Heavy metal contamination in drainage system of Konya city in Turkey[#]

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Abstract

Wastewater of the discharge channel was also used for irrigation of the agricultural area near the channel during the spring period. Chemical composition of the irrigation water is very important because the source of irrigation is untreated wastewater. The concentrations of 8 heavy metal elements in three sampling points, between Konya municipality and Tuz Lake, on the Konya main discharge channel were investigated for 6 months period that results displayed significant enrichments in Zn, Cu, Mn, Cr, Ni, Pb, Co and Cd. The major factors determining the quality of irrigation water are its salt content (salinity); its salt composition (sodality); its sediment load; and type and amount of toxic constituents. The aim of the study was to undertake the quality parameters of main drainage channels, including sewage effluent and their effects on soil contamination for Konya province of Turkey. For this purpose, water samples were taken from irrigation areas and analysed for determining the level of contaminants. According to the results, crop patterns might be affected from poor quality irrigation water. Zn, Cu, Mn, Cr, Ni, Pb, Co and Cd are 0.582, 0.035, 0.086, 0.042, 0.026, 0.027, 0.019 and 0.013 mg/L respectively.

Keywords: Water quality, Heavy metal, irrigation, drainage, channels, Konya.

Introduction

In the present time, increasing human being wastes from several activities cause important environmental problems. Effect of pollutants has realistic relation with remaining period in the environment. Pollutant levels are increasing with increasing concentration and decomposing period. Konya city is located in the middle of Anotolia where the grain production is the richest as far as Turkey is concerned. Konya Main Discharge Channel transfers polluted water originated from domestic wastewater and industrial region wastewater of Konya City. Flow rate of the discharge channel is about 1200 L/s and wastewater is carried about 150 km distance to Tuz Lake during winter period. During summer period, most of the wastewater is used for irrigation of cropland in 30-50 km distance. Discharge Channel dries after 50 km. Pollutant parameters in the main discharge

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channel are detergent, nitrogen, phosphorus, oil and grease, organic matter, sulphur, nitrate, fluorine, mercury, lead, zinc, iron, cadmium, arsenic, boron. Farming places were affected with these components by irrigation (Ayhan *et al*., 1993). The pollution of aquatic ecosystems by heavy metals has assumed serious proportions due to their toxicity and accumulative behaviour (Milenkovic *et al*., 2005).

Heavy metal pollution produced from industrial, farming and domestic activities bring out serious problem for safe rational utilization of the agricultural land (Fytianos *et al*., 2001, Adamiec & Helios-Rybicka 2002). Trace elements are main essential nutrition for the growth of plants. Tree leaves contain trace element as well as tree roots. Certainly, trace elements necessary for the plant growth, but high concentration accumulation in the plant development can pollute the environment. Accumulation in the main food plant and consumption of these products may cause serious risks for human health (Wenzel & Jackwer 1999, Qian *et al*., 1996).

Konya Main Discharge Channel water is mainly domestic origin. Precipitation water increases in the autumn and spring and a small amount of wastewater comes from industrial region of Konya. Various chlorinated organic compounds were also found in discharge channel water comes from disinfectant compounds of drinking water (Sarıkaya *et al*., 1998). Several fertilizers, agricultural medicine and many harmful compounds were used for farming in the basin of Tuz Lake. Research of Ayhan *et al.,* (1993) on bacteriologic investigation and pesticide analyses has supported this hypothesis.

Sarıkaya *et al*. (1998) were investigated evaluation of the irrational reuse option of the effluents of Konya city. They suggested that some water born diseases may be appearing in the area near the fields irrigated by the untreated and undisinfected effluents. Most of the parameters of untreated water were in the high levels for the direct weathering. Dursun *et al*. (2001) were studied on removal of nitrogenous compounds of Konya Discharge Channel water by nitrification-denitrification method in same system. Nature of the working place requires to be taken in natural protection area and discharge standards should be brought for discharge channel (Ozdemir & Dursun 2002).

The concentrations of As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni and Zn were determined in the sediments by Milenkovic *et al*. (2005). The lowest heavy metal concentrations were measured around river-km 854, downstream from the gorge. The data from this study were compared with data obtained 20 years ago in the same area. It was found that the range of mean concentrations over the entire gorge of Fe, Mn, Ni, Zn, Cu, Cr and Cd increased by 46.6% (Zn at the site Tekija) to 156.2% (Ni at the site Veliko Gradiste). Kowalkowski *et al*. (2002) description of some sorption and migration phenomena involving Pb, Zn, Ni and Cu in the surface layer of soil and sewage sludge compost was the primary objective of work. We have studied on a stream about 80 km long and Zn, Cu, Mn, Cr, Ni, Pb, Co ,Cd metals were investigated.

