Bull. Environ. Contam. Toxicol. (1996) 56:65-72

Bulletin of Environmental Contamination and Toxicology

Accumulation of Some Heavy Metals in Various Environments and Organisms at Göksu Delta, Türkiye, 1991-1993

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Received: 18 February 1995/Accepted: 12 June 1995

Over the last three decades the aquatic ecosystems have been contaminated by persistent pollutants of agricultural and industrial origin. Experimental research on toxic effects of heavy metals in waterbirds with pollutions from agricultural areas specially seed treated with use of organomercurial fungicides in agriculture resulted in pollution of aquatic systems with Hg (Beefting and Neuweshuize 1986). Heavy metals have been documented to have adverse effects on the reproduction and survival of certain waterbirds in aquatic ecosystems (Sanders, 1984; Molueg et al 1984; Rico et al 1988; Burton 1990; Fox et al 1991).

Many important wetlands in Türkiye have been polluted by different type of heavy metals and other contaminants. It is obviously that especially waterbirds are being affected. Particulary important are the reproductive effects which include decreased egg production, decreased hatchability, increased hatchling mortality and malformation (Burton 1990;Fox et al 1991). There are no detailed research on contaminations and its ecotoxicological effects on waterbirds in Türkiye. Although Göksu Delta is one of the most important breeding, and wintering area for the birds, and the environment is consequently becoming contaminated with plastics, tin cans, pesticides and heavy metals (TÇSV 1989).The paper and integrated wood plants belonging to SEKA located at Tasucu pollute the western shores of the Göksu Delta.

Nowadays undesirable effects are not known on the delta. It is already clear that hazards are going to arise in the future. Although hunting was prohibited on the Göksu Delta by a decision of Central Hunting Commision in 1988,illegal and off-season hunting still continue, including hunting of pelican and flamingo as well as endangered species such as purple gallinula and francolin.

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MATERIALS AND METHODS

Göksu Delta is an important wetland (13.000 ha) where the Göksu River empties into the sea and east of the town of Tasucu-Içel (Figure 1). Paradeniz lake is a freshwater lagoon connected with the sea and located west point of the Göksu River. Akgöl is located further to the west. Paradeniz Lagoon, which is seperated from the sea by a sand bar, is surrounded by sparse reedbeds and covered with species of the halophilic salicornia sp. The salinity level of Akgöl is as low as that of freshwater. The lake shores are 50-200 m wide and covered with dense reedbeds. The sandy strip between Akgöl and the sea is covered with dwarf shrubs of the species genistra. The area north of the lake and the eastern part of delta consist of farmland where rice, cotton and peamets are grown. The salt steppes between this farmland and the lakes are inundated in winter forming extensive marshes. In summer, on the other hand, the areas dry up entively. Grey mullet, carp, eel, and other fish are found and fisheries irregulary in both the lagoon and Akgöl. Caviar is also produced from the fish cought here in weirs (TÇSV 1989).The area is an important wetland due to its being located a long a bird migration route, and birds visit this area during their migration (DHKD 1992).

Water and sediment samples were collected in October 1991 and October 1993 from the stations indicated at Figure 1. Water samples were filtered through 0.1 mm milipore filters, acidified with concentrated nitric acid to pH less than 2.0 and stored in acid-rinced polyethylene bottles at room temperature until analysis. The upper 10 cm of sediment was collected with a stainless stell crab.Soil samples, were collected from three different parts of Delta such as agricultural, non-agricultural and dune areas. Plankton samples were obtained from Akgöl and Paradeniz lagoon systems by standart skimmer (18x55 mm). Blue crap (*Callinectes sapidus*) and fish samples (carp=*Cyprinus carpio* and grey mullet= *Mugil cephalus) were* obtained from Kurtulus Fisheries Cooperation in Tasucu. Monthly ornithological observations within Göksu Delta were executed for twelve months during the period of October 1991-October 1992. According to these, waterbirds recorded in the delta which could be found for whole year, were chosen as bioindicator (coot=*Fulica atra;* mallerd=*Anas platyrynchos* and little egret= *Egretta qarzetta*) for metal residue analysis. Tissues (liver and muscle) necessary for the analysis were removed from the shooted waterbirds by hunters. Egg samples of the bioindicator waterbirds were collected from the abondoned nests after the breeding season.All samples were placed in plastic bags and then brought to the central laboratory in Ankara (Middle East Technical University, Environmental Engineering Laboratories).

