Project deliverable 3.2.

NATIONAL SLUDGE HANDLING RULES COMPARISON

Report

2020

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INTRODUCTION

The different countries in EU have different traditions and issues about the use of sludge in agriculture, and the national legislation is also different, although the same EU-directive (86/278/EEC) regulate Limit Values of heavy metals in sludge from Wastewater Treatment Plants (WWTP) when used as fertilizer in agriculture (see table 1 and 3 below).

In the STEP project's deliverable 3.2 it is described and compared the national rules and the issues and barriers to the use of sludge in agriculture, from the perspective of each partner and the specific regulation in their country.

I. COMPARISON OF NATIONAL RULES IN GENERAL

A thorough comparison of limit-values of different compounds in sludge is published in the EU-report: Disposal and recycling routes for sewage sludge, Part 2 - Regulatory report October 2001.

Table 1. Limit values for heavy metals in sludge (mg/kg DM)
(Shaded cells represent limit values below those required by Directive 86/278/EEC)

	Cd	Cr	Cu	Hg	Ni	Pb	Zn	As	Mo	Co
Directive 86/278/EEC	20 - 40	-	1000 - 1750	16 - 25	300 - 400	750 - 1200	2500 - 4000	-	-	-
Austria	2 [a] 10 [b] 10 [c] 4 [d] 10 [e] 0,7 - 2,5 [f]	50 [a] 500 [b] 500 [c] 300 [d] 500 [e] 70 - 100 [f]	300 [a] 500 [b] 500 [c] 500 [d] 500 [e] 70 - 300 [f]	2 [a] 10 [b] 10 [c] 4 [d] 10 [e] 0,4 - 2,5 [f]	25 [a] 100 [b] 100 [c] 100 [d] 100 [e] 25 - 80 [f]	100 [a] 400 [b] 500 [c] 150 [d] 500 [e] 45 - 150 [f]	1500 [a] 2000 [b] 2000 [c] 1800 [d] 2000 [e] 200 - 1800 [f]	20 [e]	20 [e]	10 [a] 100 [e]
Belgium (Flanders)	6	250	375 [f]	5	100	300	900 [f]	150	-	-
Belgium (Walloon)	10	500	600	10	100	500	2000		-	-
Denmark - dry matter basis - total phosphorus basis	 0,8 100	 100	 1000	 0,8 200	 30 2500	 120 [g] 10 000 [g]	 4000	 25 [h]	 -	 -
Finland	3 1,5 [i]	300	600	2 1 [I]	100	150 100 [I]	1500	-	-	-
France	20 [j]	1000	1000	10	200	800	3000	-	-	-
Germany	10	900	800	8	200	900	2500	-	-	-
Greece	20 - 40	500	1000 - 1750	16 - 25	300 - 400	750 - 1200	2500 - 4000	-	-	-
Ireland	20	-	1000	16	300	750	2500	-	-	-
Italy	20	-	1000	10	300	750	2500	-	-	-
Luxembourg	20 - 40	1000 - 1750	1000 - 1750	16 - 25	300 - 400	750 - 1200	2500 - 4000	-	-	-
Netherlands	1,25	75	75	0,75	30	100	300	-	-	-
Portugal	20	1000	1000	16	300	750	2500	-	-	-
Spain - soil pH < 7 - soil pH > 7	 20 40	 1000 1750	 1000 1750	 16 25	 300 400	 750 1200	 2500 4000	 - -	 - -	 - -
Sweden	2	100	600	2,5	50	100	800	-	-	-
UK	-	-	-	-	-	-	-	-	-	-
Accession countries										
Estonia	15	1200	800	16	400	900	2900	-	-	-
Latvia	20	2000	1000	16	300	750	2500	-	-	-
Poland	10	500	800	5	100	500	2500	-	-	-

