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VEGETATION CHARACTERISTICS AND TRACE METALS (CU, ZN AND PB) IN SOILS ALONG THE SUPER HIGHWAYS NEAR KARACHI, PAKISTAN

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In this study, *Senna holosericea* and *Prosopis juliflora* are found to be the leading dominant species because of their wide ecological tolerance along the Super Highway near Sohrab Ghoth in Karachi. *Abutilon indicum*, *Fagonia indica* and *Blepharis sindica* were also found as leading species in other stands, but their importance values were rather low. Heavy metals such as Cu, Zn and Pb in stands dominated by *P. juliflora* and *S. holosericea* showed their broad range of occurrence, particularly for *P. juliflora*. One of the stands in which *B. sindica* was dominant, highest concentration of Cu (305 μg g^{-1}) and the lowest levels of Zn (35 μg g^{-1}) and Pb (15 μg g^{-1}) have been reported. Considerable higher values of Cu, Zn and Pb metals have been recorded in some of the stands, where *Suaeda fruticosa* and *Salsola baryosma* was associated with *P. juliflora*.

Key words: air pollution, heavy metal, highway, Pakistan, soil

INTRODUCTION

Pollution by heavy metals is a worldwide problem. These metals are discharged in to the air by man-made activities, *e.g.* industries, auto vehicles etc. In heavily populated areas, automobile activity is one of the major sources of heavy metal pollution, particularly on the major highways in cities.

Some of the heavy metals of which lead is the most important one are dispersed in the environment mainly through the exhaust gases of automobiles (ALBASEL and COTTENIE 1985, BEYER and MOORE 1980, BISHOP *et al.* 1975, DAVIES and HOUGHTON 1984, GILES *et al.* 1973, HARRISON and JOHNSTON 1985, HARRISON *et al.* 1985, KRYYSTOFIAK 1986, MADANY *et al.* 1990, PRICE *et al.* 1974, UDEVITZ *et al.* 1980) to a lesser extent through the emissions of industry (MAKOVSKÁ 1978, STARY and KUBIZMAKOVÁ 1987). Mostly lead is found in the aerial parts of plants and little translocation occurs (ALSTAD *et al.* 1982, GILES *et al.* 1973).

Effects on plant communities are most easily studied where a heavily polluting industry affects natural vegetation. An iron sintering plant at Sudbury, Ontario, releasing sulfur dioxide in an area of spruce forest (GORHAM and GORDON 1963) about 25 km from the plant, the dominant spruce trees of the forests were

killed by SO_2. From 25 to 7 km, the species diversities of vascular plants decreased progressively as the levels of SO_2 to which they were exposed increased. From 7 to 2 km only two plant species remained in most samples. With increased intensity of SO_2 exposure, the community height, biomass, production and coverage decreased along with diversity.

Roadside plants and crops grown near the roads were found to contain more lead and the lead levels correlated with traffic density and the distance from the motorways (ALBASEL and COTTENIE 1985, BEYER and MOORE 1980, DAVIES and HOUGHTON 1984, HARRISON and JOHNSTON 1985). However, even a large proportion of emissions may be dispersed by the atmosphere from the immediate vicinity of the roads (HARRISON *et al.* 1985). The toxicity of some metals may be so great that plant growth is retarded before large quantities of the element can be translocated (HAGHIRI 1973). Low concentration of these metals may cause growth retardation, inhibition of photosynthesis, transpiration, foliar injury, chlorosis etc., (BAZZAZ *et al.* 1974*a*, *b*; ZIMDAHL 1976).

The present population of Karachi is estimated to be more than 9.4 millions. According to the Excise and Taxation Department, Karachi had about 600,000 vehicles in the period of 1987 to 1988 and their number is increasing every year. The concentration of pollutants like lead and smoke in the city is increasing day by day (BEG *et al.* 1987). Rain in Karachi is seasonal, averaging less than 22 cm per year between June and September and rare for the remaining part of the year. Occasionally, there are dry years too, while strong coastal winds and better dew formation are the main features of Karachi. The study area lies in a broad valley which is filled by alluvium, slope wash and wind blown sand.

Phytosociological studies around Karachi had been conducted by many workers (CHAUDHRY and QADIR 1958, CHAUDHRY 1961, QADIR *et al.* 1966, SHAUKAT and QADIR 1970, IQBAL *et al.* 1983, AHMED *et al.* 1978, SHAFIQ and IQBAL 1987, 1988, SHAFIQ *et al.* 1992, IQBAL and HUSSAIN 1994, MEHMOOD and IQBAL 1995). However, no vegetation studies along the main Super Highways were completed so far.

In this paper, attempt has been made for discussing the relationship between the vegetation and some trace metals such as lead, copper and zinc.

