rivers are more polluted and have very low concentration of oxygen.

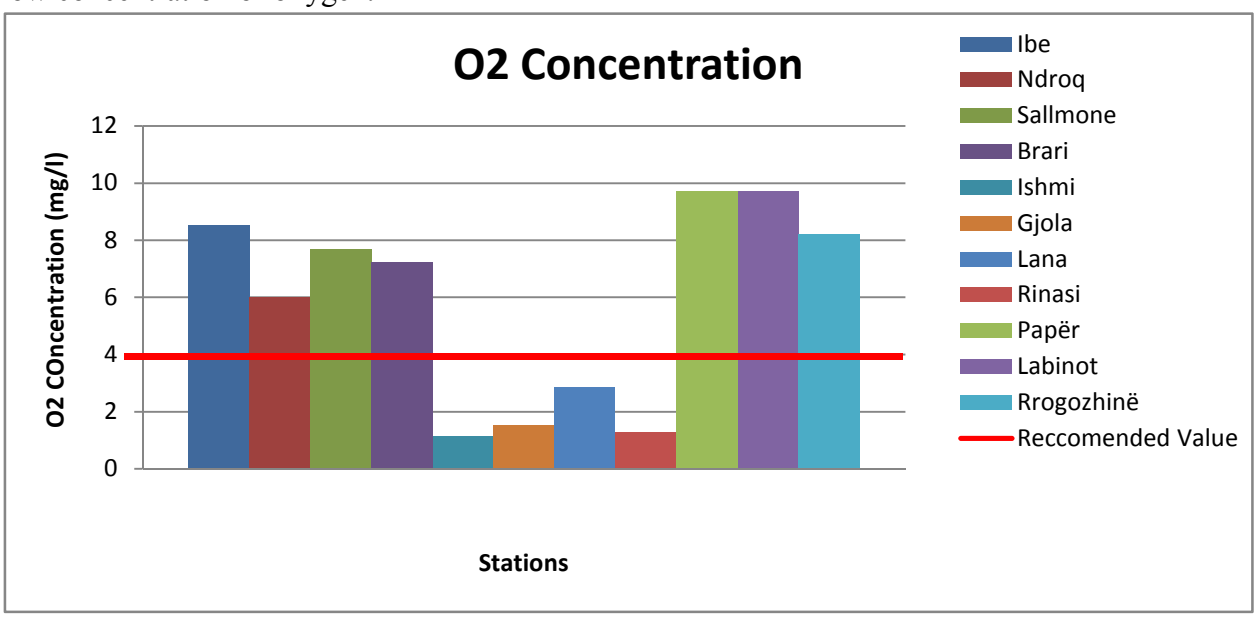


Figure 7 **Concentration of O2 at different stream station compared with the recommended value from the European Union**

Phosphorous – In high amounts Phosphorus can cause some damages to the effluent waters. The source of phosphorous is mainly the sewage waters. The maximum value is registered in Lana River.