[a] Lower Austria (grade II)
[b] Upper Austria
[c] Burgenland
[d] Vorarlberg
[e] Steiermark
[f] Carinthia
[f] These values are reduced to 125 (Cu) and 300 (Zn) from 31/12/2007
[g] For private gardening, lead value is reduced to 60 mg/kg DM or 5000 mg/kg P
[h] For private gardening
[i] Target limit values for 1998
[j] 15 mg/kg DM from January 1, 2001 and 10 mg/kg DM from January 1, 2004

Table 3: Limit values for organic compounds in sludge (mg/kg DM)

	Dioxins and Furans (PCDD, PCDF) ng TE/kg DM	PCBs	AOX	LAS [l]	DEHP [p]	NPE [q]	PAH [r]	Toluen
Austria	100 [a,b,d] 50 [f]	0,2 [a,b,d] 1 [f]	500 [a,b,f]	–	–	–	6 [f]	–
Belgium (Flanders) [k]								
Denmark - from 1/07/2000 - from 1/07/2002	-	-	–	2600 1300 1300	100 50 50	50 30 10	6 3 3	–
France	-	0,8 [m]	–	–	–	–	2 - 5 [n] 1.5 -4 [o]	–
Germany	100	0,2 [s]	500	–	–	–	–	–
Sweden	-	0,4		–	–	100	3	5

[a] Lower Austria
[b] Upper Austria
[c] Burgenland
[d] Vorarlberg
[e] Steiermark
[f] Carinthia
[k] Limit values for approximately 30 organic compounds (see p. 35)
[l] Linear alkyl-benzene sulphonates,
[m] Sum of 7 principal PCBs (PCB 28, 52, 101, 118, 138, 153, 180)
[n] Fluoranthen, Benzo(b)fluoranthen, Benzo(a)pyren
[o] When used on pasture land
[p] Di (2-ethylhexyl)phtalate
[q] Includes nonylphenol
[r] Poly aromatic hydrocarbons
[s] For each one of the six congeners

The report states: "*In particular, the limit values for concentrations of heavy metals in sludge are lower than the limit values specified in the Directive in a majority of countries. In five countries (Belgium -Flanders-, Denmark, Finland, the Netherlands and Sweden), the limit values for heavy metals in sludge are even much lower…*

In the majority of Member States, the specific regulations which have been introduced covering the disposal and recycling of sludge mainly concern the use of sludge in agriculture, while the disposal of sludge is addressed by general legislation on landfill and incineration of waste..

In the Directive, very few specific provisions for sludge from septic tanks are included in national regulations."[1]

The STEP project partners have confirmed that the contemporary limit-values are still the same in their countries as shown in the tables above.

[1] http://ec.europa.eu/environment/archives/waste/sludge/pdf/sludge_disposal2.pdf

II. DENMARK (Bornholm)

The national rules about use of sludge in agriculture have essentially been unchanged for many years. In generally the sludge quality I Denmark has improved during the years and the majority of the sludge is used in agriculture (about 75%).

On Bornholm all the sludge from wastewater treatment is used as fertilizer in agriculture. Sludge from WWTPs and septic tanks are treated separately.

Heavy metals

Cadmium – is usually the heavy metal in sludge that might come closest to, or surpass, the limit value in DK. This is not surprising when we take a look at the table comparing Limit Values: Denmark has one of the lowest limits for Cadmium in EU: 0,8 mg/kg DM (or 100 mg/kg P), where the directive operates with 20-40 mg/kg DM.

One of the WWTP's on Bornholm (Boderne) sometimes come close to, and occasionally surpasses, the Danish limit value of Cadmium. It is possible that the large amount of excess water this WWTP receives contributes to this situation.

The low Danish Limit value for Cadmium is generally not a barrier to agricultural use of sludge in Denmark or Bornholm, and it gives us a natural focus on industrial wastewater permissions, where the allowed concentration of Cadmium in wastewater is usually low.

E.g: Mass balance calculations in relation to the Cadmium input to Rønne WWTP, resulted in an allowed concentration of max 0,2 microgram/l in the condensed water from the power plant in Rønne, when the main boiler was rebuild from burning coal to woodchips in 2016. In a permit from 2018, the same maximum concentration was used for a new facility on Rønne harbour, to receive wastewater from Cruise Ships.

