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Migration, Dispersion and Distribution Pattern of Chloride and Sulphate in Groundwaters of Karachi (Pakistan)

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Abstract: Migration, dispersion and distribution pattern of sulphate and chloride concentration were studied in groundwater of Karachi from 24 monitoring water wells during the pre and post-monsoon period 2008. The data were mapped, analyzed and compared with Surface mapping system (Surfer 6.01). Concentration cluster for both solute were highest in post-monsoon as compare to pre-monsoon in the study area. In pre monsoon 45 mg/l median sulfate level below the secondary standard of 250 mg /l and 727.5 registered median chloride concentration above 250 mg / l. whereas inverse phenomena were observed during the post monsoon having median 745.5 and 114 for chloride and sulfate, concentration ranged from 85 to 1861 mg / l for sulfate and from 0 to 350 for chloride above the WHO standard of 250 mg /l. Various factors contribute to high sulfate and chloride levels in Karachi aquifer, including mineral constituents of aquifer, seepage of saline water from nearby formation, coastal saltwater intrusion and irrigation return flow. Special variations in geochemical characteristic of ground water also appeared to be related to pollution due to effluents from near by industry. The discriminate analysis when used in conjunction with box plot, suggests that Chloride and Sulphate are not distributed homogeneously in the study area.

Key words: Groundwater · Sulfate · Chloride · Karachi · Surface mapping system · Spatial distribution

INTRODUCTION

In many parts of the world, particularly in developing countries, alternatives supplies are not sufficient for whole urban population. This is true in many parts of Pakistan and in particular in case of Karachi, whereas the majority of the population are served by supplies from out side the city, The substantial population have no option, but to use shallow wells as their only source of water.

Over the last few decades deterioration of both the quality and quantity has become a global phenomenon which will further intensify the demand for drinking water increase [1]. In recent year attention on the increasing ionic concentration of the major ions, spatiallychloride and sulfate in ground water as a result of industrial effluent and natural occurring solute has been studied by various workers [2].

Chloride and sulfate are major inorganic constituents of groundwater [3] that, in high concentration, can make groundwater unfit for potable, industrial and agricultural uses.

Sulfate is present in several minerals, but is more prevalent in evaporates such as sulfate anhydrite. It is also abundant in sedimentary rocks that contain saline water trapped during deposition. The anthropogenic source of sulfate includes agriculture product such as animal manure, fertilizer and irrigation return fellow, house hold sewage, land fill leachate and industrial effluent and pumping induce salt water intrusion [4, 5].

Generally, sulfate is considered beneficial in irrigation water, especially in presence of calcium [6]. However, high concentration of sulfate with calcium forms a hard scale in steam boilers.

Sulfate is unstable if it exceeds the maximum allowable limit of 400 mg/l and causes a laxative effect on human system in ground water [7].

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Higher sulfate concentration results from the thin Gypsi-ferrous layers within the Pliocene aged deposits.

The secondary MCL (Maximum concentration limits) for chloride of 250 mg/l have been established for chloride [8]. Chloride is present in several minerals, but almost ubiquitous in sedimentary rock that contains saline sea water trapped during deposition. Higher levels of chloride are related to the use or presence of large amounts of evaporative minerals [2].

Anthropogenic source of Chloride include animals waste, crop fertilizers or industrial effluent and irrigation return fellow, sewage systems, land fill leachate and pumping induce salt water intrusion [4, 5]. Usually, the concentration of salinity from land fills, septic and sewer systems and agriculture stock operation does not increase chloride in ground water above a few hundreds mg/ l [9].

Chloride concentration above 150 mg /l is toxic to crops and generally unsuitable for irrigation [6].