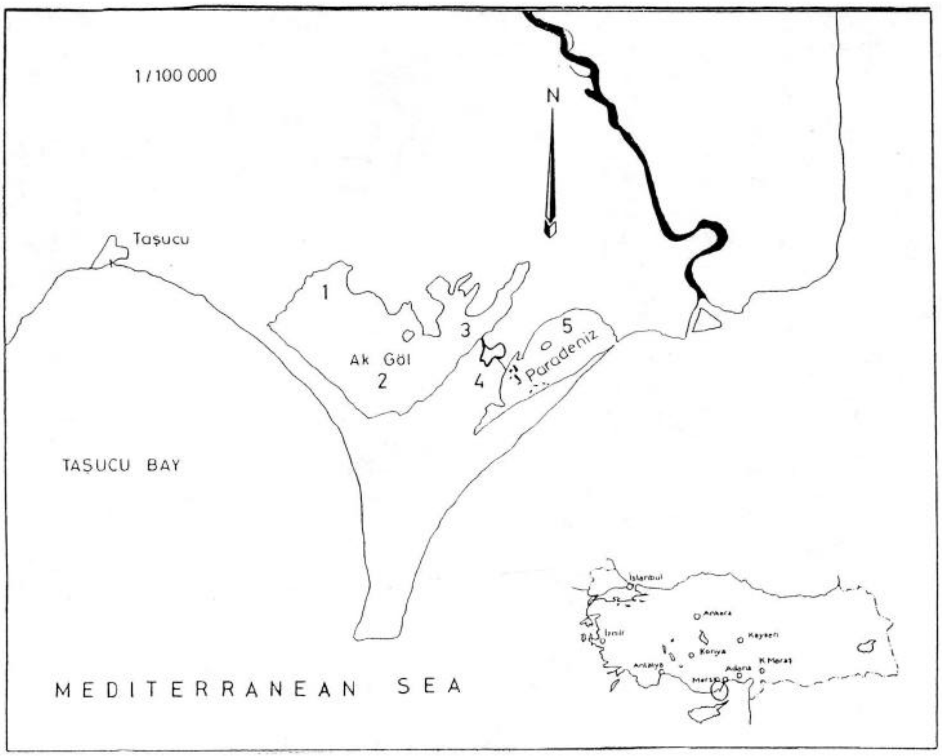

Figure l.Study area and location of stations for sample collections in Göksu Delta.

All samples were frozen at -15°C and stored for one month before chemical analysis and were analyzed by atomic absorbtion spectroscopy (Anonymous 1979) at the METU Environmental Engineering Laboratories. Laboratory accuracy and precision of the analysis were determined throught the use of standart reference materials (Rand et al 1979).

Results are presented on a dry-weight basis to avoid errors associated with varying moisture levels in soft tissues (Adrian and Stevens, 1979). Values below detection limits were assigned as Non-Detectable on the tables and geometric means were reported for residue data. Detectable concentrations were determined and the significance between the mean weights of organisms and tissues were examined by student's T-test at the 0.005 level (Sümbüllüoglu and Sümbüllüoglu 1987).

RESULTS AND DISCUSSION

Metal concentrations of water sediment and soil samples were shown on Table l.Metal concentration of plankton, blue crab, fish and waterbird samples were shown on Table 2. According to these, it was found that Hg and Pb contaminations were determined in these samples, in addition they were accumulated biologically magnificated on the food-chain. Water, sediments and soil samples in Göksu Delta contained high levels of Hg and Pb (Table 1). The level of Hg in various environments is higher than the level of Pb. Nickel level was found high in water, sediments and soil samples but nickel was not accumulated in the organisms. The levels of Cd and Cr were nondetectable.