Organics

Denmark and Sweden are some of the few countries in EU where the national legislation has Limit Values for groups of organic compounds:

- **LAS**: Linear Alkylbenzene Sulphonates are the most extensive used anionic detergents in cleansing agents. Despite the high separation efficiency in sewage treatment plants LAS outlet concentrations are in the range 0,02 – 0,9 mg LAS l-1 (Berna et al. 1989; Berna et al. 1991). LAS are only slowly degradable in anoxic environments and may become concentrated in marine environment. In estuaries and near-shore marine waters, LAS has been found in concentrations that affect normal growth and development of marine organisms (Christensen et al. 1998; Hansen et al. 1997; Kimerle 1989). LAS are now on the Danish Environmental Protection Agency's list of undesirable substances in the group of non-anaerobic degradable substances.

- **PAH**: Polycyclic aromatic hydrocarbons are of interest because of their potential toxic and carcinogenic properties. Due to their low water solubility and their high affinity for organic matter, PAHs are easily concentrated in sewage sludge. Under methanogenic conditions, PAH removal about 50% has been demonstrated; under aerobic conditions, the aerated process enhanced PAH removal up to 90%. (E. Trably · D. Patureau · J.-P. Delgenes, 2005). In one of the WWP's on Bornholm the limit value of PAH has a few times been surpassed. This problem has been solved by composting.
- **NPE**: NPE are a group of nonionic detergents which are present in many laundry and cleaning agents. Consequently, research regarding mineralization of these compounds became important to the discussion about whether the agricultural sector could continue as a receiver of sludge in the future.
- **DEHP** (diethylhexylphthalat) belongs to a group of phthalate esters which is used in large amounts as softener or plasticizer in Polyvinyl chloride (PVC), a hard, brittle plastic, only when softeners are added that it becomes softer and pliable and can be made into floors and other products. In soft PVC floorings these are not securely bound in the matrix, but can evaporate or wash off from the products or escape into the room as a result of wear.
- **DEHP in sludge**: Most of the DEHP in wastewater is decomposed in the WWTP's. But a large amount is also adsorbed in the sludge. In 1992 it was estimated that 7 tons DEHP per year was retained in sludge from Danish WWTP's.