Pre monsoon

Post monsoon

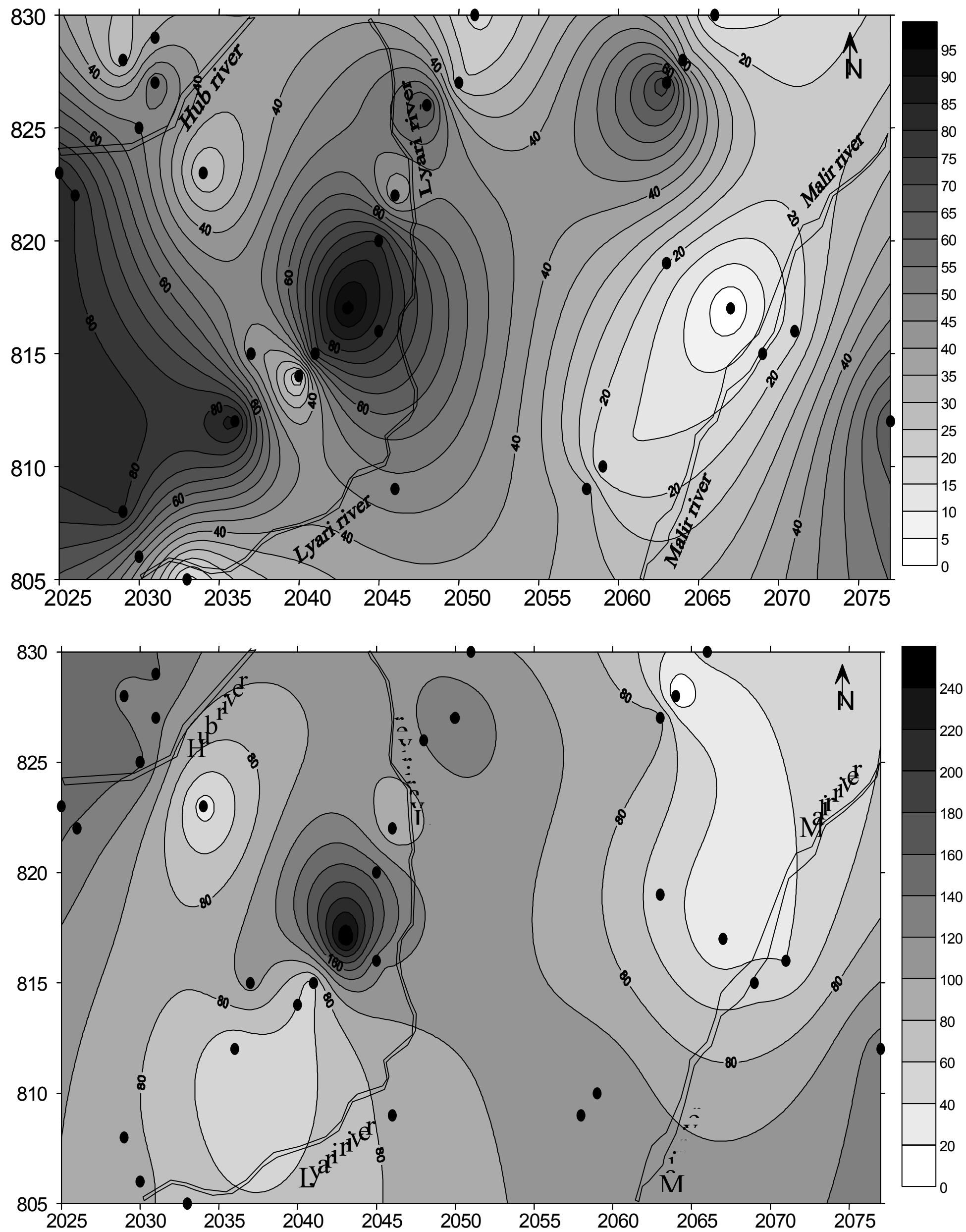