According to the results the amounts of Hg in various environments from Göksu Delta are as fallows: dune area (0.393 ppm) < water (0.613 ppm) < nonagricultural area (0.630 ppm) < agricultural area (0.690 ppm) < sediment (0.264). The amounts of Pb as follows in samples: water (0.194 ppm)< nonagricultural area (0.316 ppm) < dune area (0.430) < sediment (0.478 ppm) < agricultural area (0.571 ppm). The amount of Ni as seen in samples: sediment (0.238 ppm) < water (0.302 ppm) < dune area (1.595 ppm) < agricultural area (1.745 ppm) < nonagricultural area (1.877 ppm).

As it can be seen from these results, Hg and Pb are higher in agrucultural aeras and sediments. As it can be understood the reason of heavy metal contamination in agrucultural areas and sediments is transportation of contaminants such as heavy metals by the river from the Göksu Basin. It is known that Hg and Pb were accumulated in estuerine systems like deltas (Molueg et al 1984; Sanders 1984; Rico et al 1988).

Sanin et al.1992 determined the presence of Hg, Pb and Ni in various sediments on the River Göksu. They also found that these metals were transported to the Göksu Delta by the river from the basin. The main reason of Hg contamination in Göksu Delta can be widely usage of organomercurial fungicide in agriculture. Because the highest mercury level was found on the soil samples which collected from the agricultural area (Tablo 1). Aydogdu et al . 1982, found out that Hg concentration on marine organisms at the coast of Göksu Delta reached to its highest degree in April, May, June and July . In this season using of organomercurial fungicides in agriculture at the south region of Türkiye (Mediterranean Region) leads to this high level of Hg in marin organisms.The reason of heavy metal contamination in Delta can be resourced by the Pb coming with river and/or besides from the exhousts of vehicles and/or from the lead shot used by the hunters.

Table l.Heavy metal concentrations (ppm dry-weight) in varius habitats from areas of Göksu Delta.1991-1993.

HABITATS	N	HEAVY METALS Hg (Min-Max) Mean	Pb (Min-Max) Mean	Ni (Min-Max) Mean	Cd (Min-Max) Mean	Cr (Min-Max) Mean
WATER	16	(0.156-1.502) **0.613**	(0.077-0.314) **0.194**	(0.184-0.432) 0.382	ND	ND
SEDIMENT	16	(0.594-1.152) **0.764**	(0.296-0.864) **0.478**	(0.090-0.518) **0.238**	ND	ND
SOIL						
Agricultural	16	(0.350-1.830) **0.69**	(0.270-0.920) **0.571**	(0.820-2.720) **1.745**	ND	ND
Nonagricultural	16	(0.240-1.410) **0.63**	(0.100-0.870) 0.316	(0.620-2.600) 1.877	ND	ND
Dune	16	(0.280-1.150) **0.393**	(0.190-0.77) **0.43**	(0.770-2.480) **1.595**	ND	ND

ND: Nondetectable

Although, Balkas et al. 1982 determined that the lead and cadmium in Göksu Delta were lower that limited values, in last ten years.

In water, sediment and soil samples in Göksu Delta contain high level of Ni (Tablo 1). However it was seen that nickel didn't accumulate in organisms (Table 2). It is thought that, high nickel concentrations can have a natural origin from the basin. Because the water level of River Göksu is high, nickel concentration is high, and the reverse of this condition is true as well. A part from this, decreasing of the level of Ni was determined while going out from the cost of Delta (Salihoglu et al 1987;Yemenicioglu et a1.1987). Crom and cadmium in samples from various environments and organisms were lower than limited values. Similiar results for these metals were reported at the recent investigations (Balkas et al 1982; UNCED, 1982).

It was determined that Hg and Pb are more accumulated in liver samples of the fish and waterbirds than in their muscles (Table 2). Taking account the fish, Hg more accumulated in the livers of the grey mullets when compared with the carps. But Pb levels was nearly equal in the liver of these two fish (Table 2).

In waterbirds, the level of Hg more accumulated in the liver of the mallards when compared with the coots, but Pb more accumulated in the liver of the coots when compared with the mallards.Metal concentrations were highest in the livers of fish and waterbirds . The difference between Hg and Pb accumulations in liver and muscle tissues of fish and birds were significant ($p<0.005$). It is known that metals bind to special protein (called metallothionein) and accumulate in soft tissue like liver and kidney (Scheuhammer 1987).