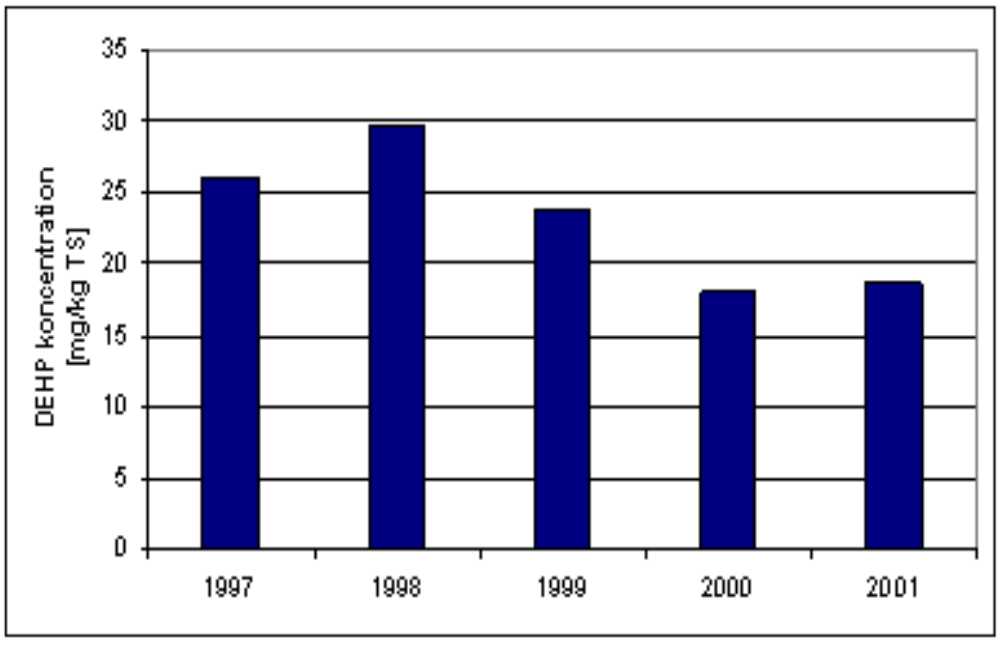

Fig.1 Concentration of DEHP in sludge from Danish WWTPs - 1997 till 2001. (Data from the Danish EPA)

"Psychological barriers"

"*The Arla directive*": The mayor Danish diary-company, Arla, don't allow their milk suppliers to use sludge on fields where their cows feed. This is related to possible reactions from costumers.

Sludge from septic tanks

Sludge from septic tanks is also regulated by the same national rules as sludge from WWTPs. On Bornholm the sludge from septic tanks (app. 5000) is composted to reduce the content of organic compounds, e.g. LAS, below the limit values. The sludge is composted with straw cut in bits, and then mixed with burned lime, before it is used as fertilizer in agriculture.

This is a cheap, energy-effective way to handle sludge from septic tanks. A problem with this is misdisposed inorganic material e.g. Plastic bits, in the sludge, that is an unwanted (mostly visual) pollution of the fields.

A case study between different practical methods of handling sludge from septic tanks is also done in the STEP-project.

Table 4: Comparison of heavy metals and organics in sludge from septic tanks and WWTP (Rønne)

	Analysis of composted sludge from septic tanks (mean)	**Analysis of sludge from WWTP (Rønne - mean)**	**Limit values**
	mg/kg DM	**mg/kg DM**	**mg/kg DM**
Pb	26	12	120
Cd	**1,4**	0,8	0,8
Cu	258	168	1.000
Cr	13	10	100
Hg	0,7	0,3	0,8
Ni	17	10	30
Zn	1.070	495	4.000
Cd/P (mg/kg P)	**76**	35	100
Hg/P (mg/kg P)	38	14	200
Tot N (g/kg DM)	29,5	48,3	
Tot P (g/kg DM)	18,5	22,8	
LAS	423	< 108	1.300
sumPAH	1,7	0,6	3
sumNPE	3,4	1,5	10
DEPH	2,5	5,5	50

III. SWEDEN (Höör/Hörby)

Close to one million tons of sludge derived from wastewater is collected every year in Sweden. Between 25 to 30 % of this sludge is spread on arable land. The remaining part is used as e.g. soil conditioner or for covering landfills.

In Sweden a water utility can be certified by the Revaq-standard. Revaq is a system which aims to reduce the stream of harmful substances to the wastewater treatment plant (WWTP), so that a lot of nutrients can be sustainable redistributed. Obtaining a Revaq-certificate signifies that the operator of a WWTP is working with these issues in an active and structured manner and that there is a continuous strive for self-improvement of the organization.

Revaq is the product of Swedish water (the trade association for Swedish water- and wastewater utilities). It is also linked to the agricultural sector and the food business as well as the Swedish environmental protection agency. Revaq was launched in 2008 and so far 42 WWTP's have been certified (roughly corresponding to 50% of all generated wastewater sludge).

Some of the stipulated criteria for the certification of sludge according to Revaq are:

- The sludge should be hygenized to avoid infections.
- Leachate from landfills cannot be connected to the WWTP.
- Threshold limits for the addition of metals to arable land cannot be exceeded. The limits are calculated based on grams per person, hectare and year. These limits are lower than the national legislation.

The legislation in Sweden concerning the usage and spreading of sludge originating from wastewater was passed in 1994. During the last 15 years, parliament and government have worked out a new proposal for legislation but it has not been passed as of the writing of this report (2019).

