Assessing ecosystem functions under metal stress in a grassland area

Stefan A.E. Kools (1), M.E. Boivin (1,2), C.A.M van Gestel (1), M. Rutgers (2), H.A Verhoef (1), A. van der Wurff (3), N.M. van Straalen (1)

(1) Department of Animal Ecology, Institute of Ecology, Vrije Universiteit Amsterdam (VU)
e-mail: skools@bio.vu.nl
(2) National Institute of Public Health and the Environment (RIVM)
(3) Wageningen University and Research Center (WUR)

The nature-reserve area "De Ronde Venen", located 30 km southeast of Amsterdam is a grassland area, which is extensively grazed by sheep and is one of the three areas selected for SSEO research. It was selected, because from the 16th to the 20th century, municipal garbage from cities was dumped in this area to enrich the land. This resulted in a new soil profile: sand/clay on peat. Nowadays, these soils are considered to present a potential risk, because they contain elevated levels of lead, copper, zinc and cadmium. Given the fact that the area is a nature reserve, ecological implications of these levels are a grave concern and are therefore being investigated by a consortium of RIVM, WUR and VU. The scope of this research was described in SSEO Newsletter 4 and presented at the SETAC Europe meeting in Vienna, Austria. Preliminary results were shown at last year's meeting of the SSEO programme in Utrecht, The Netherlands.

The project started by compiling an inventory of the field situation. Metal concentrations and abundances of some dominant species present (microbes, nematodes and enchytraeids) were determined in these grasslands. Subsequently, an indoor experiment was designed to investigate functional implications of heavy metal pollution. It was hypothesised that ecological functions would be affected by pollution, as key species would have disappeared or adapted. The functional variables that we monitored in these experiments were: primary production (i.e. plant growth), decomposition (i.e. CO_2 production) and nitrogen mineralisation (nitrate and ammonium levels). Bait-lamina sticks containing a cellulose & bran mixture were inserted into columns to calculate consumption by primarily enchytraeids and earthworms. Resistance to stress is considered another important function and this was assessed by applying an increasing level of extra stress to intact soil cores from locations with different levels of metal pollution. The cores were incubated in the laboratory under standard climatic conditions and the extra stress applied was an increased level of zinc chloride in rainwater. A complete ecological assessment of the area will be made by closely monitoring system-related variables during this period and determining structural variables, e.g. nematodes, bacteria, enchytraeids and earthworms.

Results of the monitoring under stress revealed that total plant production did not change by the application of zinc. No obvious results were found of a range of different treatment levels. Because several plant species are present in these grasslands, it is premature to draw firm conclusions about the Zn concentration, although it is generally considered vital in ecosystem functioning. Decomposition (~average CO_2 production) was found not to have changed by the extra stress factor either, although variation increased with increasing treatment levels. Likewise, nitrate and ammonium levels did not show a consistent pattern. It was concluded from these results and from the fact that no structural changes were observed that none of the functions showed any response to the extra stress. We propose changes in methodology because the desired level of stress was not achieved which may limit the firmness of this conclusion. Following

experiments will use another stressor to assess these functions and will be

performed in 2003 again by the same consortium.
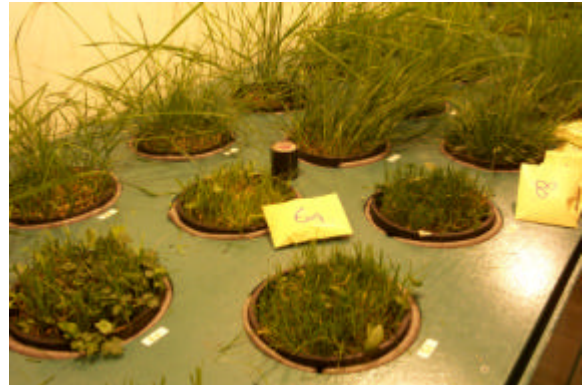

Fig. 1: A cut-open example of the columns used for this project (above)

Fig. 2: Determination of functions (here: total plant production) in a standardised incubation room (above)

Even though the ecological functions examined in this experiment did not show any changes with increasing stress application, some fascinating observations were made. It was shown that not only different heavy metal concentrations existed the within a single field, but also different a-biotic factors such as pH, soil humidity, total carbon and total nitrogen levels which could affect the outcome of functional variables. The responses of structural aspects revealed that for example the abundance and diversity of enchytraeids did indeed correlate negatively with increasing metal levels. This could be an explanation for the observed reduction in consumption of the bait-lamina sticks in the more polluted columns. Noteworthy was the fact that this was also consistent with increasing treatment levels of zinc, so this was the only variable that showed any response.

This result was not expected, as the zinc treatment did not cause any changes in diversity or total numbers of earthworms or enchytraeids. The combined research effort of RIVM, WUR and the VU will be further integrated this year to make a full ecological assessment of these grassland areas. In co-operation with the same partners, an intensive field campaign will be conducted this year to relate more detailed information on structural and functional aspects. This field sampling campaign involving a grid to spatially plot the relationships between different grassland areas and heavy-metal pollution levels will take place in the polluted Demmerikse Polder, as well as other locations to enable comparisons to be made.