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Monitoring Surface Water Quality of Asi River During the 2006 Muslim Sacrifice Holiday

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In 2006, the last 90 km of the river (Turkish part only) is studied in terms of water quality during the Sacrifice Holiday that was observed on January 10–14. With respect to time, trace metal concentrations, in general, were found to decline but an increase in metal flux due to rise in river flow occurred.

Key Words: Asi River, Muslim sacrifice holiday, Tracer study, Trace metals.

INTRODUCTION

Asi river basin is situated in Lebanon, Syria and Turkey. As a main river system in the Middle East, the river is extensively used for irrigation and water supply for some residential areas in the region. Kassem *et al.*[1] noted that soil that has been irrigated with sewage including river water of Asi (Orontes) river is contaminated with trace elements. More than one million residents inhabiting Asi river basin discharge their untreated wastewater into the river. There is an ongoing sewer treatment project aiming at domestic wastewater treatment of Antakya and 9 municipalities around it. Furthermore, several industries use this river to obtain their water and to release their wastewaters. It is well known that both Syrian and Turkish parts of Asi (Orontes) river basin are extensively used for agrarian production. Soil was found to be rich in dolomite and iron resources in Antakya and Samandag, where the 2nd and 3rd sampling stations were established. Approximately 60% of the land area closely surrounding the Turkish part of the river is classified as agricultural land and rural people (*ca.* 280,000) exceed urban inhabitants (*ca.* 180,000). More than 49,000 cows, goat and sheep are fed in the same region.

It is a conservative estimate that *ca.* 10,000 animals were sacrificed in this region (Antakya) during the 2006 Muslim Sacrifice Holiday. Despite diffuse, some animal blood and contaminants associated with animal waste, such as rumen ingredients, reached the river. In some rural areas, the principal author observed animal heads,

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rumens and legs left carelessly and unconsciously on bridge legs. Therefore, spiked water contamination was expected during the sacrifice holiday. This study was tailored to characterize surface water contamination in Turkish part of the Asi (Orontes) River between January 10 and 14, 2006.

EXPERIMENTAL

River surface water samples were taken daily from three different locations on the Turkish part of Asi river. There was a little rain between January 10 and 11, 2006 on the study area and water net depth was quite low. Despite the fact that rain stopped on January 12, 2006, a remarkable precipitation occurred on January 13, 2006 and this event increased water level notably on the same day and the day after. River depth increased from 6 scale to 56 unit-scale between the initiation and final sampling days at the first sampling site (Demirköprü). Samples were stored in 1/2 L dark-coloured glass bottles. The collected samples were acidified, transported to laboratory and then kept in fridges set up to 4°C until the completion of the analyses.

