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Original Research Paper

Effect of Agricultural-Industrial Wastes on Vegetation of Some Selected Sites of Alaniya River System Near Kota, Rajasthan

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ABSTRACT

In the present study, different heavy metals like copper, zinc and mercury were recorded in water and soil samples at different sites along Alaniya river system. Higher concentrations of these metals were recorded at polluted sites compared to non-polluted site of the study area. Soil samples showed higher concentration of metals compared to water samples. The vegetational analysis of the study sites observed higher number of plant species at non-polluted site, while less number of plant species were present at polluted sites. Some plant species were recorded only at the non-polluted sites but absent at polluted sites.

INTRODUCTION

Water pollution is the biggest menace of urbanization, industrialization and modern agricultural practices. It leads to alteration in physical, chemical and biological characteristics of water bodies as well as of our environment. It directly or indirectly affects the life processes of flora and fauna of water bodies, mainly because of chemical toxicants (Kumari et al. 2006, Indira & Sivaji 2006, Krishnan et al. 2007).

The industrial and agricultural wastes are discharged generally in the form of collides, suspensions and particulates containing heavy metals, which are ubiquitous and cumulative poisons in both aquatic and terrestrial ecosystems (Midigosky et al. 1991). Studies on heavy metal pollution in aquatic systems indicates that they get incorporated into various components of ecosystems, especially in water, sediments and biota (Veith et al. 1979, Dixon & Sprague 1981, Whiton et al. 1982). Of all the heavy metals, Zn, Pb, Hg, Cd and Cr are considered to be of principal interest in pollution biology (Hellawell 1986). Excess of heavy metals in soils also results from natural processes and from anthropogenic or human activities. Most of the heavy metals reach the plants in various chemical forms through pesticides, insecticides, industrial and agricultural wastes, solid wastes, etc.

Alaniya river is a small flowing river near Kota city of Rajasthan. Many seasonal streams discharge their water contents at the reservoir site near Alaniya. During its course, river water gets contaminated from industrial effluents discharged by various industries located in the industrial belt of Kota. It also receives agricultural wastes from nearby fields.

MATERIALS AND METHODS

In the present study, three different sites were selected along the Alaniya river system near Kota.

Site-1: Alaniya (CL): At this site water is without any polluting impregnation, hence, considered as non-polluted site.

Site-2: Devli-arab (HP): At this site, industrial effluents are discharged through a perennial stream in the Alaniya river. Agricultural run-off also mixes with water at this site. The site is considered as the highly polluted site.

Site-3: Manasgaon (LP): At this site, Alaniya river meets the Chambal river. Here, much dilution of pollutants occurs. The site is considered as comparatively less polluted site.

For analysing heavy metals like copper, zinc and mercury, the water and soil samples were collected from all the sampling sites. Water and soil samples were collected in triplicate in the three seasons, i.e., winter, summer and immediately after rains. Soil samples were collected horizon-wise as per soil taxonomy.

The metals were analysed by Atomic Absorption Spectrometry (ASTM 1986) method as described by Klein (1973) and Standard Methods jointly by APHA (1989).

For vegetational analysis, systematic survey of vegetation was carried out to prepare a list of plant species occurring at different study sites of Alaniya river system. All the sites of study area were visited at short intervals covering all the seasons in such a manner that all the plant species growing in the area were collected in flowering and fruiting condition.

RESULTS AND DISCUSSION

Industrial wastes discharged by the industries located in the nearby areas and agricultural run-off mixes with river water and hence makes Alaniya river water as contaminated one. These wastes contain different amounts of various heavy metals, which were observed in water and sediments.

Heavy metal contents in river water, soils and number of plant species at different sites are given in Tables 1, 2 and 3 respectively. The zinc content in the water samples at all the sites vary from 0.02 mg/L to 2.265 mg/L. At non-polluted site its concentration ranged from 0.042 mg/L to 0.2 mg/L but at polluted sites, its values were 0.02 mg/L to 2.265 mg/L. The highest zinc contents were recorded at highly polluted site i.e., Devli arab (2.265 mg/L). The high contents of zinc were because of industrial effluents meeting the river water at this site. Many workers in their studies also recorded high zinc contents in water due to industrial discharges. Girisha & Raju (2008) recorded high concentrations of zinc in sewage water at Bangalore.

The concentration of copper recorded varies from 0.019 mg/L to 0.106 mg/L at all the sites. The higher copper content was recorded at Devil arab site (0.10 mg/L), while a low value of copper concentration (0.019 mg/L) at non polluted site. The high concentrations of copper in polluted water were also recorded in many studies because of industrial and domestic wastes. Gupta et al. (2006) recorded a high value of copper content at different sites of Amanishah Nala due to wastewater released from many industries located at Sanganer, Jaipur, Rajasthan.

The mercury content of river water at all the sites varies from 0.0002 mg/L to 0.0988 mg/L. At non-polluted site its concentrations recorded were 0.061 mg/L to 0.065mg/L but at polluted sites the values were 0.0002 mg/L at 0.098 mg/L. The highest concentration of mercury was recorded at Devli arab (0.0988 mg/L) compared to the non-polluted site (0.0616-0.0653 mg/L). The higher concentration of mercury at Devli arab was due to the industrial effluents and agricultural run-off mixing in the water at this site.