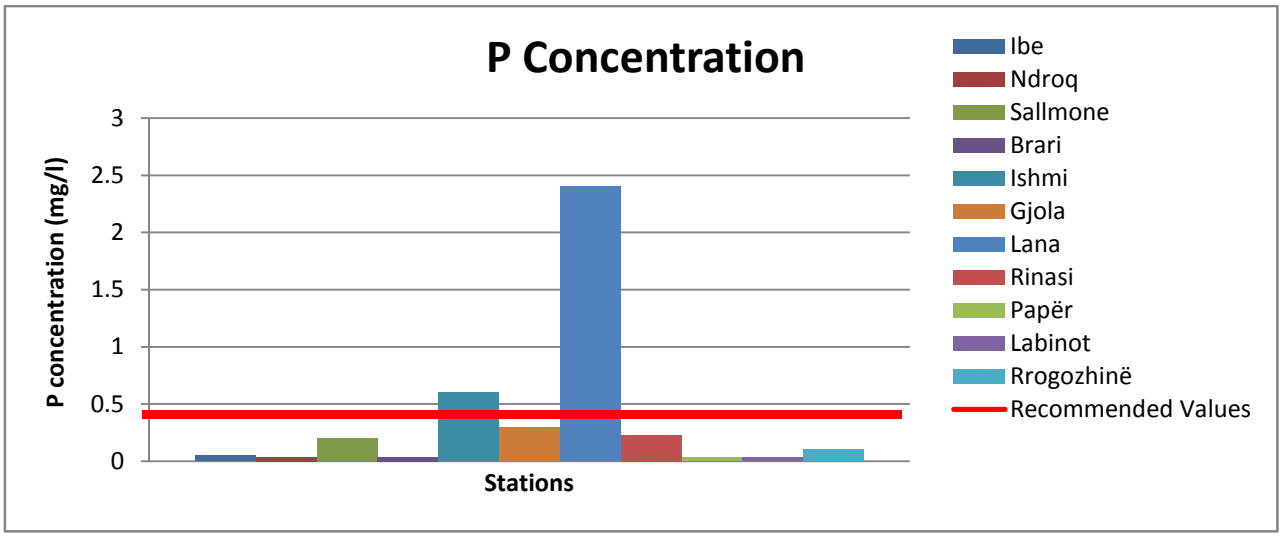


Figure 8 Concentration of P at different stream station compared with the recommended value from the European Union

Nitrates and Nitrites – the main sources of nitrates are the fertilizers or the farm waste. The most polluted rivers in the Tirana Durres Region are Ishmi River and Lana River (both part of the Ishmi river). The maximum values of NO3 and NO2 concentrations are registered in Ishmi River respectively 3.55 mg/l and 1.15 mg/l.

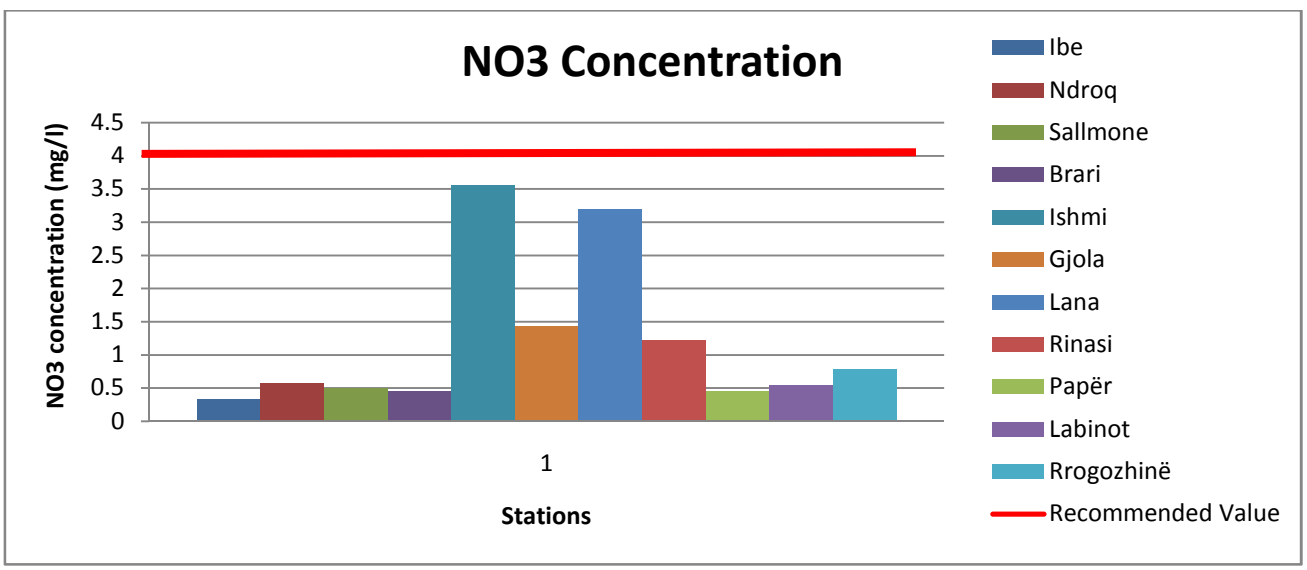


Figure 9 Concentration of NO3 at different stream station compared with the recommended value from the European Union.