MATERIALS AND METHODS

The vegetation is predominantly composed of halophyte and xerophyte species. The disturbance is mainly due to the construction of new structures, cutting, cattle grazing, pollutant disposal etc. Sampling of the vegetation near the main Super Highways joining the two big cities of Pakistan, Karachi and Hyderabad was conducted by quadrat method. Sampling was started from Sohrab

Ghoth in the outskirts of Karachi up to a distance of 20 km towards Hyderabad. The sampling of the vegetation was done 7 m away from the road to avoid any road edge effects. The disturbed area was not included in the sampling. At every stand, 20 quadrats of 8.0 m × 1.5 m were taken randomly. Number of individuals of all the species as well as their circumference was recorded. The relative cover, relative density and relative frequency of all the species were calculated. An Importance Value Index (IVI) was obtained by the addition of the above mentioned community attributes.

Soil samples from every stands were collected from 30 cm depth, dried at 80 °C for 24 h, ground and sieved to remove particles greater than 1 mm. Then 1 g of soils was weighed into a 250 ml beaker, 10 ml concentrated HNO_3 was added and the mixture was evaporated to dryness on a hot plate. After cooling, this procedure was repeated with a second aliquot of HNO_3. After this, 10 ml concentrated HCl was added to the residue and warmed to 40–50 °C. The mixture was filtered through a Whatman No. 54 filter paper, the residue washed with 1n HCl and the filtrate volume was made up to 100 ml. Pb, Cu and Zn were then determined by atomic absorption spectrophotometer (Model Perkin Elmer 23380) upon the solution direct or after tenfold dilution with 1n HCl.

RESULTS AND DISCUSSION

Phytosociological results including leading as well as other dominant species and their Importance Value Index have been indicated in Table 1. Metal analysis results for Cu, Zn and Pb for all samples have been also included in this table. In Table 2, mean Importance Value Index, concentration of Cu, Zn and Pb and their ranges have been given only for the 5 most dominant species. This table also shows the number of stands of occurrence of the dominant species. The results indicate that the two species, *Senna holosericea* and *Prosopis juliflora* are found in sites where disturbance is the primary factor. *S. holosericea* and *P. juliflora* have been found occurring in 10 and 7 stands, out of 20 stands, respectively. In arid regions, the vegetation cover is low and sparse (EMBERGER and LAMEE 1962). Under the arid conditions, the density of vegetation decreases with decreasing precipitation (MOND 1954). Most of the species are characterized by a shallow root system with a considerable horizontal growth (WALTER 1961). The highest mean importance values were also been recorded in *S. holosericea* (55.07) and *P. juliflora* (53.48). Both species (*S. holosericea* and *P. juliflora*) also showed a broad range of importance values, showing their wide ecological amplitude. Though, *Abutilon indicum*, *Fagonia indica*, and *Blepharis sindica* were also found as a leading species in other stands, but their importance value was rather low.

Table 1. Dominant species in different stands along the Super Highways showing Importance Value Index and Cu, Zn, Pb concentrations.

					Concentration ($\mu g\ g^{-1}$)		
Stand	First Dominant	IVI	Other Dominants	IVI	Cu	Zn	Pb
01	*Senna holoserici-cea* (Fresen.) Gretter	77.09	*Prosopis juliflora* DC.	10.45	300	120	10
			Aerva javanica (Burm. f.) Dandy	08.96			
02	*S. holosericea*	76.39	*P. juliflora*	17.93	143	45	33
			Zizyphus nummularia (Burm. f.) Wt. et Arn.	05.66			
03	*S. holosericea*	72.60	*Calotropis procera* (Willd.) R. Br.	22.18	130	08	08
			Z. nummularia	05.21			
04	*S. holosericea*	65.22	*C. procera*	25.64	315	130	43
			Fagonia indica L.	09.68			
05	*S. holosericea*	61.99	*P. juliflora*	25.53	248	115	30
			C. procera	07.10			
06	*S. holosericea*	45.41	*Z. nummularia*	29.49	125	110	17
			A. javanica	25.08			
07	*S. holosericea*	45.09	*P. juliflora*	20.66	243	135	07
			C. procera	19.02			
08	*S. holosericea*	38.26	*F. indica*	29.37	128	18	20
			P. juliflora	20.54			
09	*S. holosericea*	36.49	*P. juliflora*	13.49	145	30	05
			A. javanica	13.46			
10	*S. holosericea*	32.11	*P. juliflora*	24.71	118	225	40
			F. indica	09.16			
11	*Prosopis juliflora*	81.99	*S. holosericea*	11.83	40	140	28
			Z. nummularia	04.14			
12	*P. juliflora*	61.61	*S. holosericea*	30.50	205	13	29
			C. procera	06.27			
13	*P. juliflora*	61.30	*S. holosericea*	18.04	200	05	08
			A. javanica	17.93			
14	*P. juliflora*	52.49	*A. javanica*	16.95	23	125	38
			C. procera	11.82			