Heavy metals

In the table below it can be seen that the concentrations of some of the metals signify a problem; it can be difficult to spread the sludge from Höör and Hörby. For the sludge produced in Höör, the levels of lead, cadmium, copper and mercury have been observed to be above this threshold limit. For Hörby it is only cadmium which exceeded the limit.

Höör and Hörby are situated on top of bedrock rich in lead and cadmium. Since elevated levels of these metals also have been found in the soil layers above, it cannot be ruled out that one source could be infiltration through cracks and other irregularities in the sewer network.

According to Swedish standards, it is necessary for a cadmium-phosphorus quota of 17 up until the year of 2025. The sludge from the Höör and Hörby WWTP's have quotas of 72 and 42 respectively.

In the proposal for new regulation, threshold limits for silver will also be included. This compound is not monitored on a daily basis at Mittskåne water. However, according to available, there should be no problem in fulfilling this new requirement.

Table 5. Comparison of threshold limits form legislation with metal contents at the WWTP's in Höör and Hörby. Average values within parenthesis.

Compounds	**Threshold limits**	**Threshold limits, proposed legislation (2030)**	**Hörby sludge**	**Höör sludge**
Pb (mg/kg DM)	100	25	6,1-10 (8,6)	3-55 (13)
Cd (mg/kg DM)	2	0,8	0,45-0,96 (0,75)	0,31-1,3 (0,8)
Cu (mg/kg DM)	600	475	390-460 (411)	150-560 (419)
Cr (mg/kg DM)	100	35	15-24 (19)	6,2-12 (8,7)
Hg (mg/kg DM)	2,5	0,6	0,19-0,94 (0,31)	0,06-0,61 (0,23)
Ni (mg/kg DM)	50	30	8,6-14 (11)	4,3-11 (7,6)
Zn (mg/kg DM)	800	700	430-570 (480)	110-570 (330)
Ag (mg/kg DM)	-	3	(1,8)	(0,8)
NH_4-N (g/kg DM)	-	-	6,4-19 (12)	1,1-3,7 (2,5)
N-tot (g/kg DM)	-	-	47-68 (61)	16-30 (24)
P-tot (g/kg DM)	-	-	17-24 (20)	4,5-19 (12)
DM (% of sample)	-	-	(17)	(37)

If the Swedish threshold limits are compared to the legislation around Europe, it can be seen that the Swedish ones are generally lower. That is to say, the legislation in Sweden puts a tougher demand on sludge quality than most European countries.

Organics

The substances that are regulated in Swedish law are these: PAH, PCB, Nonylfenol och Toluen. In the table below it can be seen that the levels of organics at the WWTP's in Höör and Hörby are well below the stipulated threshold values.

Table 6. A comparison of the threshold limits compared to levels measured in the sludge at the WWTP's in Höör and Hörby.

Organics	Swedish regulation, target limits	Threshold limits, proposed legislation (2030)	Hörby sludge	Höör sludge
PAH (mg/kg TS)	3,0	-	0,15	1,6
Nonyfenol (mg/kg TS)	50	-	2,2	0,01
Toluen (mg/kg TS)	5,0	-	0,5	2,1
PCB(mg/kg TS)	0,4	0,04	0,01	0,009
PFOS (mg/kg TS)	-	0,02	-	-
Klorparaffiner (mg/kg TS)	-	2	-	-
BDE-209 (mg/kg TS)	-	0,5	-	-

"Psychological barriers"

A debate has been ongoing in Sweden about the suitability of fertilizing with sludge originating from WWTP's. In the end of the 90s and in the beginning of the 00s it was prohibited to disperse the sludge in this way. E.g. the milk company Arla did not want their cattle to receive food grown with sludge as a basic nutrient. The Federation of Swedish farmers has for the last decades encouraged their members not to spread sludge on arable land. This is the basic historical foundation for Revaq, to ensure the quality of the sludge.

For over ten years there has been work carried out to elaborate new regulations. The suggestions concern stronger regulations for hygenisation and recirculation of phosphorous to arable land. The threshold limits for metal contents are also considered to be lowered.

