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AVAILABLE LEAD, COPPER AND ZINC IN THE SOILS OF PORTO, PORTUGAL

Heavy metals are one of the residues of human activity that pose sever problems, and sometimes hazards, for sustainable urban development. The cities of countries like Portugal have been undergoing rapid change in the 20 years since 1975 through the impetus of membership of the European Union and the general increase in well-being of the population. This has led to large increases in vehicular traffic and thus of exhaust emissions.

Measurements of atmospheric lead at the Science Faculty building of the University of Oporto show concentrations ranging from 0.069 to 3.8 $\mu g\ m^{-3}$ with 10% of all observations exceeding the Portugese guideline of 2$\mu g\ m^{-3}$ (Vasconcelos, 1988). The mean concentration in Oporto of 0.48 $\mu g\ m^{-3}$ exceeds reported mean values for Oslo, Chicago and Tuscon, but is slightly less than that for Copacabana of 0.499 $\mu g\ m^{-3}$. The pattern of occurrence of high atmospheric concentrations is influenced by both human activity and weather, with times of traffic congestion and dry weather favouring development of high levels of lead in the air.

Levels of lead in the soil reflect the historic build-up of heavy metals and not the immediate weather or traffic conditions, although lead and other heavy metals are leached slowly to lower soil horizons. A survey of 84 sites in the city of Oporto was initiated in July 1990 and repeated in July 1991 and July 1992. Surface soil samples were collected and their EDTA-extractable lead, copper and zinc contents were determined. Mean lead concentrations ranged from 110.9 $\mu g\ g^{-1}$ in 1990 to 132 $\mu g\ g^{-1}$ in 1991, while copper showed a range in the overall mean from 32.1 $\mu g\ g^{-1}$ in 1991 to 103.5 in 1990. The highest individual lead concentration was 380 $\mu g\ g^{-1}$, the highest copper 308 $\mu g\ g^{-1}$ and the highest zinc 1320 $\mu g\ g^{-1}$. Cites close to the centre had the highest lead concentrations and were higher than any sites immediately adjacent to major traffic arteries in the suburbs.

A more extensive survey of 183 sites in 1993 which determined both EDTA-extractable (available) and aqua regia-extractable (total) lead, copper and zinc revealed available lead concentrations ranging from 12 to 1552 $\mu g\ g^{-1}$, copper from 1 to 146 $\mu g\ g^{-1}$ and zinc 8 to 504 $\mu g\ g^{-1}$. Total concentrations ranges were lead: 15 to 10125 $\mu g\ g^{-1}$, copper 5 to 362 $\mu g\ g^{-1}$ and zinc 8 to 825 $\mu g\ g^{-1}$.

The pattern of concentration closely corresponds to that in Manchester, UK with high levels of lead in surface soils in the older, more central parts of the city and then relatively high concentrations close to main traffic arteries running out from the city centre. Manchester also exhibits the general tendency of decreasing surface soil load away from the main roads (Douglas et al, 1993). To test this in Oporto, the large, tree-covered roundabout, Rotounda da Boavista was sampled intensively in 1991 and 1992 with three transects running from the kerb to the centre of the roundabout. In all cases, except on one occasion at one transect. lead concentrations decreased away from the kerb demonstrating that at present, and in the recent past, vehicular emissions of lead are the major source of lead in surface soil near main traffic routes.

This analysis indicates the local variability of lead in urban soils and the significantly higher concentrations of heavy metals in inner cities. Local pockets of extremely high values indicate the need for information on contaminated land and the importance of developing databases of environmental information for planning the sustainable development of cities.