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A Comparative Analysis of Turkish and European Union Regulations Concerning Use of Sewage Sludge in Agriculture[1]

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Abstract

This study presents a comparative analysis between the current regulations for the agricultural use of urban sewage sludge application and sludge management policies in Turkey, and the regulations which deal with these matters in European Union countries. It aims to examine and compare the effectiveness of current policies designed to prevent sewage sludge causing soil pollution in these countries. In doing so, different practices in the different countries have to be taken into account. The aim of this study is to reveal to what extent the values adopted by both the European Union member countries and Turkey deviate from the stated values and intentions of the European Union. The results indicate that the Netherlands has proved to be the country which has been most protective of its environments in this field, by specifying the lowest levels in Europe for the five heavy metals found in sewage sludge when it is applied to the soil. Since Turkey accepts the lowest levels for heavy metals in soil, it is considered to provide more protection than the European Union countries

Key words: Sewage Sludge Regulation, Soil Protection, Environmental Policy, Agriculture

1. Introduction

Sewage sludge is a waste generated by urban and industrial treatment plants. It is used for soil amendment because of the nutrients it contains. However, it also contains heavy metals and other polluting substances which harm the soil and the environment. According to the European Union's Urban Wastewater Treatment Regulations of 08.01.2006, in order for Turkey to be considered for full membership of the Union, treatment plants should be established in any sites which have a

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population of more than 2,000 (TOG, 2006). After this, sewage sludge production will be allowed to increase incrementally within the following five to ten years.

Domestic and industrial sludge which is released into the environment without being treated results in a number of health problems associated with low quality water (De Angelis, 2001), such as coughing, sore throats and skin problems including reddening of the hands, face and eyes (Lewis et al., 2002). There is also a high risk of cancer among workers in treatment facilities and among those who apply sludge to the land (Thorn and Keretes, 2001; Hansen et al., 2003; Ayres et al., 2007). Therefore, a sustainable environment protection policy requires the treatment of all urban and industrial wastes.

According to the data from 2008, there are 236 urban wastewater treatment plants in Turkey. These serve 46% of the country's population (TSI, 2008). Figure 1 shows the proportions of the population served by urban wastewater treatment plants in European Union countries and Turkey. According to Figure 1, the rates are: 94,80% in the countries of group 1 (Netherlands, Germany, Austria, Spain); 83,86% in the countries of group 2 (Denmark, Greece, Estonia, Sweden, Ireland, Finland, France); 75% in the countries of group 3 (Czech Republic, Portugal, Norway); 67,20% in countries of group 4 (Latvia, Belgium, Italy, Lithuania, Poland); 55,75% in the countries of group 5 (Hungary, Slovakia, Iceland, Slovenia); 46,33% in the countries of group 6 (Malta, Bulgaria, Turkey) and 29,50% in the countries of group 7 (Cyprus, Romania). In this case, with its 46% ratio, Turkey could be grouped with some of the least efficient countries in terms of the extent to which its population benefits from wastewater treatment plants (TSI, 2008; EC, 2009).

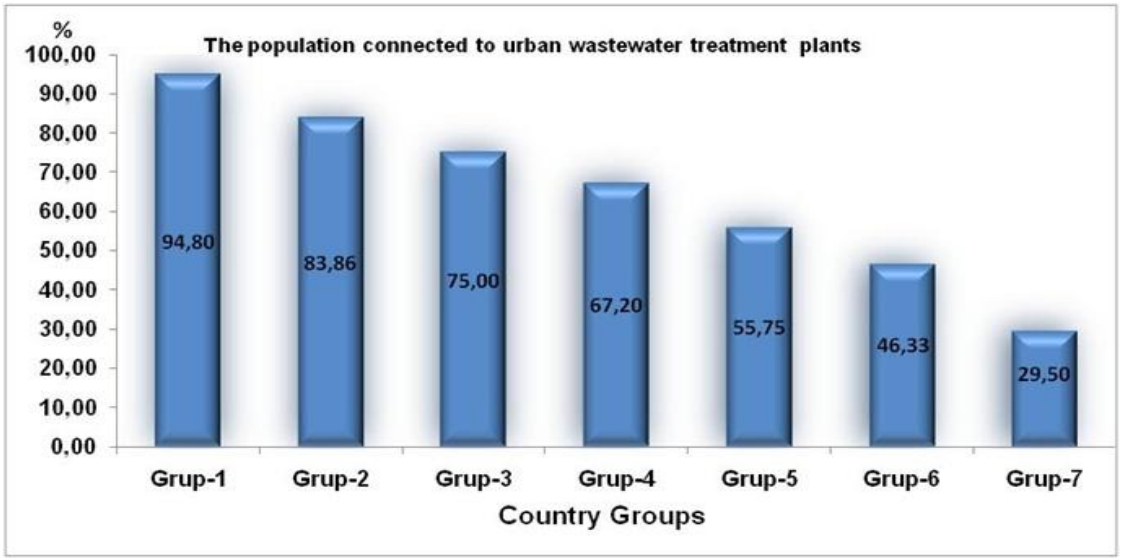

Figure 1: The population ratio connected to urban wastewater treatment in EU and Turkey