As part of the creation of a non-toxic environment, the government launched an investigation in 2018 which would elaborate a proposal for the prohibition of dispersal of wastewater sludge on arable land as well as put demands in place which would force utilities to recover more phosphorous. All this within the larger paradigm of 'A Circular Economy' where waste is treated as a resource. The aim of the investigation is for phosphorous to be extracted in a non-toxic and safe way from the sludge and reused to a larger extent within the agricultural sector. The investigation should prepare draft-versions of regulations for the recirculation of phosphorous from wastewater sludge.

A prohibition of the dispersal of sewage sludge should not mean an obstacle for the generation of biogas. The aim is set for both energy and phosphorous to be recovered from the sludge without running the risk of potentially harmful substances reaching the environment.

Sludge from septic tanks

In Höör and Hörby there exist roughly 6 000 septic tanks. The sludge from these are collected by lorry and driven to the wastewater treatment plant where it is added to the incoming wastewater stream. Thereafter the septic tank sludge is treated according to the same processes as any other wastewater reaching the plant. Investigations have found relatively large quantities of metals in the sludge originating from septic tanks (sometimes more than 50 % of the total metal content).

Table 7. The calculated ratio of metals being added from the septic tanks.

Year	Pb	Cd	Cu	Ni	Zn
	%	%	%	%	%
2013	52,9	36,5	9,0	81,0	25,6
2014	33,3	11,1	15,6	40,6	23,0
2015	70,0	15,0	17,1	45,4	27,2

Within the STEP-project a pilot-plant has been setup. Here the sludge coming from septic tanks will be treated externally. It is hoped that this way of separating the waste streams will improve the quality of the outgoing sludge from the treatment plant. Hence, the opportunity for the recirculation of nutrients on arable land will be enhanced.

IV. LITHUANIA (Klaipeda)

Legislation review

Directive 86/278/EEC is the main document defining the requirements on sludge management in agriculture in EU level. Well as the other Directives also have significant role on sludge management, this document contains national rules comparison with respect to Directive 86/278/EEC requirements.

Lithuanian legal system has 2 documents regarding wastewater sludge management in agriculture:

1. The main national document regarding transposition of Directive 86/278/EEC requirements into Lithuanian legislation is Environmental Protection Normative

document LAND 20-2005: Requirements on the use of Sewage sludge for Fertilization and Reclamation[2] adopted by the Order of the Ministry of Environment.

2. Environmental requirements for composting, anaerobic treatment of biodegradable waste adopted by the Minister of Environment order[3]. Requirements determine the conditions for composting, anaerobic treatment of biodegradable waste, types of composted, anaerobically treated waste, requirements for the quality and use of compost, anaerobic fermentation. The main points, regarding sewage sludge management in agriculture:

    - Composting or anaerobic treatment can be used for sludge I and II categories and A, B classes (according to LAND 20-2005).
    - Compost is considered suitable for usage when the values of heavy metals in the compost made from sludge does not exceed the category II limits (according to LAND 20-2005).

It is necessary to mention, that new version of LAND 20-2005 document is planned to be adopted this year. At the moment new version of LAND 20-2005 is on coordination process with all responsible institutions and stakeholders involved. It is expected, that new document will come to the legal power this year. The main draft changes will be mention in this document below.

LAND 20-2005: Requirements on the use of Sewage Sludge for Fertilization and Reclamation[4]

The sludge management is regulated by the order of the Ministry of Environment – an Environmental Protection Normative Document LAND 20-2005 - Requirements on the use of Sewage Sludge for Fertilization and Reclamation (Hereinafter - Order). The order aims to regulate sewage sludge in agriculture, energy crops (fast growing plantations for the direct use as biofuels) and the cultivation of damaged areas (quarries, peat empty, closed landfills, roadbed, etc.) and dumpsites so that no negative effects are caused on soil, vegetation, animals and humans. Its requirements apply to household and municipal or similar industrial (e.g. food) waste water sludge.

