Concentration of Lead and Population of Ants in roadside soil of Kolkata and relationship in between: A GIS Approach

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INTRODUCTION

Ants (Hymenoptera : Formicidae), the most intelligent social insect, are seen in almost all ecological niches. They have the ability to survive in polluted environment too (Chattopadhyay & Ghosh, 2003). However, their adaptive power to withstand the pressure of pollution varies among the species. Pollutants, therefore, exert their effects on species diversity of ants (Biswas *et al*. 1998).

Kolkata is considered as one of the highly polluted metros in India. It is well known that vehicular exhausts are the major contributor of lead pollution. Use of lead free fuel for vehicles has become mandatory in this city from the 1st February 2000. Before that the lead used to come out with the vehicular exhausts and get deposited on the roadside soil without much drifting.

In that condition also ants are seen to survive as usual. Attempts were made to measure lead concentration of road side soil and to find out community structure and population density of the major species of ants residing on soil under such polluted condition.

After the change condition, i.e., using lead free fuel for vehicle mandatorily, both the parameters are measured again for comparison.

The data thus obtained is fed to GIS and the results thus obtained would probably help to analysis easily the relation between faunal data with the soil parameters. This approach may be useful to the end user to study the status of road side soil pollution, the biodiversity on the soil, the relationship in between and to establish thereby the dominating species for that particular type of soil.

MATERIALS & METHODS

Four major roads of Kolkata were selected as study sites, one each at East, Central, North and South Kolkata which will be referred to as EC, CC, NC and SC respectively (Fig. 1).

Soil samples were collected at monthly intervals for 24 months (1995-1997) from three horizontal plots – A, B and C - away from the road respectively. Each plot measured about 15 feet by 5 feet.

Ten random samples of soil were collected from each plot from 0-5 cm depth following standard procedure.

Ants were separated from the soil samples by hand picking and through light extraction funnel (Holldobler and Wilson, 1990). Identification and numerical strength of ant species were estimated.

Estimation of lead (in ppm) content in soil samples was done by AAS Geochemically with the help of Geological Survey of India, Kolkata.

The same procedures were followed at the time of repeating the samples in the year 2003-2004.

A GIS (using Arc View and its internal geo-database) is prepared with the accumulated data of concentration of lead of road side soil as well as the population density of dominating species of ant before and after the introduction of the lead-free fuel. Selected portion of the roads (study sites) has been considered to prepare the GIS on KMDA ward boundary data. Three buffers created on roads for representing the zone of study A, B & C (Sarkar, 2003).