The effective disposal of the sewage sludge generated from wastewater treatment plants without harming the environment is an important challenge. The European Union Commission, in its decision dated 19.07.2006, suggested that the sewage sludge could be used as a fertilizer, provided that it is not a threat to the environment, or human and animal health (EC, 2006). Turkey has set out a number of principles and regulations regarding the use of sewage sludge in agricultural land through

its SPCR (Soil Pollution Control Regulation), of 3 August 2010, which were issued as part of the process of its application for EU membership. EU countries also issued various regulations on sewage sludge between 1987 and 1999, in accordance with EUSSD (European Union Sewage Sludge Directive) of 1986.

2. Data and Material

In this study, the regulations on the agricultural use of sewage sludge in Turkey, the EU and its member states have been used as a primary data source. As a secondary data source, the results of inland and overseas studies on similar subjects have been considered.

3. Research Methodology

In comparing the sewage sludge regulations, we have benefited from the studies of Tanrıvermiş (2006) and have applied a method of comparison in which the values of heavy metals have been accepted as 100, as set out in the regulatory framework of the EU.

In comparing the EUSSD with other countries' regulations, the following indicators have been taken as the basis of the analysis:

1- The maximum heavy metal limits for sewage sludge when it is applied to the land,

2- The maximum heavy metal limits allowed in the soil,

3- The pathogenic values of sewage sludge,

4- The prohibitions imposed on sewage sludge application,

5- The amount of sewage sludge allowed to be applied to a hectare.

Since applying industrial sewage sludge to the land is forbidden, only sludge generated from urban treatment plants has been referred to in this study.

4. Results and Analysis

Regulation about sewage sludge was issued in Turkey in 2010 (TOG, 2010). Before this regulation, Turkey put into force 5 regulations which do not include *sewage sludge* in their title. But the term of sewage sludge has been mentioned in some sub-sections of these 5 regulations.

Table 1 shows the amount of sludge generated and the rate of agricultural use in some of the EU member countries and in Turkey. Germany comes first with 2.049 million ton/year, UK comes second with 1.761 million ton/year and Spain comes third with 1.205 million ton/year by means of sludge production. UK comes first in using sewage sludge in agriculture with a figure of 69.34%. It is followed by Denmark with 65%, Spain with 57.016% and France with 42.81% (EC, 2006; Jantzen and Woerd, 2007). In Turkey, it is estimated that annual sludge production is 800 kton DM (1000 ton Dry Material) and agricultural use rate is about 10%.

Countries	Sludge Production (kton DM)	Observingg Year	Agricultural Use (kton DM)	Observing Year	Rate of Agricultural Use (%)
Germany	2.049	2006	611,6	2006	29,85
Austria	254	2008	39,5	2006	15,55
Denmark	140	2007	91	1998	65,00
Finland	160	2000	19	2000	11,88
France	1.087	2008	465,3	2004	42,81
Netherlands	373	2006	0		0,00
UK	1.761	2009	1221,1	2005	69,34
Spain	1.205	2009	687	2006	57,01
Sweden	212	2009	30	2006	14,15
Italy	1056	2005	236,4	2005	22,39
Turkey	800	2009	80	2009	10
TOTAL	9.756		3.464		35.51

Source: Adapted from Jantzen & Woerd (2007) and EC (2009)

Table 1: Sludge production and agricultural use figures in EU member countries and Turkey

4.1. Comparison of the limit values for heavy metals in sludge to be applied on land

Table 2 shows that the maximum level of heavy metals allowed in sewage sludge which will be used in agriculture has been accepted as 100 according to EUSSD. As we can see, the Netherlands is the country which has adopted the most stringent values for preventing soil pollution by adopting the lowest levels for five heavy metals (copper, mercury, lead, nickel, zinc). Denmark has been second in applying the strictest measures in using sewage sludge, by adopting the lowest levels for two heavy metals (cadmium and nickel). Luxemburg is the country which adopts the highest limits for four heavy metals and has been the least restrictive country in terms of the heavy metal limits allowed in sewage sludge.