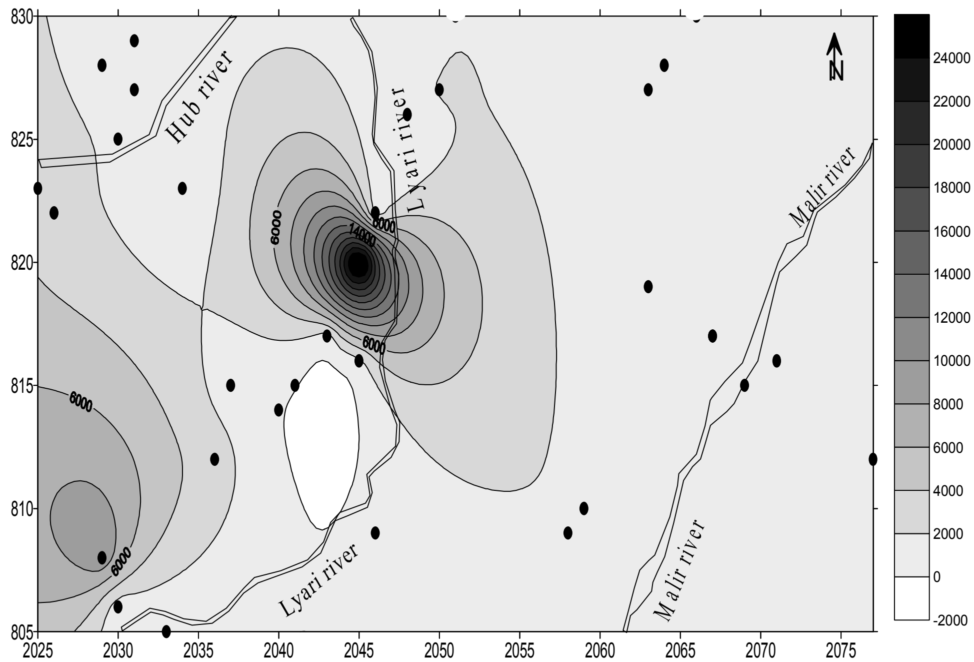
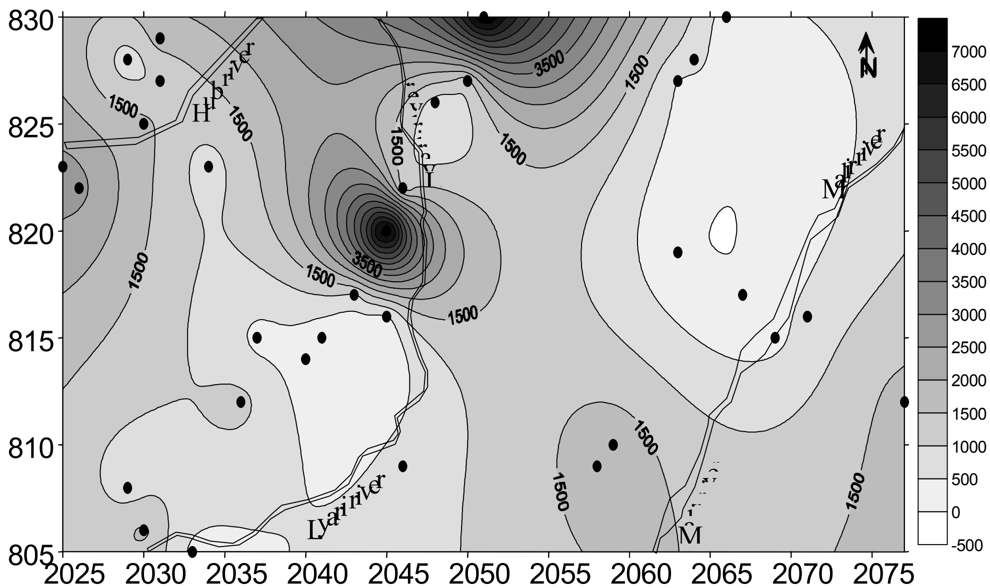


