Screening of hot spots of emerging pollutants in soil, ground water and surface water in The Netherlands: breaking the vicious cycle

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Background

Emerging pollutants are well known from the aquatic environment, but often less studied in the soil environment. There are, however, many pathways by which emerging pollutants may reach the soil and consequently the ground water by infiltration or the surface water by leaching. However, little attention has been paid to these contamination pathways up to this day.

Study design

In 2012 a pilot project was conducted with the objective to investigate the presence and potential risks of pharmaceuticals (veterinary and human) and steroidal hormones in the Dutch soil environment. Pilot studies focussed on four scenarios of contamination that were chosen in collaboration with stakeholders such as the Dutch Soil Network SKB, two water boards, two regional authorities (provinces) and the Soil Protection Technical Commitee TCB, all of which also contributed financially to the study. Contaminants in soil were studied in relation to their presence in ground water and surface water where relevant. In addition to chemical analysis, *in vitro* screening for hormonal activity (CALUX assays) was applied.

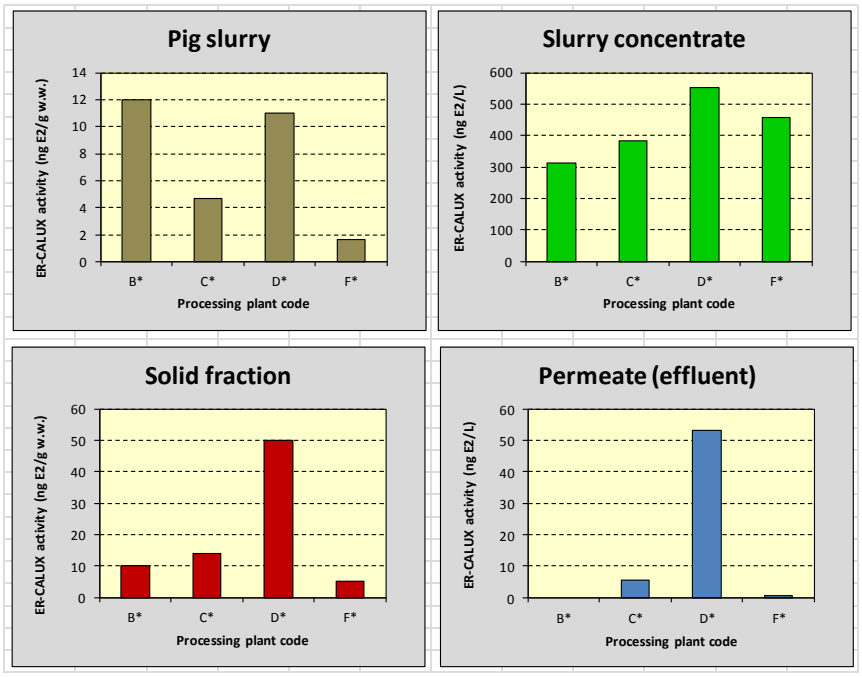

***Figure 2**. Estrogenic acticity (ER-CALUX) in pig slurry and different fractions after processing in slurry processing plants.*

Conclusion

In general the results indicate that the investigated sources were contaminated by pharmaceuticals and hormones as expected (horse dung, sludge, sewerage, slurry concentrate), but that application to the soil did in most cases not result in measurable contamination of soil, ground water or surface water during a monitoring period of 2 months.

***Figure 1**. Equestrian sports facility where dung contaminated with parasiticides is deposited on the pasture (Scenario 1, left) and dumping of sludge from a stream contaminated with hormones and pharmaceuticals on an adjacent field (Scenario 2, right).*

Results

Scenario 1 - Parasiticide use in equestrian sports facilties

- Concentrations of ivermectin in dung shortly after treatment are high enough to kill dung insects.
- Ivermectin and moxidectin were not detected in soil, ground water and surface water at or near the pastures of the facilities where frequently treated horses are kept (see Fig. 1).

Scenario 2 - Dumping on soil of sludge dredged from a sludge trap in a contaminated stream

- No hormones or human pharmaceuticals were detected in soil or ground water up to 2 months after applying sludge to a pasture. (Fig. 1)
- However, concentrations of (persistent) hormones and human pharmaceuticals present in the sludge itself, could be high enough to pose a risk to aquatic life in the stream.

Scenario 3 - Soil infiltration of sewerage from overflows and leaking sewers

- Human pharmaceuticals (sulphamethoxazole and diatrizoic acid) were detected in a drinking water well close to a leaking sewer. This represents an undesired presence, but currently levels do not pose a risk to human health.
- Several hormones and human pharmaceuticals were present in the sediment and surface water of a pond that frequently receives discharges from a sewer overflow. The substances were not found in the ground water at the site.

Scenario 4 - Application of pig slurry concentrate on arable fields as an alternative for artificial fertilizers

- Pig slurry contains many different hormones, hormonal activity (Fig. 2) and veterinary antibiotics.
- After processing the slurry, most hormones and antibiotics are found in the slurry concentrate and the solid residue. The permeate (effluent) is relatively clean.
- Application of concentrate to an arable field did not result in measurable levels of hormones, hormonal activity and antibiotics in soil, ground water and drainage water.

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