Countries	Cd	Cu	Hg	Pb	Ni	Zn	Average Value
Germany	25,00	45,71	32,00	75,00	50,00	76,92	50,77
Austria[a]	15,50	23,66	19,20	29,85	14,29	33,85	22,73
Belgium	20,00	27,83	30,00	25,00	25,00	35,38	27,20
Denmark	**2,00**	57,14	3,20	10,00	**7,50**	123,10	33,82
Finland	3,75	34,29	4,00	**8,33**	25,00	46,15	20,25
France	25,00	57,14	40,00	66,67	50,00	92,31	55,19
Netherlands	3,13	**4,29**	**3,00**	**8,33**	**7,50**	**9,23**	**5,91**
Spain	*75,00*	*78,57*	84,00	81,25	87,50	100,00	84,39
Sweden	5,00	34,29	10,00	**8,33**	12,50	24,62	15,79
Italy	50,00	57,14	40,00	62,50	75,00	76,92	60,26
Luxembourg	*75,00*	*78,57*	84,00	81,25	87,50	100,00	84,39
Poland	25,00	45,71	20,00	41,67	25,00	76,92	39,05
Portugal	50,00	57,14	64,00	62,50	75,00	76,92	64,26
Turkey	25,00	57,14	40,00	62,50	75,00	62,50	53,69

[a] States average

Table 2: Comparison of the limit values for heavy metals in sludge for EU and Turkey

4.2. Comparison of the heavy metal limit values for soil to which sludge is applied

Table 3 shows the data organized according to the application of limit values of 100 for heavy metals allowed to be concentrated in the soil to which the sewage sludge will be applied, according to the EUSSD's recommendations. Turkey has adopted the lowest value (6.67) and Portugal has adopted the highest value (133.33) of cadmium. Turkey has adopted the lowest value (4.17) and Spain has adopted the highest value (150) of copper. Turkey has adopted the lowest (5) and Portugal has adopted the highest value (133.33) of mercury. In nickel, Turkey has adopted the lowest value (20) and Spain has adopted the highest value (149.33). In lead, Turkey has adopted the lowest value (4,67) and Portugal has adopted the highest value (150). In zinc, Denmark and Latvia have adopted the lowest values (33.33) and UK (150), Spain (150) and Portugal (150) have adopted the highest values. Spain, Luxembourg and Greece have adopted values equal to or higher than the EU limits for all heavy metals. Since some of the countries have adopted higher limits in accordance with soil pH values, their scores have been counted as more than 100. As a result, Turkey is the country which has adopted the most stringent values for preventing soil pollution by adopting the lowest levels for five heavy metals and Portugal is the country which adopts the highest limits for five heavy metals and has been the least restrictive country in terms of the heavy metal limits allowed in soil.

Countries	**Cd**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**	**Average Valuel**[a]
Germany	50	42,86	66,67	66,67	33,33	66,67	54,37
Austria[b]	66,67	71,43	100	80	33,33	100	75,24
Belgium	66,67	35,71	86,67	66,67	33,33	66,67	59,29
Denmark	16,67	28,57	33,33	20	13,33	**33,33**	24,21
Finland	16,67	71,43	13,33	80	20	50	41,91
France	66,67	71,43	66,67	66,67	33,33	100	67,46
Netherlands	26,67	25,71	20	46,67	28,33	46,67	32,34
UK[c]	100	142,86	66,67	146,67	100	150	117,70
Spain[c]	100	150	100	149,33	100	150	124,89
Sweden	13,33	28,57	20	40	13,33	50	27,54
Italy	50	71,43	66,67	100	33,33	100	70,24
Luxembourg	100	100	100	100	100	100	100,00
Poland	100	53,57	100	66,67	26,67	60	67,82
Portugal[c]	133,33	142,86	133,33	146,67	150	150	142,70
Turkey	**6,67**	**4,17**	**5**	**16,67**	**4,67**	50	**14,53**

[a] EU values as (6<pH<7) [b] States average c Different limits defined according to soil pH

Table 3 Comparison of the limit values for heavy metals in soil for EU and Turkey (EU max=100)

4.3. Comparison of the limit values for pathogen concentration in sludge

The EUSSD regulations do not specify limit values for pathogens in sewage sludge. However, some of the member states have identified the values they allow for the salmonella pathogen. France has identified 8 (8 MPN[2]/10 g DM) of salmonella to be allowed in 10 g sewage sludge. Italy has identified the maximum amount of salmonella to be allowed in 1 g sewage sludge as 1000 (1000 MPN/g DM).