Fig. 1: Distribution of sulfate in groundwater of Karachi during 2008



Pre monsoon



Post monsoon

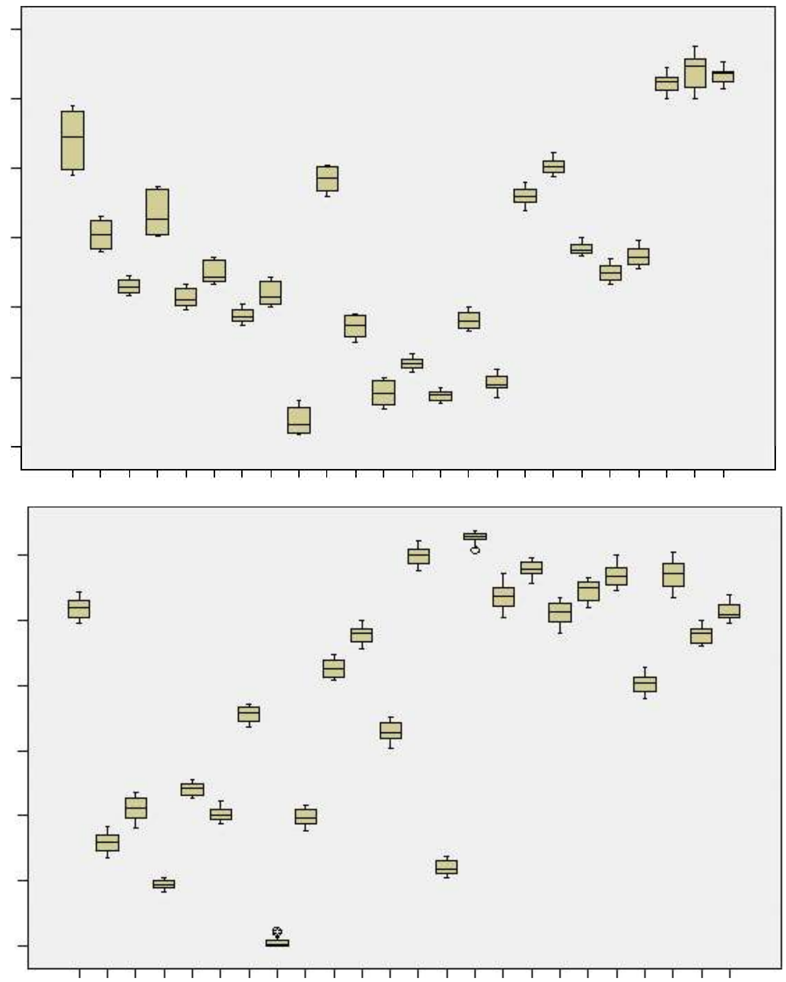
Fig. 2: Distribution of chloride in groundwater of Karachi during 2008

High chloride concentration also corrodes pipes. Water containing more then 350 g / l chloride.

The purpose of this study was to evaluate regional trends in the chloride and sulfate content of Karachi groundwater and to identify potent ional causes of spatial variability among these ions, with special reference to two rainy seasons (Pre and post monsoon season, 2008).

MATERIALS AND METHODS

In all 48 groundwater samples from 24 monitoring wells were sampled during year, 2008 pre and post monsoon as part of a regional hydro-geochemical study. These samples were collected in such a manner that it does not deteriorate or get contaminated with any other substances. It was sampled from the wells only when



Pre monsoon

Post monsoon

Fig. 3: Box plots of Sulphate ion concentration

the well was pumped sufficiently long enough to ensure that pH, temperature and specific conductivity stabilize and samples represent the groundwater of the study area. All the sampling points are close to the basin and toward the hydraulically down gradient end, as determined from groundwater gradient and topographic maps, in an attempt to increase the probability that the groundwater samples would be representative of the seasonal effect. Standard methods for the examination of water and waste water from the USEPA were used for determination of chloride and sulfate.