A study of Mcgrath *et al*. (1988) showed that increase of the metal concentrations in the agricultural soils originated from the irrigation with wastewater which soil was irrigated with polluted water or unpolluted water. Machelett *et al*. (1990) investigated an arable field irrigated with the swage water for nine years that concentrations of Cd, Cu, Ni, Pb and Zn increased in the soil and there was a significant positive correlation between heavy metal content of soil and plant.

The aim of this investigation was measurement of pollution levels of wastewater samples collected from several points on Konya Main Discharge Channel and its effect on pollution of Tuz Lake. We have also estimated effect of levels on crop production for the working area irrigated by untreated wastewater.

Material and Methods

Study area:

Konya has been located in the middle of Anatolia and surrounded by mountains. The city of Konya is located between 36.5-39.5-north latitude and 31.5-34.5 east longitudes. Industry in Konya is not very heavy. There were 993 industrial establishments. The large factories in the city centre produce brick, paper, oil, cement, and sugar. Due to industrial establishments, most of the source of air pollution is rural heating (Anonymous, 2000). So that, the winter months were selected for sampling period in this investigation. There is a great development in Konya city in last decades. Environmental pollution increases parallel with the population and industry with this development. Study area, where is the east part of Konya city. Konya Main Discharge Channel reaches to Tuz Lake along 150 km distance and affects about 300-km^2 areas. Konya city is approximately 1100 meters above sea level and has a semi-arid climate hot and dry in summer, cold and snowy in winter.

Although Konya city, Aksaray city and Şereflikoçhisar town wastewaters are main influents to Tuz lake, Konya is much more important than others. Area is a closed basin that summer evaporation is only water loss from the Lake (Dursun & Afsin 1996). Precipitation and polluted water in the region comes from settlement places, industrial region of Konya by swage system and connects with Keçeli stream. Konya sewage system brings also overflow water of region. There are three-promotion stations on the Konya Main Discharge system. First station is about 15 km far away from the city centre and water was elevated 5 m at each pump station. Channel can also take overflow of Beyşehir lake in winter period and total channel length extends about 350 km. Working region is quite flat until Tuz lake except for Tutup hill area that there is a tunnel for channel. Average flow rate of the discharge channel is about 25 m^3/s.

Water sampling and chemical analysis:

Three sampling point were selected on the Konya main discharge cannel which are 1st, 2nd and 3rd elevation pump station on the channel. Samples were taken in 1 L dark glass bottle with addition of 2 ml concentrate HNO_3. Chemical analyses of water samples were performed on the simultaneous ICP-AES (Vista series ICP-AES spectrometer) after filtrated with Whatman Glass Micro-fibre filter (GF/C) (APHA, 1989).

Results

Analysis of heavy metal pollution in the wastewater was performed during the months of January to June because of agricultural irrigation with the water of Konya main discharge channel was the period of May to June months.

According to the results of heavy metal analysis, chromium concentration was in the highest value in June, concentrations are in order of 1st, 2nd and 3rd pumps 0.0421, 0.0334 and 0.0405 mg/L respectively (Figure 4). The concentration of manganese was the highest value in March as 0.01817 mg/L at the 3rd pump, and values of other sampling points were 0.0867 mg/L for 1st pump and 0.0813 mg/L for the 3rd pump (Figure 3). Cooper ion concentration was at maximum at 3rd pump in May as 0.0346 mg/L and 0.0251 mg/L at 2nd pump (Figure 2). Similarly, zinc concentrations were also the highest values in May for sampling points of 1st and 2nd pump stations but at the 3rd pump in June (Figure 1).

