Science for Environment Policy
DG Environment News Alert Service
European Commission

29 March 2012

Antibiotic contamination of soils mapped across Europe

A new study provides an approach for estimating the risk of antibiotic contamination associated with different soils and different antimicrobial products. The researchers estimated and mapped soil contamination risk across Europe and suggest that their methods could be used to inform antibiotic resistance monitoring or policies designed to reduce contamination.

Previous studies have found that releasing antibiotics into the environment contributes to the development of antibiotic resistance. A major source of antibiotics entering the environment is through agricultural use, in the prevention and treatment of livestock diseases. The drugs are transferred to soils when manure from the animals is spread on farmland. Under Directive EC 92/18/EC, all drugs used in veterinary medicine are subject to ecotoxicological assessment of their environmental risks, but after a product is marketed, there is no requirement to monitor build up in the environment, or resistance.

The characteristics of different antibiotics and soils affect how the drugs accumulate in the environment. In environmental risk assessment, the contamination risk associated with an antibiotic depends on its behaviour in the environment, including how quickly it breaks down and how well it sticks to particles in the soil. Soil factors, such as organic matter content, as well as the chemical nature of the drug itself, can influence this behaviour.

This study estimated the effects of different soil types and farming practices on soil contamination by antibiotics. The results were mapped to reveal how the risk of contamination varies across Europe. Contamination risk was estimated using a measure the researchers called 'soil vulnerability', focusing on 12 common antibiotics used in pig and cattle feed. They calculated soil vulnerability based on livestock densities (determining the amount of antibiotic released), soil and antibiotic type, and land use.

According to their assessment, Belgium, Ireland, the Netherlands, Switzerland, Denmark, Germany and the UK face the highest risk of contamination, while Bulgaria, Greece and Sweden face a much lower risk. The antibiotic enrofloxacin, which previous studies have found in soil fertilized with poultry and cattle manure, was associated with the highest risk of soil contamination in this study of soils fertilized with cattle and pig manure. Tetracycline antibiotics, tylosin and sulfodiazine were also high risk, while chlorpyridazine, florfenicol and sulfamethazine were low risk. Tetracyclines are the most heavily used antibiotics in agriculture, and have been found previously in soils fertilized with manure from pigs, cattle and poultry. But the high risks associated with tetracyclines and enrofloxacin are also related to values describing their ability to stick to and remain in the soil – compared to some of the lower risk antibiotics they stick tightly and take a long time to break down.

The researchers say their study, based purely on data analysis and mapping of vulnerability, provides a framework for evaluating antibiotic contamination risk over large areas. Using grids with 10km-wide squares, they were also able to illustrate risk at smaller scales, for instance, they could pinpoint contamination hotspots in the southwest of England and the north-western tip of France.

Approaches that rank different regions and antimicrobial products according to contamination risk may be useful in decision-making about antibiotic use and in prioritising monitoring of antibiotic resistance. However, in the current study, estimates were produced without detailed national data, requiring assumptions and oversimplifications that may leave the results open to some inaccuracy. It would be preferable to use data accurate to the level of individual farms or even individual animals. Environmental risk data for antibiotics were also limited because companies are not required to release such information publicly. The researchers say open access to this data would help improve future contamination risk assessments.

Source: De La Torre, A. Iglesias, I., Carballo, M., Ramírez, P., Muñoz, M.J. (2012). An approach for mapping the vulnerability of European Union Soils to Antibiotic Contamination. *Science of the Total Environment*. 414: 672-679.
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Theme(s): Agriculture, Soil