Different amounts of metals in the soil can be used to estimate the degree of soil exposure to heavy metal pollution though, this is not generally well correlated with metal mobility and bioavailability (Kuo et al. 1983). Zinc contents in the soils of Alaniya river system vary from 0.05 µg/g to 32.36 µg/g. At non-polluted sites, it was 1.6 µg/g to 4.0 µg/g, but at polluted sites, its values ranged from 0.05 µg/g to 32.36 µg/g. In this study, the highest concentration of zinc in soils was recorded at highly polluted site, Devli arab (2.6-32.36 µg/g), while at non-polluted site it was lower (1.6-4.0 µg/g). The increase in zinc content at this site was due to industrial wastes meeting at this place and also because of agriculture run-off mixing in the water courses. The increase in zinc content in soil samples of river Nile at polluted sites were also recorded by Abd-EI-Hady (2007) due to domestic discharges and industrial effluents in Egypt. The higher concentrations of Zn were due to discharges from industries (Cook 1976).

The copper content in the soils of the study area varied from 0.18µg/g to 6.14µg/g. At non-polluted site, its value ranges from 0.18 µg/g to 0.688 µg/g, while at polluted sites from 3.75 µg/g to 6.14 µg/g. The concentration of copper was recorded high at the polluted site, Devli arab (4.6-6.14 µg/g). This increase in the concentrations of copper was due to addition of agricultural-industrial discharges at this site. The findings of Indra & Sivaji (2006) also supported these observations. They also recorded high concentrations of copper in sewage-sludge from rural areas of Vellore district in Tamil Nadu. Copper has a tendency to form complexes with organic moieties (Disassanayke 1983).

Mercury content in the soils of Alaniya river system ranges from 0.0074 µg/g to 0.386 µg/g. The concentration of mercury ranged from 0.007 µg/g to 0.163 µg/g at non-polluted site, while 0.008 µg/g to 0.386 µg/g at polluted site.

In the present study, the concentration of heavy metals was found to be considerably higher in soils than water. Similar observations were also made by Kreuskopf (1955) and Gurits (1966). Kreuskopf (1955) has suggested that the heavy metal concentration increases in the sediment due to the adsorption of cations and organic matter present in the sediment layer.

The life in aquatic ecosystems is directly or indirectly depends on the water quality. The alternation in the physico-chemical properties of the water affected biota in its number and diversity. In present study, pollution of water and soil affected the vegetation of the study area. At Alaniya site (non-polluted) a total of 57 plant species were recorded. Less number of plant species were recorded at polluted site, Devli arab (47), and Manasgaon (50). The decrease in plant diversity was on account of the discharges of industrial effluents and agricultural run-off at this site in the river water. Khandelwal (1996) also recorded decrease in vegetation of Luni river due to discharge of dyeing industrial wastewaters. Constituents of polluted water not only spoil land surfaces, but also percolate into the groundwater making it polluted and rendering unfit for drinking and irrigational purposes.

It was also observed in the present study that some plant species were present only at clean site (Alaniya) remaining absent at polluted sites. These plant species include

Table 1: Heavy metal content in water at different sites of Alaniya river system.

Study sites	Zinc (mg/L)			Copper (mg/L)			Mercury (mg/L)		
	Dec. 2005	May 2006	Sept. 2006	Dec. 2005	May 2006	Sept. 2006	Dec. 2005	May 2006	Sept. 2006
Alaniya	0.2	0.042	Tr.	0.019	Tr.	Tr.	0.061	N.T	0.065
Devli-arab	0.02	2.265	Tr.	0.106	Tr.	Tr.	0.092	0.0002	0.098
Manasgaon	0.3	0.03	Tr.	0.020	0.09	N.T	0.074	N.T	0.073

Tr. = Traces; N.T. = Non-Traceable

Table 2: Heavy metal content in soil at different sites of Alaniya river system.

Study sites	Zinc (μg/g)			Copper (μg/g)			Mercury (μg/g)		
	Dec. 2005	May 2006	Sept. 2006	Dec. 2005	May 2006	Sept. 2006	Dec. 2005	May 2006	Sept. 2006
Alaniya	1.6	4	3.6	0.688	N.T	0.18	0.147	0.007	0.163
Devli-arab	32.36	16	2.6	6.14	N.T	4.6	0.369	0.085	0.386
Manasgaon	10.8	6.62	0.05	3.156	N.T	N.T	0.221	0.008	0.286

N.T. = Non-Traceable

Table 3: Heavy metal content (mean values) and number of plant species at different sites of Alaniya river system.

Study sites	Conc. of zinc		Conc.. of copper		Conc. of mercury		No. of plant species
	Water (mg/L)	Soil (μg/g)	Water (mg/L)	Soil (μg/g)	Water (mg/L)	Soil (μg/g)	
Alaniya	0.012	3.06	0.019	0.43	0.042	0.105	57
Devli-arab	1.142	16.98	0.106	5.37	0.063	0.274	47
Manasgaon	0.165	5.82	0.055	3.75	0.073	0.171	50

Andrographis paniculata, *Caesulia axillaris*, *Celosia argentea*, *Gomphrena celosoides*, *Justicia procumbens*, *Ocimum canum*, *Oryza rufipogon*, *Murdannia vaginata*, and *Melanocenchris jacquemontii.* These plant species can be grouped as sensitive species as they were not found at the polluted sites of this study. A common plant species *Ludwigia perennis*, studied in detail, showed luxuriant growth at all the sites of the present study (Jangid 2009).

Plant species were differently sensitive to the contamination of substrata. Some of them decrease in number and may totally disappear, while others become dominating. The resulting effect was the change in community structure (Salanki 1986). In the present study, it was also observed that at highly polluted site, the diversity of vegetation was much affected by pollutants. The finding of Ali & Soltan (1996) also supported this. They found that in effluent channels, submerged vegetation was absent and dominated by large growth of sewage fungus and some emergent vegetation while studying the impact of three industrial effluents on submerged aquatic plants in River Nile in Egypt.

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