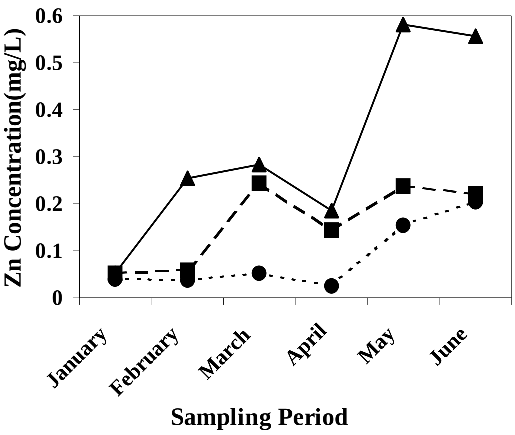

Fig. 1 - Zn concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

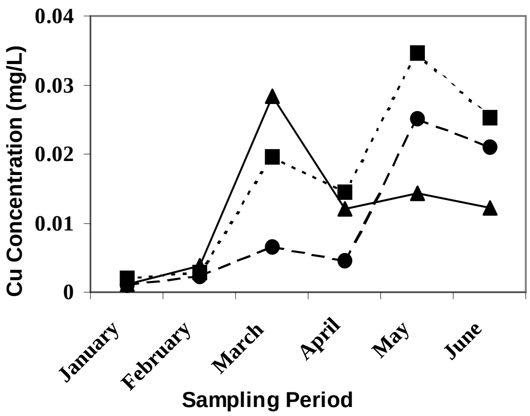

Fig. 2 - Cu concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

Nickel concentrations were the highest values in June for three sampling point 0.025, 0.0248 and 0.0264 mg/L respectively (Figure 5). There was not any detectable lead concentration in

January, February and March samples, but concentrations were ascended 0.0269 mg/L at 2nd pump station in June which is the high irrigation period for the agricultural places(Figure 6). Similarly, cobalt concentration reached to measurable levels in May and increased maximum levels in June for three sampling points (Figure 7). Mostly Cadmium concentrations are in very low levels and maximum concentration was 0.0131 mg/L at the sampling point of 2nd pump station in June (Figure 8).