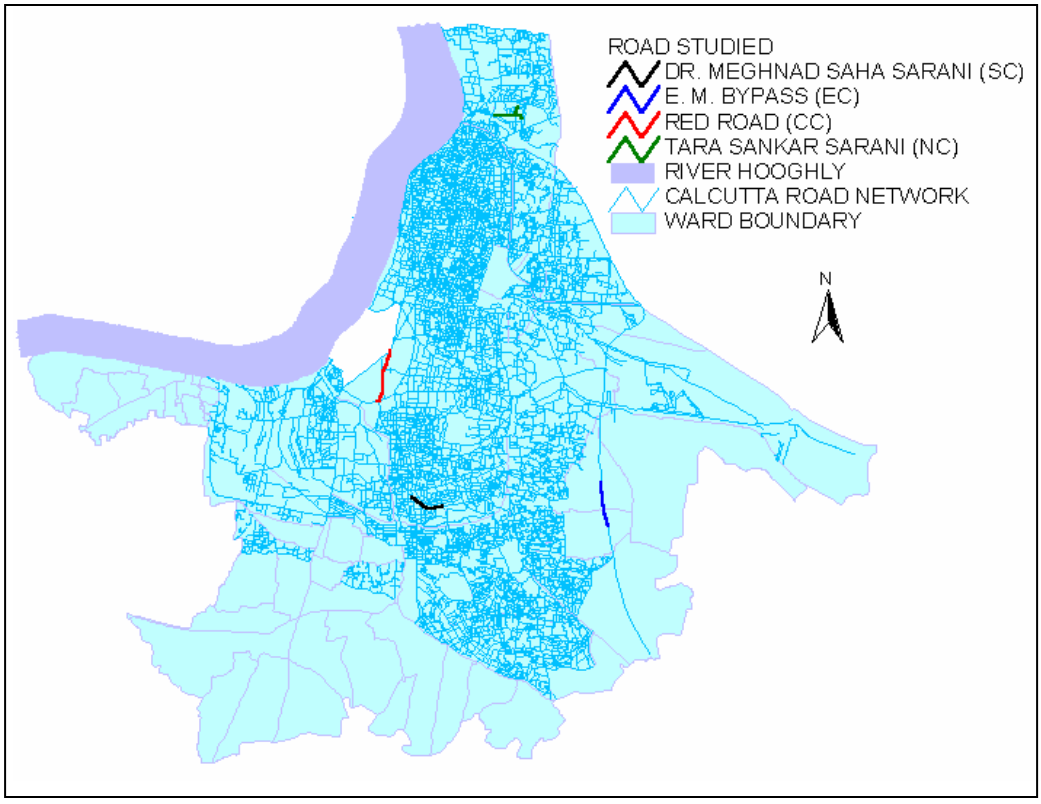

Fig. 1. Showing the Study Sites

RESULTS AND DISCUSSION

Concentration of Lead (in ppm) in soil:

Concentration of lead was found to vary at different plots and sites, as well (Table 1). Except NC, in all other sites maximum concentration was found at plot A, nearest to the road and minimum was at plot C, farthest to the road. On the other hand, on an average minimum concentration of lead was found at EC and maximum was found at NC. Though lead load in road side soil is directly related with the intensity of the vehicles and congestion of the road, vegetation on the soil also played a role in uptaking lead load from the soil (Bhalsberg – Phalsson, 1989, Migula and Binkowska, 1993). Very poor vegetation and congested road at NC in comparison to any other sites might have contributed maximum concentration of lead in soil; whereas at EC the concentration of the same is found minimum. The concentration of lead in the road side soil of SC and CC were in between in increasing manner might have been described in the same light (Table 1 & Fig. 2).

		Plot	NC	SC	EC	CC
1st Observation	Lead (ppm)	A	358.3	203.75	140	301
		B	210	107.5	108.75	296
		C	435	103.75	125	183
	Population of *S. geminata* (Mean)	A	4.21	15.00	18.67	18.71
		B	5.13	10.67	14.08	6.38
		C	11.21	5.00	7.67	4.96
2nd Observation	Lead (ppm)	A	365	52.5	75	195
		B	295	25	95	120
		C	230	25	40	130
	Population of *S. geminata* (Mean)	A	3.85	12.00	14.00	15.5
		B	3.61	8.35	15.02	8.00
		C	7.38	7.00	7.01	4.59

Table 1 : Site and Plot-wise Concentration of Lead and population of *S. geminata*

In the second observation it is found that the concentration of lead in soil has lowered down considerably in all the plots of all the sites; which might be the effect of mandatory use of lead-free fuel for the vehicles. The maximum concentration is again found to be at NC, whereas the minimum is at SC. AT NC no marked change is seen in total condition of the road area. But at SC a well-maintained garden on the divider of the road has come up which might be the cause of lowering the lead load in the soil remarkably (Table 1, Fig. 3 & 4).