Graphics program such as SURFER is used to prepare contour maps. The concentrations of chloride and sulfate in ground water were plotted (pre and post monsoon) on Karachi basin maps to define migration with hydrological gradient. Contour map thus prepare indicates the areas of higher and lower concentrations.

RESULTS AND DISCUSSION

Figs. 1 and 2 illustrate a heterogeneous distribution of sulfate and chloride concentration as well as these solutes exhibit different spatial patterns. In journal, the study area having the highest levels of each solute occupies central and south east part.

Usually, the concentration of salinity from landfills, septic and sewer systems and agriculture stock operation dose not increase chloride in surface water or groundwater above a few hundred mg / l [9]. Higher levels of chloride are related to use or presence of large amounts of evaporite minerals.

CONCLUSION

Special variations in geochemical characteristic of ground water appeared to be related to pollution due to

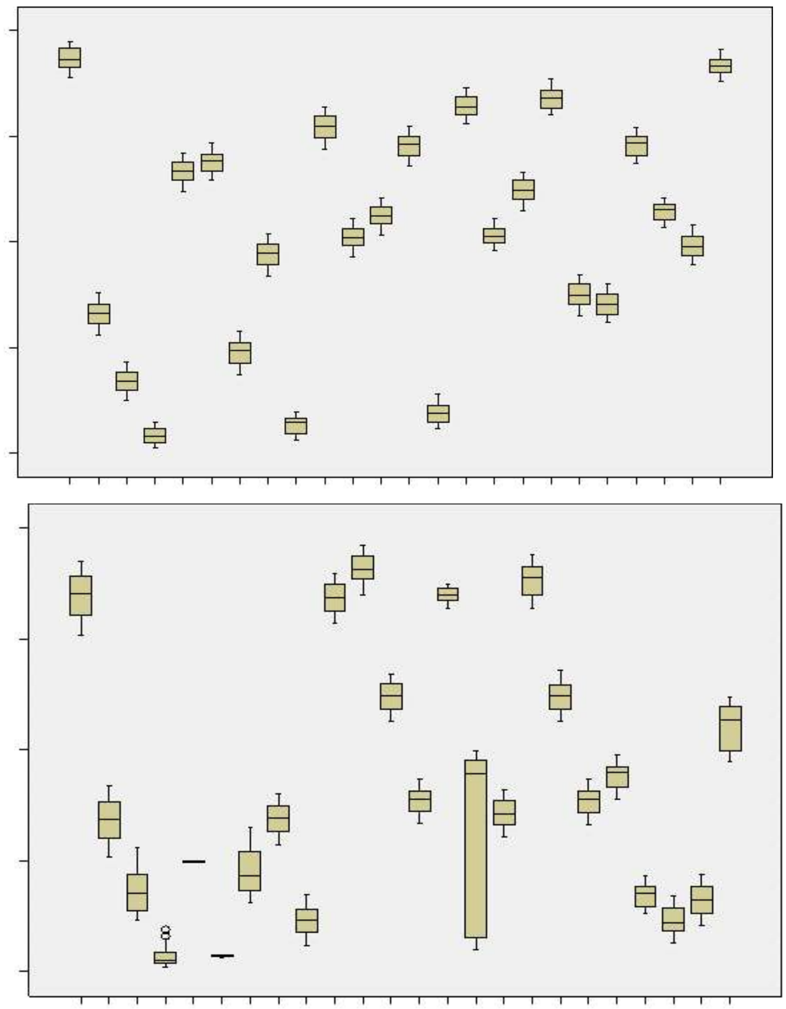


Fig. 4: Box plots of Chloride ion concentration

effluents from near by industry. The discriminate analysis results, when used in conjunction with the box plots provided statistical evidence that measure anions such as chlorides and sulphate were not homogenous distributed in the study area (Figs. 3, 4).

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