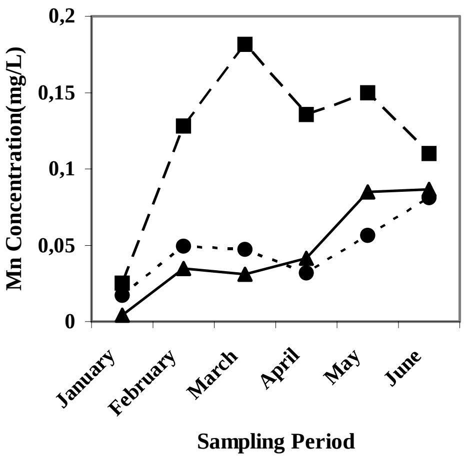

Fig. 3– Mn concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

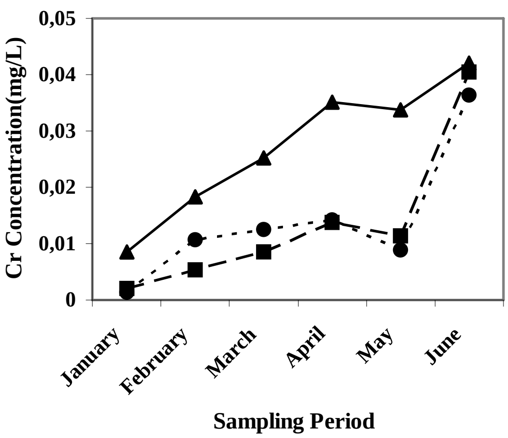

Fig. 4 – Cr concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

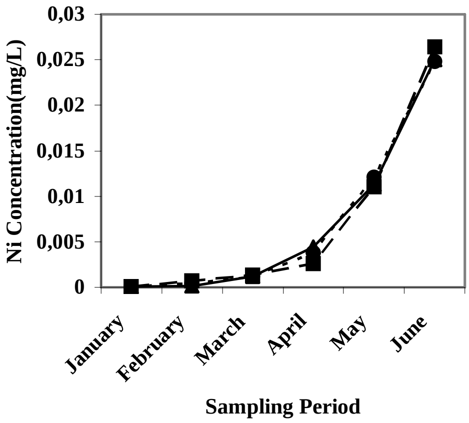

Fig. 5 – Ni concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

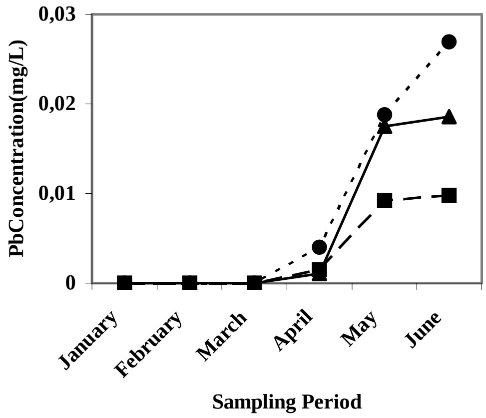

Fig. 6 – Pb concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

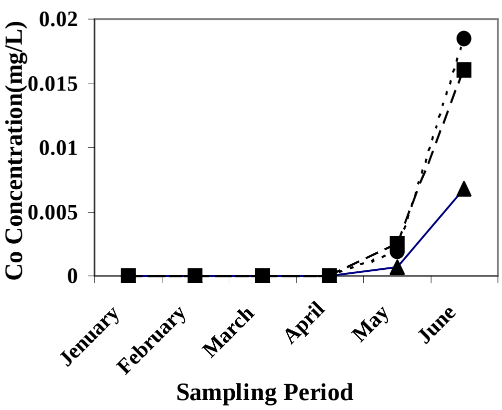

Fig. 7 – Co concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

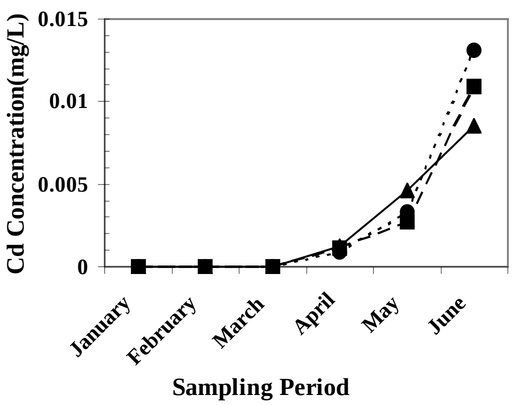

Fig. 8 - Cd concentration change at sampling point during January and June, 2003(▲ 1. Pump, ● 2. Pump, ■ 3. Pump)

Discussion and Conclusion

According to the results of heavy metals measurements in the sewerage system showed that all of the measured concentrations were lower than 1 mg/L. These values are not in risk levels for the wastewater; the concentrations of heavy metals are critical levels for the agricultural area. It is possible to accumulating heavy metals in the soil and in the agricultural yield.

There is an investigation on heavy metal accumulation at soil and plant due to irrigation with the wastewater (Truby & Raba 1990). This investigation showed that heavy metal absorption as like Zn, Pb and Cd was increased in the soil irrigated with the sewerage water of Freiburg (Germany) and heavy metal accumulation was also risen in the garden plant of lettuce, cabbage, spinach, carrot, potato, onion, beans, cucumber and tomato. Similar work by Mcgrath *et al*., (1988) comparison between the two types of soil treatment with and without sewerage water also show that increase of heavy metals in the soil was appeared from the wastewater application. A study of Machelett et. al., (1990) application of sewerage water on the agricultural soil for nine years put forward that Cd, Cu, Ni, Pb, and Zn contents of soil were increased and there was linear increase of correlation of heavy metal contents of plants and soil.

In our investigation, the wastewater used for irrigation may not have high heavy metals as its contents but it could increase heavy metal concentrations in the soil during irrigation for a long time period. If the problem is not considered as important as it is, accumulation will be more harmful. Agricultural soil chemistry might be changed due to heavy metal accumulation and also crops that produced in heavily polluted agricultural area may have toxic effect on the human health. Heavy metal concentrations in the wastewater would increase by increasing population and industrial developments in the region. Wastewater might be adequate for irrigation after treatment.

The large agricultural fields are irrigated by the untreated industrial and domestic wastewater of sewage in Turkey. This type of irrigation with polluted water causes low quality of agricultural products and reduction of soil productivity. On the other hand, increase of the heavy metal concentration in soil as high as toxic level irrigated with polluted water may be reach to human and animal food as like affect to plant growth and quality. Higher concentration of heavy metal ions in soil effects the physiological function of plant and also effect to function of enzymes, vitamins and anther biological compound and givers some problems with production of different compounds and synthesis of unwanted nutrient. (Luo & Rimmer 1995). Our investigation showed that same heavy metals are present in the discharged wastewater of Konya city that used for irrigation and this might be increased heavy metal concentration in soil and its product in this area. Furthermore, some people might be effected people and animals using these products.

Soil systems have higher buffer capacity than water and air systems against the external factors. However solve the problems of corruption effect by the addition of the pollutants to the soil system may be very important and compensation of the effects are difficult and expensive. (Topbaş et. al., 1998). Around Konya main discharge channel, most of the people were using wastewater of discharge cannel and productivity of soil around this area was decreased and it is not possible production without using higher value of fertiliser. It is possible to see in short time that farmer would not use this field in the future.

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