[2]MPN= Most probable number

Poland and Denmark, however, have not allowed the use of sewage sludge containing salmonella (EC 2001) at all. In the regulations of other countries, no explicit identification was encountered. In the draft regulations issued by the EU in 2000 and in Turkey's Soil Pollution Control Regulations of 2010, the pathogenic values allowed in sewage sludge were not defined.

4.4. Comparison of prohibitions on using sewage sludge

In the European Union sewage sludge regulations, a number of prohibitions regarding the agricultural use of sludge have been identified. The use of raw sludge in agriculture and on the land is forbidden. The use of stabilized sewage sludge is subject to certain regulations. The prohibitions of use of sewage sludge are as following (ECC, 1986):

a) on grassland or forage crops, if the grassland is to be grazed or the forage crops are to be harvested before a certain period of time has elapsed (this may not be less than three weeks);

b) on fruit and vegetable crops during the growing season, with the exception of fruit trees

c) on ground intended for the cultivation of fruit and vegetable crops which are normally in direct contact with the soil and normally eaten raw, for a period of ten months preceding the harvest and during the harvest itself.

The member states which have adopted these prohibitions have set out more prohibitions in their regulations. Table 6 shows the prohibitions adopted by EU member states and Turkey, in addition to the prohibitions in the EUSSD in terms of the surface application level of sewage sludge. As a result, France has set out prohibitions for surface application of sludge in six items; Poland in five; Austria, Latvia and Belgium (Walloon) in four and Turkey in three items (EC, 2001; TOG, 2010).

4.5. Comparison of the maximum quantities of sludge to be spread on land in EU and Turkey

It has been accepted that the average amount of sludge used in EU member states is 40 tons / ha per year (Schowanek et al., 2007). The average sewage sludge application amounts per hectare allowed by member states are as following: 25 tons/ year, 100 tons / 3-year in different states of Austria; 120 tons / 3-year in the Walloon region and 40 tons / 2-year in the Flemish region of Belgium; 70 tons / year in Denmark; 50 tons / year in Germany; 150 tons / 3-year in Italy; 20 tons / year in Ireland; 30 tons / year in Luxembourg; 20 tons / year in Netherlands; 60 tons / year in Portugal; 12.5 tons / year in Sweden (Samsoe and Petersen, 2003). Of these countries, Denmark and Austria have adopted the highest level of sludge application with 70 and 100 tons / year and Sweden has adopted the lowest level with 12.5 tons / year (EC, 2003). Turkey has not specified a clear value for this yet and it has been specified in SPCR that the amounts applied would be set in accordance with the analyses made of the lands where the sludge will be applied, with regard to the works to be done in compliance with EU Rules (TOG, 2010).

5. Conclusions

In accordance with the Water Pollution Control Regulations which came into force in Turkey in compliance with EU rules, within a few years, the numbers of treatment plants and therefore sludge production will at least double. Because of this, the need for environmentally safe disposal of sewage sludge is now even more pressing. The results of some studies reveal that the agricultural

usage of sewage sludge is the cheapest disposal method (Jantzen and Woerd, 2007) and increases productivity in a short time (Turkmen et al., 2001; Epstein, 2002) as sludge contains useful nutrients for the soil (Prasatsrisupab et al., 2002; Akyarlı et al., 2005). On the other hand, the results of most of studies reveal that using the sludge can harm human health both in the mid-term and the long term (Fries et al., 1999; Hansen et al., 2003; Ayres et al., 2007). There are adverse effects on plants, land, air quality and underground water, which it may not be possible to reverse (Jones and Northcott, 2000; De Angelis 2001; Lewis et al. 2002). Thus, sewage sludge should be categorized as dangerous waste and the regulations regarding its agricultural usage should be repealed. Regulations need to be introduced that lead to a sustainable environmental management policy which clearly sets out rules for the disposal of sludge in the EU and its member states without harming the environment. The essential measures for the protection of employees during production, and for the carriage of the sewage sludge, should be put into force; as should effective methods for decreasing the amounts of sewage sludge to be dealt with at source.

According to the results of the comparative analysis, the Netherlands has the most effective policy for environmental protection because it adopts the lowest level of five heavy metals in the sludge and Luxembourg and Spain are the least protective country because their score are the highest for five heavy metals. In terms of the heavy metal limits allowed to be concentrated in the soil, Turkey is the most protective country, having the lowest score and Portugal is the least protective country, having the highest score. Thus, the legislation that regulates the agricultural usage of sewage sludge in Turkey has given sufficient consideration to soil pollution, but insufficient for sludge in comparison with the regulations of the EU and its member states.