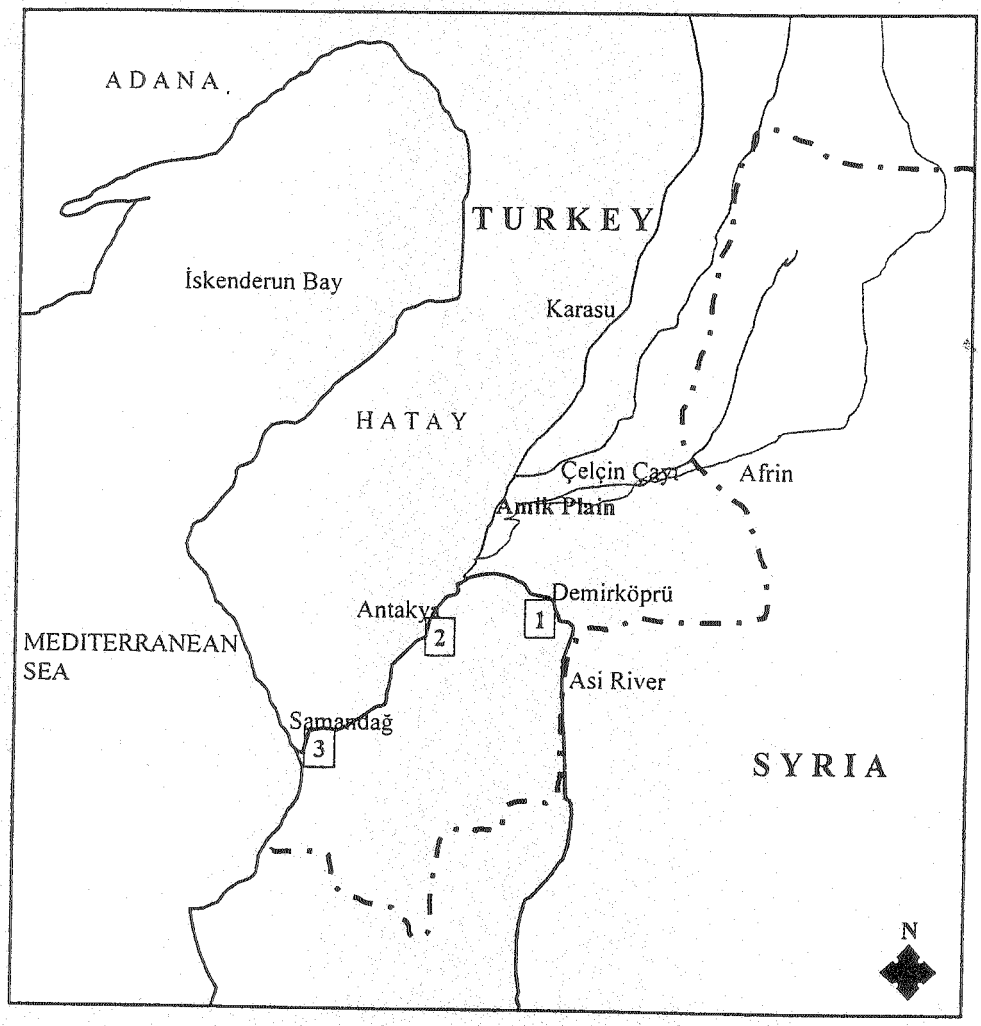

Fig. 1. Locations of sampling stations (map has no scale).

Some fundamental water quality parameters, namely electrical conductivity, CO_3^{2-}, HCO_3^-, Cl^-, NO_2^-, NO_3^- and total hardness were determined. The samples were then filtered through glass fibre filter to obtain totally dissolved fraction of

trace metals determined. Furthermore, total metal concentrations were also determined using Varian® Liberty II Series inductively coupled plasma atomic emission spectrophotometer located at Mustafa Kemal University Science Research Centre in Antakya, Hatay. Metal concentrations and loads (flux) were determined. Additionally, both acute and chronic limit values for metal concentrations were computed in the light of water hardness values.

RESULTS AND DISCUSSION

Table-1 summarizes the fundamental water quality parameters determined in the river. It should be noted that pH of water from upstream to downstream becomes more alkaline. Furthermore, electrical conductivity, sulphate, chloride decline with respect to the way water takes. Interestingly, total hardness, NO_2 and HCO_3 increase between the province centre (Antakya) and the last water monitoring station, Samandağ. The reader should be informed that the last sampling point (3) is under estuarine conditions. NO_3^- level on the first sampling site is at alarming concentration probably due to untreated wastewater discharges before this location.

TABLE-1
MEAN WATER QUALITY PARAMETERS (January 10–14, 2006)

Parameters	Demirköprü (1)	Antakya (2)	Samandağ (3)	Mean	SD
pH	7.71	7.84	7.87	7.81	0.085
EC (μmhos cm^{-1})	846	775	727	783	59.9
SO_4^- (mg L^{-1})	152	135	99	129	27.1
Cl^- (mg L^{-1})	142	120	109	124	16.8
NO_2^- (mg L^{-1})	0.40	0.31	0.71	0.473	0.210
NO_3^- (mg L^{-1})	134	30	30	64.7	60.0
CO_3^- (mg L^{-1})	0.14	0.22	0.15	0.170	0.044
HCO_3^- (mg L^{-1})	2.82	2.72	2.98	2.84	0.131
Total hardness, $CaCO_3$ (mg L^{-1})	10.1	10.2	10.6	10.3	0.265

Table-2 provides information on mean metal levels during the study period. To keep clarity and straightforwardness, daily concentrations are not provided here. In spite of the fact that under wet weather conditions, due to mixing and flush of environmental contaminants from agricultural and urban areas, dissolved fraction of metals out of total metal levels was found to increase, it should be given that dissolved metal fractions out of total metal levels for barium, cobalt, chromium, iron, copper, lead, nickel and zinc are approximately 40, 5, 65, 80, 65, 35, 20 and 30%, respectively. These values were found to be generally in agreement with the reported cases throughout the world. Cobalt and lead were noted to impact cell metabolism[2]. Surprisingly, total lead concentration was found to exceed total copper level in surface water during the study period. This could be by reason of heavy truck traffic in the area due to the fact that Hatay Province as a whole has the second largest truck vehicle fleet in Turkey.