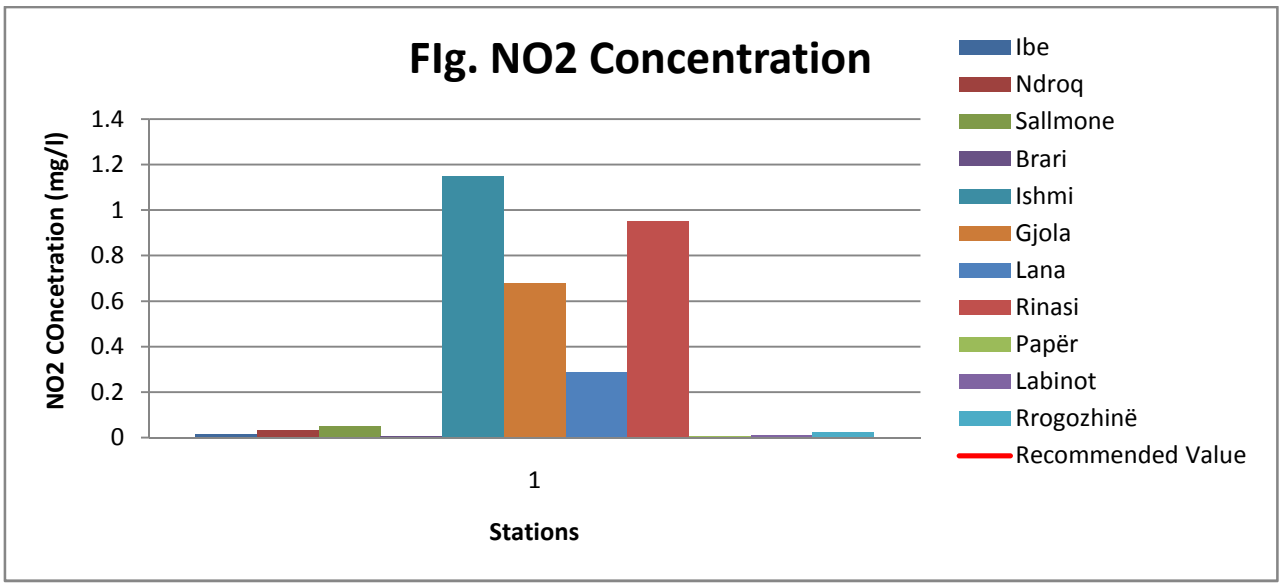


Figure 10 Concentration of NO2 at different stream station compared with the recommended value from the European Union

Biological need for oxygen NBO_5 is the amount of oxygen consumed over 5 days by aerobic bacteria in the presence of air. It represents biodegradable organic pollution. The maximum value is registered in Lana River (21 mg/l).