Article 5.2 of the order defines treated sludge as biologically, chemically or thermally affected, stored for long time or undergone any other process that reduce its fermentability and the health hazards. The order provides limit values for heavy metal concentrations in sludge, soil and average annual loads. Two kinds of limit values are provided for the

[2] 28/07/2016 Order of the Ministry of Environment with latest amendment No. D1-517: https://www.e-tar.lt/portal/lt/legalAct/TAR.3536A8337E8A/oOjEMmzJtx

[3] 14/03/2016 Order of the Ministry of Environment with the latest amendment No. D1-186 https://www.e-tar.lt/portal/legalAct.html?documentId=63c2f1c0ea7d11e58deaaf0783ebf65b

[4] 28/07/2016 Order of the Ministry of Environment with latest amendment No. D1-517: https://www.e-tar.lt/portal/lt/legalAct/TAR.3536A8337E8A/oOjEMmzJtx

concentrations of heavy metals in soil – background limits (which influence the frequency of performing soil analysis), and maximum permitted concentration values – for sand/sandy loam and loam/clay soils.

Furthermore, the sludge is differentiated to categories (I, II, III – depending on heavy metal concentrations) (Table No. 1) and classes (A, B, C – depending on microbiological and parasitological parameters). Lithuanian legislation regulates the pathogen content of sludge – parameters considered are the following: Escherichia coli, Clostridium perfringens, helminth eggs and larvae as well as pathogenic enterobacteria (Table No.2).

Sludge of III category or C class, as well as untreated sludge cannot be used. Also, according to general rules on the use of sludge, regardless of category/class, it is forbidden to use sewage sludge on the areas near drinking water bodies, areas of surface water protection zones, and extensive karst areas. For agricultural purposes: (i) none of the categories/classes of sludge can be used on the areas planted with fruits and vegetables (excluding fruit trees), and also areas where soil pH is < 5.5; (ii) the use of II category sludge is prohibited on the grasslands, areas devoted for vegetables, fruits or crops, as well as if the concentration of heavy metals in the soil exceeds 70 % of the maximum permissible concentrations; it also cannot be used more often than every 3 years; (iii) on the areas for cultivation of vegetables and grassland or forage/feed crops, only A class and I category sludge may be used; areas for the cultivation of fruit crops and vegetables that are in direct contact with the soil and eaten raw, fertilized no later than 10 months before harvest and during harvest, grassland or forage crops – not later than three weeks before use (mowing or grazing); (iv) maximum amounts nutrients applied with sludge are: nitrogen – not more than 170 kg/ha per year, phosphorus – not more than 40 kg/ha per year; and (v) sludge should be worked into the soil within 2 days after spreading on the surface, and it cannot be spread if the air temperature is higher than 20 °C.

Table 8. Sludge differentiated into categories according to heavy metals concentrations

Sludge category	**Heavy metals concentration, mg/kg (LAND 20-2005)**						
	Pb	**Cd**	**Cr**	**Cu**	**Ni**	**Zn**	**Hg**
I	<140	<1,5	<140	<75	<50	<300	<1,0
II	140-750	1,5-20	140-400	75-1000	50-300	300-2500	1,0-8,0
III	>750	>20	>400	>1000	>300	>2500	>8,0
EU Directive 86/278/EEC limit values in sludge(mg/kgDM)	**750-1200**	**20-40**	**-**	**1000-1750**	**300-400**	**2500-4000**	**16-25**

Table 9. Sludge differentiated into classes according to microbiological – parasitological parameters

Sludge class	**Faecal intestinal rod (*Escherichia coli*), col. number/g**	**Anaerobic clostridia (*Clostridium perfringens*), col. number/g**	**Helminth eggs and larvae unit/kg**	**Pathogenic enterobacteria col. number/g**
A	≤ 1000	≤ 100 000	0	0
B	1001–100 000	100 001–10 000 000	1–100	0
C	> 100 000	>10 000 000	> 100	>1