Table 1 (continued)

Stand	First Dominant	IVI	Other Dominants	IVI	Concentration ($\mu g\ g^{-1}$) Cu	Zn	Pb
15	*P. juliflora*	41.65	*S. holosericea*	24.87	30	36	13
			Capparis decidua (Forsk.) Edgew	17.86			
16	*P. juliflora*	39.72	*Salsola baryosma* (R. B. S.) Dandy	26.41	330	268	48
			S. holosericea	19.00			
17	*P. juliflora*	35.57	*S. holosericea*	26.12	110	200	45
			A. javanica	20.56			
18	*Abutilon indicum* (L.) Sweet	35.24	*S. holosericea*	32.57	120	105	23
			P. juliflora	25.20			
19	*Fagonia indica*	34.89	*S. holosericea*	33.26	135	100	25
			P. juliflora	26.94			
20	*Blepharis sindica* Stocks ex T. Anders	27.52	*C. decidua*	22.65	305	35	15
			Haloxylon recurvum (Moq.) Bunge	17.77			

Soil analysis of the stands showed that the average Zn and Pb concentrations in stands in which *P. juliflora* was the most dominant species was 112.4 and 31.3 $\mu g\ g^{-1}$, respectively (Table 2). The average concentration of Cu was comparatively lower (134.0 μg^{-1}) in *P. juliflora* dominant stands than *S. holosericea*, which showed the average concentration of Cu in stands to about 189.5 $\mu g\ g^{-1}$. The stands in which *A. indicum*, *F. indica* and *B. sindica* were present showed comparatively less Zn and Pb concentration than *P. juliflora* stands. Cu concentration on the other hand was greater in *F. indica* and *B. sindica* stands than the average level of Cu in *P. juliflora* stands. Whereas, the reverse was the case for *S. holosericea* stands. The *B. sindica* stand showed the highest concentration of Cu (305 $\mu g\ g^{-1}$) and the lowest of Zn (35 $\mu g\ g^{-1}$) and Pb (15 $\mu g\ g^{-1}$) as compared to any other stands analyzed.

Some of the species which were rare have been shown in Table 3. Their importance value was not more than 16.0%. *Salvia santolinifolia* was found in four stands, while *Aerva javanica* and *Calotropis procera* were recorded in 3 stands. At these stands, the levels of Cu, Zn and Pb in soils were not high. In one stand, where *Suaeda fruticosa* was the least dominant species, the levels of Cu, Zn and

Table 2. Range and mean values for the most dominant species along the Super Highways.

Dominant species	NSD	IVI		Cu ($\mu g\ g^{-1}$)		Zn ($\mu g\ g^{-1}$)		Pb ($\mu g\ g^{-1}$)	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Senna holosericea	10	32.11–76.60	55.07	118–315	190	8–225	94	5–43	21
Prosopis juliflora	07	35.57–81.99	53.48	23–330	134	5–268	112	13–48	31
Abutilon indicum	01	–	35.24	–	120	–	105	–	23
Fagonia indica	01	–	34.89	–	135	–	100	–	25
Blepharis sindica	01	–	27.52	–	305	–	35	–	15

Abbreviations: IVI = Importance Value Index, NSD = Number of stands dominant

Pb were the highest. *Salsola baryosma* stand also showed higher values for Zn and Pb, but for Cu, the level was low. On the other hand, the stand in which *Indigofera cordifolia* was the least dominant showed low concentration of Zn and Pb but for Cu, the concentration was much higher. One stand where, *Haloxylon recurvum* showed 15.89% importance value, the concentrations of Cu, Zn and Pb was low.

The effects of metals on vegetation are varied and could involve in the extinction of some species. Extinction of some rare species would result in the increase of the prevalence of relatively stable species, such as *Prosopis juliflora* and *Senna holosericea*.

Table 3. Mean values for the rare species along the Super Highways.

	Nos of stands for rare species	IVI	Concentration ($\mu g\ g^{-1}$)		
			Cu	Zn	Pb
Suaeda fruticosa	1	3.72	330	268	48
Fagonia indica	2	6.58	308	125	26
Indigofera cordifolia	1	2.26	305	35	15
Rhyncosia minima	1	2.69	200	5	18
Aerva javanica	3	10.61	191	86	14
Zizyphus nummularia	2	5.44	137	27	21
Calotropis procera	3	3.48	133	78	18
Salsola baryosma	1	6.17	110	200	45
Salvia santolinifolia	4	4.27	77	127	32
Haloxylon recurvum	1	15.89	30	36	13

Abbreviation: IVI = Importance Value Index

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