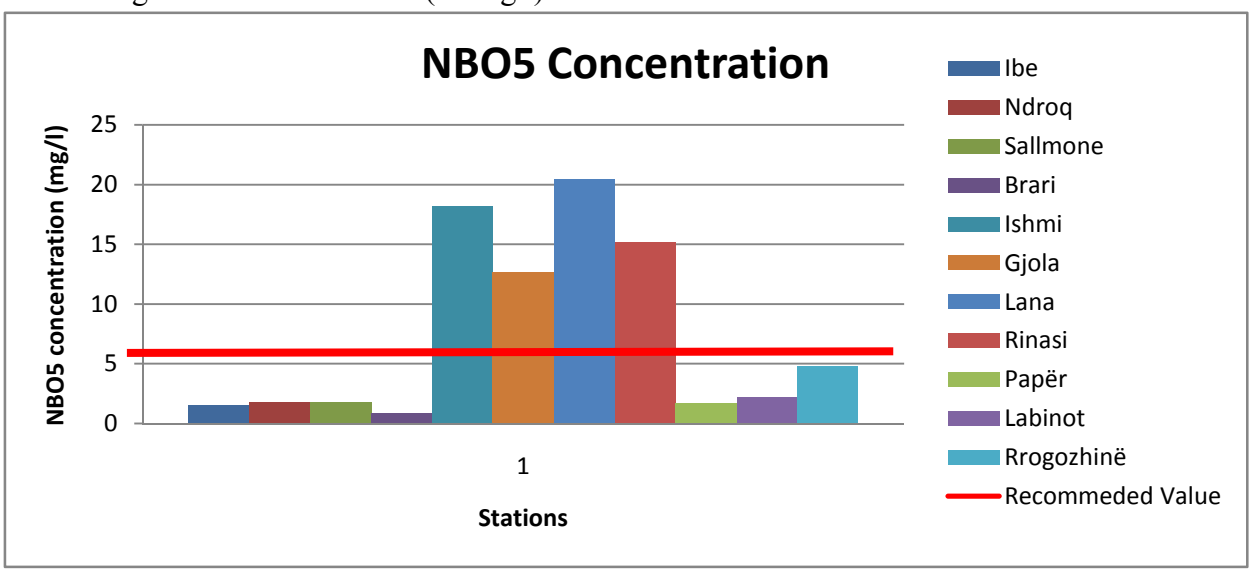


Figure 11 Concentration of NBO5 at different stream station compared with the recommended value from the European Union.

Ammonium – can be transformed (nitrified) to nitrate *is a very* important parameter to monitor the status of the fluent waters. The high concentrations of NH4 ions can indicate the poor statues of the effluent and additional treatment are required prior to discharge in the sea.

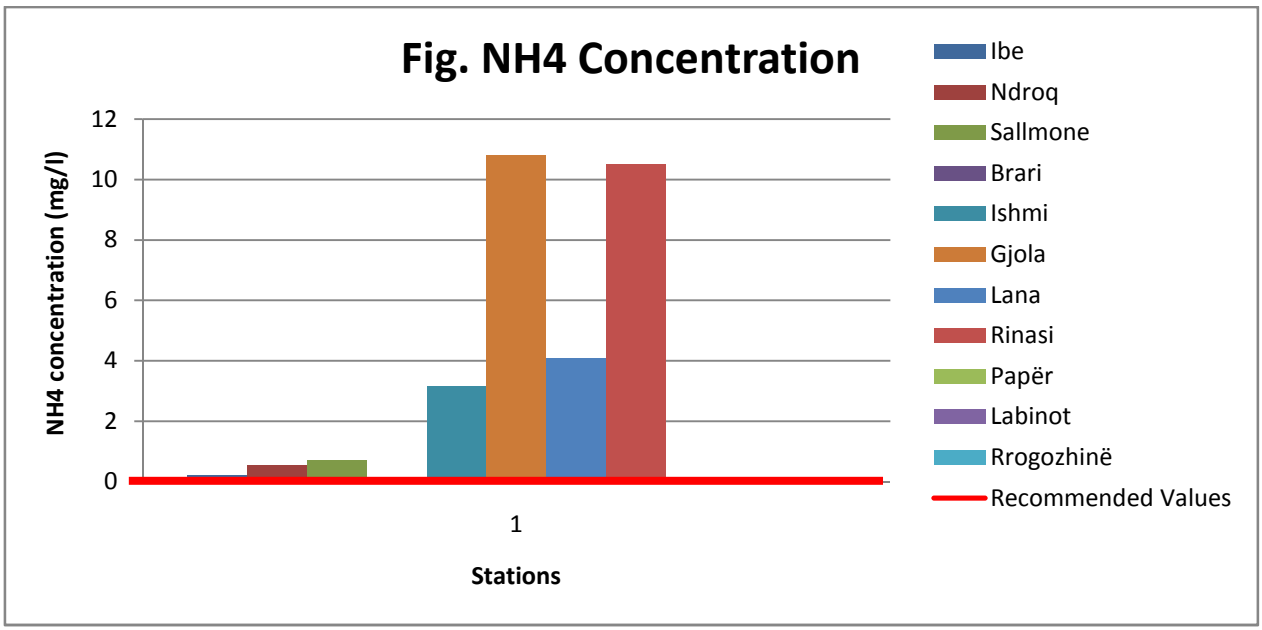


Figure 12 Concentration of NH4 at different stream station compared with the recommended value from the European Union

