Title: A new approach to impact assessment of the use of sludge in agriculture

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Summary:

This poster discusses a new approach for assessing the use of sludge in agriculture. This multidisciplinary method includes, soil, water and microbiological aspects of urban sludge application in agriculture. The discussion on the impact of urban sludge application on agricultural land has traditionally dealt with the determination of heavy metals in soils. In this context, international and national regulations have been introduced in order to determine the feasibility of the use of urban sludge as soil amendments. However, other environmental impacts caused by high amounts of nitrogen and phosphorus, or the presence and transmission of microbial pathogens, have not been taken into account until recently. Only a few specific guidelines have been developed for these indicators, and there are no clear international agreements. In order to measure –using a multidisciplinary approach– the influence of other pollutants such as dissolved organic carbon, nitrogen and the presence and persistence of microbial pathogens, we have devised a field study using both aerobic or anaerobic urban sludge at three different concentrations. The experiment has been running for two years under the Mediterranean type of climate, in a calcaric fluvisol used for agricultural purposes.

Introduction

In Spain, one of the most popular uses of urban sludge is for application on soil for agricultural purposes. The proposed Integrated National Waste Plan (2008-2015) (PNIR) envisages the development of a second National Plan of Sewage Sludge, as the data indicate that there has been a significant increase in the production of sludge, and its use in agriculture. According to the National Plan, the amounts for agricultural recovery in recent years rose from 606,119 (2001) to 725,433 tons (2005), which represents a notable increase in percentage terms. This 20% increase in the amount of sewage sludge in a four-year period indicates that there will be increasingly important quantities of sludge available for agricultural land use. Systems are therefore needed to assess the conditions for its application, in order to ensure that there is no risk to public health or to the environment. Some authors consider the soil as one of the most important components for its role as a carbon source and destination of both organic and inorganic forms. Other authors such as (Bellamy, Loveland et al. 2005) have proposed a revision of the current status of the role of soil in relation to climate change, based on a review of studies in the UK. The role of soil in carbon sequestration is being carefully examined by numerous authors. One of them, (Lal et al, 2003), proposes the use of soil as a carbon sink for greenhouse gas emissions. Another significant aspect is the biosecurity of the sludge. It should be noted that sludge is basically the support and

entry route for new organisms into agricultural ecosystems. These microorganisms are in some cases pathogenic bacteria which are usually transmitted through non-drinking water. Thus, in the U.S., it has been found that 60% of the pollution of rivers and 45% of that of lakes is due to treatment of agricultural sources with amendments from slurry (1998 USA National Water Quality Inventory), and that the most frequently encountered bacterial agents are Escherichia coli and Salmonella. Between 1991 and 2000, 65 episodes of human infections associated with water were recorded in the UK, while in USA it was 230 (Guber et al, 2007). In view of these cases, the increased use of agricultural amendments based on municipal waste and animals requires careful examination. Several studies have shown that coliform appears to be a clear trend in decreasing levels over time after application to agricultural land. However, other pathogens such as enterococci or Salmonella require further study.

Materials and Methods

Three blocks of 8 plots each, with an area of 25 m^2 each were randomly distributed in a homogeneous area in an experimental farm provided by IMIDRA (Institute for Crop and Food Research). The blocks were sufficiently separated from each other so as to avoid any possible effect due to contact between the blocks. Different type(s) and dose(s) of sewage sludge were applied in each one. In total, two types of sewage sludge were used at 3 different doses (40, 80 and 160 ton/ha), each with three replicates. A monitoring program was designed depending on the studied parameter; either soil, groundwater or microbiological aspects. After 2 years of monitoring, the results were analysed. The indicators considered to be relevant from the standpoint of health and environment were derived from the results of panel discussion and comparison with the results from other similar research.

Results

Mineralisation and transformation of organic matter into CO_2 are the main processes that occur after application of sewage sludge. There are statistically significant differences in relation to treatment and soil respiration. The larger the doses, the higher the respiration during the first year. Annual variations could be explained by the irregular climatic data for the monitoring period. The maximum values relate to rainfall events and moderate temperatures. Soil respiration notably increases, although in this case the pattern appears to be linked to the weather conditions. Maximum values of respiration show a pattern linked to periods of rain and moderate temperatures. There is also an increase in soluble carbon concentration during the first year. In addition, electrical conductivity increases and pH decreases with the application of sludge.

All these data suggest that the focus of the environmental assessment of this technology is incorrect, since European legislation has been based on monitoring heavy metals, a key element in food security. However this approach does not address the influence of climate change on the use of sludge and proposes the use of previous indicators such as the monitoring of soil respiration per unit area as standard indicators of global climate change impact.

With regards aspects related to biosecurity, the evolution of microbial populations after the application of sludge is a key aspect. There is a total lack of specific legislation on this issue, except for the initial analysis of sewage sludge. The results of our experiment

are inconclusive, but generally we see a decrease in faecal coliform content over time. There were also significant differences in the evolution of the type of microbial populations. The evolution of microbial populations differs in relation to the doses and period of the year, and can regulate certain ecological aspects such as nitrification capacity. We consider it necessary to design new microbial indicators capable of ensuring biosafety.

In relation to the flow and transport of soluble contaminants into groundwater, infiltration tests and flow patterns reflected the mobility of potentially contaminating soluble elements such as different forms of nitrogen. Our results are consistent with other research groups (Jego et al, 2008), (Martínez Y, Albiach J. 2006), (Navarro A, Carbonell M. 2007), and highlight the importance of addressing these aspects of diffuse pollution from a geographic point of view. New criteria need to be established for sludge application linked to groundwater quality standards.

In summary, except in very specific cases, assessments are not carried out to determine the health aspects of the use of sludge in agriculture, and they therefore do not evaluate the release of potentially pathogenic microorganisms, or the appearance of pollution phenomena in underground waters due to the transformation of nitrogenised compounds to nitrates. The development of new criteria which include these aspects is essential for an environmental and/or health assessment of this practice, as these are key parameters which should be included in both the strategic environmental assessment procedures and in the assessment of environmental impact in specific projects.

Conclusions.

The current legislation has proved ineffective for an appropriate environmental assessment of the application of sewage sludge. It is therefore necessary to develop new assessment criteria in order to include the recommendations of the FAO (1992) and WHO (2008) on biosecurity and microbiological control of drinking water, and to estimate the impact of this technology on climate change.

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