Table 2.Heavy metal concentrations (ppm dry-weight) in organisms from areas of Göksu Delta.1991-1993.

		HEAVY METALS				
SPECIES	N	Hg (Min-Max) Mean	Pb (Min-Max) Mean	Ni (Min-Max) Mean	Cd (Min-Max) Mean	Cr (Min-Max) Mean
PLANKTON	4	(0.312-0.916) **0.615**	ND	ND	ND	ND
CRAB *(Callinectes sapectus)*	13	(0.215-1.767) **0.872**	(0.107-0.412) **0.214**	(0.066-0.861) **0.135**	ND	ND
FISH						
Carp(Cyprinus carpio)						
Liver	27	(0.313-0.620) **0.464**	(0.113-0.712) **0.453**	(0.173-1.562) 0.262	ND	ND
Muscle	27	(0.071-1.863) **1.021**	(0.116-0.512) **0.372**	ND	ND	ND
Mullet(Mugil cephalus)						
Liver	26	(1.686-4.494) **2.195**	(0.242-0.793) **0.0412**	ND	(ND-0.082) 0.063	ND
Muscle	26	(0.086-2.135) **1.353**	(0.186-0.474) **0.216**	ND	ND	ND
WATERBIRDS						
Coot (Fulica atra)						
Liver	25	(1.065-6.742) **2.66**	(1.612-4.197) **2.412**	(ND-0.198) **0.122**	ND	ND
Muscle	25	(0.091-0.715) **0.312**	ND	ND	ND	ND
Egg	11	(0.102-0.441) **0.112**	ND	ND	ND	ND
Mallard *(Anas platyrynchos)*						
Liver	27	(0.342-7.652) **3.795**	(0.412-2.563) **1.641**	ND	(ND-0.075) 0.015	ND
Muscle	27	(0.367-2.072) **0.312**	ND	ND	ND	ND
Egg	16	(0.097-0.217) **0.118**	ND	ND	ND	ND
Little Egred *(Egretta garzetta)*						
Egg	7	(0.122-0.175) **0.342**	(0.054-1.126) **0.341**	ND	ND	ND

ND: Nondetectable

Hg and Pb accumulation in grey mullets were higher than carps. Because carps lives in freshwater in Göksu Delta (like drainage channel and Akgöl Lake) all year long and they eat the deep forms such as plants and small invertabrates in whole year. However grey mullets live either in freshwater and sea as well. For this reason mercury concentration can be expected to be higher in grey mullets than carps.It was found out that metal accumulation in waterbirds is correlated with feeding.Mallards are omnivor and primarly eat small invertebrate and plant which is on the surface of water (surface feeding duck).Coots are herbivor and primarily eat only plants (Welty and Baptista 1988).For this reason Hg levels can be expected tobe higher in livers of coots than mallards.Hg was determined on the eggs of the all coot, mallards and litle egrets which were choosen as bioindicator. The highest levels of Hg was determined on the eggs of little egrett. However Pb was only determined on the eggs of the little egrett. The Hg and Pb levels of the eggs of little egret were as high as in the soil,sediment and water samples (Table1 and 2).Hg was determined in the eggs of belong to all bioindicator waterbirds. However, Pb only was determined in eggs of little egret. Because of this, little egrets are eat fish (piscivorus) . Similiar results for accumulation Hg and Pb in aquatic ecosystem were documentedat there recent investigations (Fimreite,l974;Scheuhammer 1987, 1989 and Schuler et al. 1990).It is known that levels of Hg and Pb which were determined on the eggs collected from Göksu Delta cause, brain lesions (Heinz and Locke 1976) embryomortality and malformations even very low level of concentrations (Heinz, 1980: Scheuhammer 1987; Cairns and Mount 1990).A part from this, it was seen that waterbirds on the top of the food chain in deltas could be the most affected organisms and contaminants could be effective on the reproductive succsess.

In this study the preventation of agricultural and industrial contaminations in the Göksu Delta which has an international ornithologically importance is a must and interested authorities must be warned for this aim.

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