Heterogeneity as an index of anthropogenic disturbance of soil and vegetation in urban Parks

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The conditions of urban ecosystems depend on a wide range of anthropogenic factors, one of which is visitor pressure on urban parks.

This study aims: (1) to analyze soil properties and vegetation characteristics of different open areas, and (2) to determine an index of disturbance for these areas, according to their spatial heterogeneity.

The study was conducted in Tel-Aviv, and addressed two scales: (1) Land Use Units (municipal parks and vacant lots); and (2) Microenvironment (under tree, under bush, herbaceous area, lawn, and path). In each type of microenvironment, soil was sampled at seven points, from layers at two depths (0-2 and 5-10 cm). Before the sampling, penetration depth, litter biomass and vegetation characteristics (vegetation cover, number of species, and vegetation height) were determined in the field. In each soil sample gravimetric soil moisture and organic matter contents were determined, and pH, electrical conductivity and soluble-ion contents were measured in a 1:1 water extraction.

The level of disturbance by visitors was scored for each microenvironment according to field evidence of trampling, such as lack of vegetation cover and litter biomass.

The results show strong differences in soil properties among the various microenvironments: penetration depth ranged from a few millimeters up to $\sim$ 3 cm; organic matter content from less than 1% to 10%; soil moisture content from a few percents to $\sim$ 30%; electrical conductivity from $\sim$ 0.3 to $\sim$2 dS/m; sodium content from $\sim$ 1 to 7.5 meq/kg; chlorine content from $\sim$ 0.5 to $\sim$9 meq/kg; and litter biomass from 0.5 to 1.4 kg/m2.

The vegetation characteristics also varied among the microenvironments: vegetation cover ranged from 11 to 99 %; number of species from 2 to11; and vegetation height from 5 to 35 cm.

In order to assess the level of heterogeneity of soil and vegetation, an integral index, based on the number of Duncan groups, has been calculated.

Regarding the Scale of Land Use unit, it was found that the highest heterogeneity of soil characteristics corresponded with the lowest species richness.

For the smaller-scale unit – Microenvironment – an index was developed that defines the status of disturbance, and it was used to sort the microenvironments into several groups.

High correlation between percentiles and averages of soil properties was found for the microenvironments. This hints at a fractal structure of soil properties distribution at the microenvironment level.