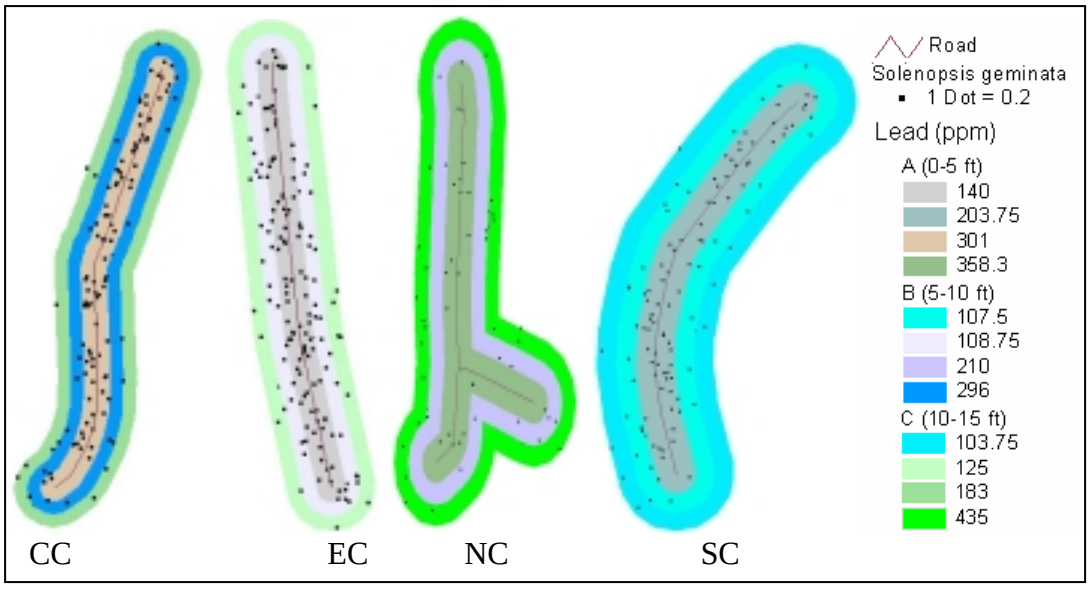

Fig. 2 : Showing the concentration of Lead (in ppm) along with the population of *S. geminata* in different plots of different sites during 1995-97 (1st observation).

Faunal Composition:

During first observation 20, 17, 17 and 13 species were recorded from EC, CC, SC and NC respectively. It might be the positive effect of rich vegetation and low concentration of lead in soil, which influenced the maximum diversity of species at EC and the reverse condition at NC might have negative effect on the variation of species. Out of all those species recorded, *Solenopsis geminata* (Fabricius) was found to be dominating in all the sites outnumbering all other species. This might be attributed to the better adaptability of *S. geminata* than any other species to this environment and using the opportunity of less interspecific competition in that particular condition of those sites.

In the second observation also it is seen that the *S. geminata* again have come up as a dominating species in all the sites, though the average total population is found somewhat less than the earlier observation (Table 1). As this time of observation lead load of soil in all the sites is measured lower, the other species of ants, which are less tolerant to the lead, have flourished better than earlier condition. This might be the cause of lowering down the population of *S. geminata* due to stiffer interspecific competition (Table 1 & Fig.3).