TABLE-2
SOME PROPERTIES OF TOTAL METAL LEVELS AS μg L^{-1}
(AVERAGE OF THREE STATIONS)

Metal	Maximum	Minimum	Range	Mean (± SD)
Barium	48.60	35.50	13.10	40.9 (±3.66)
Cobalt	3.31	0.24	3.07	1.021 (±0.78)
Copper	81.30	12.40	68.90	26.69 (±18.7)
Chromium	58.90	13.80	45.10	32.99 (±15.4)
Iron	26.30	9.97	16.30	16.76 (±6.35)
Lead	91.40	10.40	81.00	54.5 (±17.9)
Nickel	41.40	13.20	28.20	20.84 (±7.51)
Strontium	1067.00	749.00	318.00	882 (±132)
Zinc	154.00	13.60	140.40	51.18 (±38.5)

Table-3 summarizes the acute and chronic metal levels determined by an equation that only depends on water hardness[3]. This equation is expressed as $e^{(a * \ln(\text{hardness}) + b)}$ where a and b are coefficients specific to metal[3].

TABLE-3
ECOTOXICALLY CRITICAL TRACE METAL
CONCENTRATIONS AS μg L^{-1}

Metal	Acute ecotoxical level	Chronic ecotoxical level	Comparison
Copper	2.593	2.068	Excessive
Chromium(III)	327.000	38.930	Normal
Lead	6.081	0.237	Excessive
Nickel	252.000	28.060	Normal
Zinc	20.770	18.820	Excessive

Based upon computations, copper, lead and zinc were all found to be above their toxic levels even under acute (short term) toxicity criteria. While copper and zinc have agricultural use (fertilizers and pesticides), lead is a contaminant discharged from trucks and leaded gas using motor vehicles.

Table-4 provides information on metal flux values during the study period. Flux was computed by multiplying relative flow rate and metal concentration in water column. First two days of sampling (January 10 and 11, 2006) had the same flow depth. On the other hand, gradual and then remarkable increase in flow was observed through the last half of the sampling period. Water depth at the first sampling station (Demirköprü) measured by Turkish Electrical Works Authority was accepted as a tool for computation of metal flux levels. According to field water depth measure at the first sampling station, water level was observed to be 6 scale both on January 10 and 11; 9 scale on January 12; 18 scale on January 13 and 56 scale on January 14, 2006.

Based on computation for flux, there is little, if not decreasing, change in flux levels of copper, lead, nickel and zinc between the first three days of sampling. On the other hand, barium, cobalt, chromium, iron and strontium fluxes increased with respect to increasing water depth or precisely water flow even if velocity was

assumed to be constant during the sampling. The changes in these (barium, cobalt, chromium, iron and strontium) metal flux trends are similar to what was computed for boron[4].

TABLE-4
RELATIVE METAL FLUX LEVELS (IN ANTAKYA)
DURING JANUARY 10–14, 2006

Metal	Flux (kg d^{-1})			
	Jan 10, 11	Jan 12	Jan 13	Jan 14
Barium	100.000	148.000	282.000	820.00
Cobalt	0.311	0.471	0.873	1.71
Copper	31.400	35.100	72.300	212.00
Chromium	18.100	29.400	41.300	135.00
Iron	20.100	34.400	77.500	229.00
Lead	67.900	21.300	185.000	749.00
Nickel	18.500	19.500	104.000	238.00
Strontium	804.000	1261.000	2488.000	7695.00
Zinc	56.000	34.800	51.900	446.00

High amount of strontium is also an indicator of high amount of calcium. Although it is not measured for this study, it is expected that calcium concentration as well as flux in the river is notably high and has similar pattern of strontium. This provides a rich calcium and strontium environment to the river delta on Samandağ (the last sampling point). The beach located there provides an important nesting place for sea turtles (both *Chelonia mydas* and *Caretta caretta*) in summer months. The strontium concentration in sand in densely nested segment (Şeyhhizir), which is situated on northern side of the river mouth, is remarkably high[5] and it is thought to be good for successful hatching of these species. However, other chemical compounds (*e.g.* lead, copper and zinc) should be managed more properly in order for environment to be healthier and safer in the whole Asi river basin.

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