Discussion and Conclusion

1) Salt Water Intrusion

Salt Water intrusion occurs in freshwater coastal aquifers where the density difference between fresh water and saline water causes the sea water to intrude in the freshwater aquifer. Saline intrusion can be detected by monitoring the amount of Cl-, K+, Na+, water conductivity and TDS in the coastal aquifer. According to EPA, to asses the presence of saline intrusion the electrical conductivity should be more than 0.8mS/cm and the Cl- concentration should be more than 24 mg/l. These two values indicate a possible salt water intrusion..

The saline investigation for this case study was determined by evaluated the distribution maps of Cl, Na+K and TDS (Figure 1, 2 and 3). These maps clearly illustrate that the concentration of these parameters increases towards the coast line of Durres. The highest value for Cl- concentration is registered in Durres city (400mg/l in the period 1982-2001). Further analyzes of two time series data (Cl distribution map for the period 1982-2001 and 2010) shows that the amount of Cl- ions has increased toward the centre of the region.

The main source of this intrusion is the urbanization of the area and the high demand of freshwater. The groundwater is the primarly in Durres City for drinking, domestical and irrigation purpose. The fresh water is withdrawn at a faster rate than it can be replenished.

Another reason of saline intrusion is the poor management of the river sediments that are discharged in Durres city. Erzeni and Ishmi River's sediment are highly exploited for construction materials. Through past ten years, due to this situation, the sea line has progressed towards the land, and most possibly intruded to the ground water resources.

Immediate measurements should be taken to control and improve the current situation. A recommended solution is to build injection wells. These injection wells should be placed strategically such that the injected freshwater can produce barriers to prevent further intrusion of the salt water.

2) Surface Flow Contamination

The most polluted river observed is the Ishmi River. The main arteries of this river: Gjola, Lana and Ishmi posses very high concentration of pollutants which exceeds the standards values recommended from Foreign Agencies and from the Ministry of Environment in Albania (Fig.7-12). Urban sewage water and other disposal affect directly the quality of these rivers. The soils in Tirana-Durres region are permeable and the coefficient of infiltration is moderately high. Therefore the risk of groundwater contamination is very high. Immediate action should be taken in order to improve the quality of these waters and to prevent the contamination of the freshwaters.

3) Tirana-Durres Aquifer Contamination

The groundwater resources of this region generally have good chemical properties; they don't have odor, taste and color and the temperature of the water ranges from 15.5-17.5^0 C.
They are used for drinkable water supply for Tirana and other vicinities. There are very small concentrations of NH4 and the concentration of NO3 is below the maximum permitted values (50mg/l). Probably, these concentrations come from the agricultural use of the chemicals in the north fields of Tirana. The NO2 concentration has been found only in Kamza region exceeding the recommended values (Fig. 6). The mapping is impossible since there are only two points data. There are no chemical analyses for the well in the Sharra region where the city damp site is located. Further research and investigations should be performed to evaluate the amount of NO2 in the groundwater resources and the possible contamination from the polluted rivers.

Iron concentration exceeds the recommended values in Durres region (Fig.4) and has the maximum values of 2.2 mg/l in Porto-Romano Durres. Port-Romano is well known from past environmental hazards due to the chemical fabric located near the sea side. Possible radioactive substances may contaminate the aquifer. The concentration of iron in the groundwater doesn't cause health problems, however hard metal analyses should be performed for Porto-Romano area to determine the risk of radioactive contamination.

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