References

Akyarlı, A. and Şahin, H.(2005). Lime in sewage sludge treatment. *I. National Sewage Sludge Semposium*, Proceedings, 191-200.

Ayres, J.G., Dick, S. & Semple, S. (2007*). Human health and the environmental impacts of using sewage sludge on forestry and for restoration of derelict land*. Scotland.

De Angelis, A. (2001*). Issues and problems related to sewage sludge application in agriculture and forest land.* EC agricultural directorate general. Brussels.

EC (2001). European Commission, *Disposal and recycling routes for sewage sludge. Part 1-Sludge use acceptance report. Part 2 regulatory report. economic sub-component report. scientific and sub-component report.* European Commission dg Environment. Luxembourg

EC (2003*). European Commission, Report from the Commission to the Council and the European Parliament on the implementation of community waste legislation for the period 1998-2000*. Commission of the European Communities.250 final/3, Brussels.

EC (2006). *European Commission, Decision Number: com (2006).* 406 final.

EC (2009). European Commission, Eurostat official web site, URL: http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home,(Accessed:09 April 2011).

EEC (1986*). Eurepean Council, The Sludge (use in agriculture) Regulations*. Council Directive 86/278/EEC,

Epstein, E.(2002). *Land application of sewage sludge and biosolids.* Lewis publishers. Washington.

Friis, L., Mikoczy, Z., Hagmar, L. & Edling, C. (1999). Cancer incidence in a cohort of Swedish sewage workers: Extended follow up. *Occupation. Environment. Medicine*. 56(10):672-673.

Hansen, E.S., Hilden, J., Klausen, H. & Rosdahl, N. (2003). Wastewater exposure and health--a comparative study of two occupational groups. *Occupation. Environment. Medicine*, 60(8):595-998.

Jantzen, J.& Van der Woerd, H.,(2007). *Sound sludge*. project report about "Disposal and recycling routes for sewage sludge".

Jones, K.C. & Northcot, GL., (2000). *Organic contaminants in sewage sludges*: A survey of UK samples and a consideration of their significance.-final report to the department of the environment, transport and the regions. Waterquality division.

Lewis, L., David, GDK., Novak, ME., Sanchez, S. & Pumphrey, C., (2002). Interactions of pathogens and irritant chemicals in land-applied sewage sludges (biosolids). *Bmc Public Health*, 2:11.

Prasatsrısupab, J., Sabua, V., Tammarate, S., Pumklom, M., Chaıwanakupt, P. & Srithongtım, S., (2002). The effects of irradiated wastewater sludge cake on maize and environment. *17th World Congress of Soil Science. Conference report. organized by IUSS* (International Union of Soil Sciences) and held in Bangkok, August 14–21, Thailand.

Samsøe-Petersen, L. (2003), *Organic Contaminants in Sewage Sludge.* Sweden Environmental Protection Agency, Sweden.

Schowanek, D., David, H., Francaviglia, R., Hall J., Kirchmann, H., Krogh, H., Schraepen, N., Smith, S. & Wildemann, T., 2007. Probabilistic risk assessment for linear alkylbenzene sulfonate (las) in sewage sludge used on agricultural soil. *Regulatory Toxicology and Pharmacology*, 49(3), 245-259.

Tanrıvermiş, H., (2006). The development of organic farming and its impacts on farms in Turkey: A discussion on research results. *Pakistan Journal of Biological Sciences*. 9(6). 1192-1204.

Thorn, J. & Kerekes, E., (2001). Health effects among employees in sewage treatment plants: A literature survey. *American .J. Ind.Med.* 40:170-9.

TOG, 2006. The Turkish Official Gazette, *Urban Wastewater Treatment Regulation*. No 26047, date: 08.01.2006.

TOG, 2010. The Turkish Official Gazette, *Soil Pollution Control Regulation*. Number:25831, Date: 31.05.2005.

TSI, 2007. Turkish Statistical Institute, *Turkish statistics yearboo*k. Pub. no: 3063, Ankara.

TSI, 2008. Turkish Statistical Institute, web page, News Bulletin Number:74, date:28 April 2008,

Türkmen, Ö., Şensoy, Ş. & Çıkra, M. (2000). The Effect of Sewage Sludge on the Emergence and Seedling Growth in Cucumber. *Yüzüncü Yıl University, Faculty of Agriculture, Journal of Agricultural Sciences,* 11(1), 1-4. Van, Turkey (in Turkish).