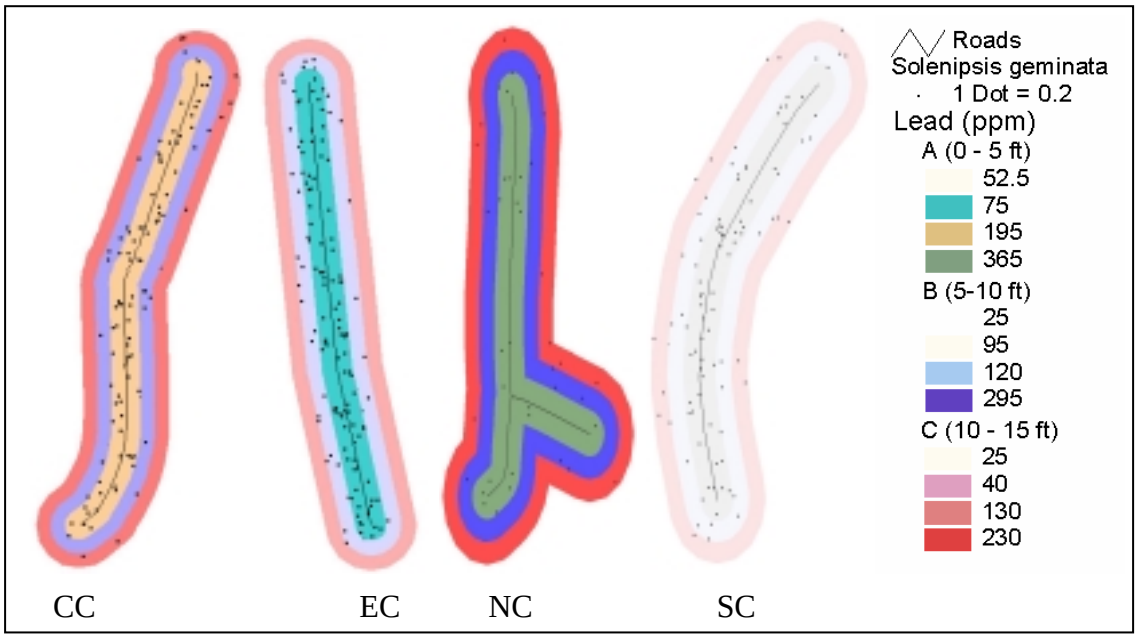

Fig. 3: Showing the concentration of Lead (in ppm) along with the population of *S. geminata* in different plots of different sites during 2003-04. (2nd observation)

Whatever it may be, the species *Solenopsis geminata* has come out as the most dominating species of ant thriving on the road side soil.

This wide spread presence of *S. geminata* in the road side soil of Kolkata supported by earlier findings of Wheeler (1913)

This high level of tolerance of *S. geminata* to the polluted environment and ability to flourish its population in that condition have conjointly make it possible to establish this species as an 'Index Species'. Though thorough investigation in this regard is necessary to come to a final inference.

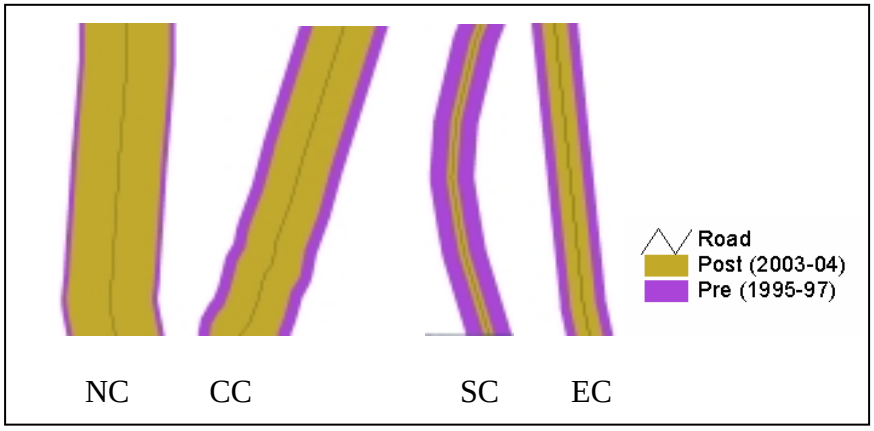

Fig. 4 : Showing lead load on road in pre and post situation

CONCLUSION

This attempt might be useful to make the end users understand about the concentration of lead or other pollutant in the roadside soil of Kolkata and would help to create maps on this aspect. It would be useful also to establish the pattern of soil biodiversity and to know about the population abundance of a particular soil dwelling species and to draw relationship between the edaphic factor and that species population.

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REFERENCE

Bahlsberg-Phalsson, A. 1989. Toxicity of heavy metals (Zn, Cu, Cd, Pb) to vascular plants, *Water Air, Soil Pollut*., **47** : 287-319.

Biswas, B.K., Chakraborty, D, Konar, S.K. 1998. Impact of Environmental Pollution on species diversity of macrobenthic fauna in river Damodar, *Environment & Ecology*, **16(4)** : 919-923.

Chattopadhyay, Achintya and Ghosh Soumyendra Nath. 2003. Effect of Vehicular lead pollution on biodiversity with special reference to ants. *Rec. zool. Surv. India* : **101** (Part 1-2) : 139-160.

Holldobler, B. and Wilson, E.O. 1990. *The Ants*. Harvard University Press, Cambridge, MA, 732 pp.

Migula, P and Binkowska, K. 1993. Feeding strategies of grasshoppers (*Chorthippus* sp.) on heavy metal contaminated plants. *The science of the Total Environment*, Supplement 1993, Elsevier Science Publishers B.V., Amsterdam.

Sarkar, B.C. 2003. Geographic Information System and its role in Geo-Environmental Issues. ENVIS Centre on Mining Environment, Indian School of Mines, Dhanbad, 143 pp.

Wheeler, W.M. 1913. *Ants.* Columbia Univ. Press, New York. 663 pp.