The Order regulates also the use for recultivation and for fertilization of energy crops. In both cases, maximum allowed amount of sludge to be used is 100 tons of dry matter per hectare, but this can be increased if justified by a site remediation project and are proven to be environmentally safe. Moreover, there are limitations of these ways of sludge application – it cannot be used on surfaces when up to 0.5 km deep there is flow of underground water extracted for drinking water preparation; or the highest ground water level depth of the sludge application layer pad is less than 1 meter. Additionally, sludge can be used for energy crops fertilization only in areas where in the upper soil layer (not less than 1 m) the average filtration rate is less than 10–2 m/d. In turn, the sludge recultivated damaged areas later (though, not defined exactly) can be used to grow agricultural crops for human or animal consumption.

The Order contains rules of performing analyses of soil and sludge before its use. Before delivering the sludge to the user (not earlier than 30 days), the sludge must be analyzed in order to determine the dry matter content, pH value, total nitrogen (N) and phosphorus (P) concentration in dry matter, and microbiological/parasitological indicators. The latter, however, are not required to be measured if the sludge:

- was treated by raising the temperature above 70 °C and maintaining that for longer than 1 hour;
- was dried at 100 °C and higher temperatures;
- has undergone anaerobic, aerobic or lime (by increasing sludge pH>12 for longer than 2 hours, after 24 hours pH should be maintained at > 11.5) stabilization;
- Was prepared for composting – temperatures above 55 °C, maintaining at least 2 weeks.

The frequency of sludge analyses for heavy metal concentrations are determined depending on the load of waste water treatment plant, ranging from 12 times per year for a plant with capacity more than 50 000 PE to once per year for a plant with capacity less than 10 000 PE.

At the same time, the Order does not explicitly indicate who is responsible for the conducting this analysis. However, it is stated as the responsibility of sludge supplier to keep the records regarding sludge usage (treatment, analyses results, and data on users of sludge).

Before the first application of sludge for agricultural purposes, soil should be also analyzed in order to determine its quality indicators: concentrations of heavy metals, texture and pH level. Further frequency of soil analysis depends on the results of the first tests (whether heavy metal concentrations do or do not exceed background limit values), and on category of sludge applied.

New draft version of the Requirements for the use of sewage sludge for fertilization and recultivation [5]

The draft document has the main proposals:

- Establishing the criteria for classifying sludge compost and sludge ferment (yeast) as a product. Maximum levels of heavy metals in sludge compost are proposed (as product). The draft order proposes that sludge compost, sludge ferment (yeast) that meets the criteria for product designation will have to be certified by the Ministry of Economy and can be used without fertilization plans: (i) Concentrations of organic pollutants (PCBs and PAHs) in sludge compost and sludge ferment (yeast) do not exceed the proposed limits; (ii) amount of undesirable admixture as (glass, metal, plastics, sprouting seeds, weeds, rhizomes, stones) in them does not exceed the permissible limits; (iii) microbiological-parasitological parameters do not exceed the requirements, etc.
- To tighten restrictions for heavy metal values from 2021 (Table No. 3), allowing water management and other companies to prepare for the implementation of this legislation, and to align with the Urban Wastewater Regulation, which requires canceling effluent (including cadmium) of priority hazardous substances by 2020.
- Only sludge of **category I** can be used in agriculture.

Table 10. Sludge differentiated into categories according to heavy metals concentrations (proposal)

Sludge Category	**Heavy metals concentration, mg/kg**						
	Pb	Cd	Cr	Cu	Ni	Zn	Hg
I	<140	<1,5	<140	<300	<50	<800	<1,0
II	140-750	1,5-20	140-400	300-1000	50-300	800-2500	1,0-8,0

[5] Draft order of the Ministry of Environment:
https://e-seimas.lrs.lt/portal/legalAct/lt/TAP/16d38e20c88c11e8a82fc67610e51066?jfwid=-w4wfq4b9z

Sludge Category	Heavy metals concentration, mg/kg						
	Pb	Cd	Cr	Cu	Ni	Zn	Hg
III	>750	>20	>400	>1000	>300	>2500	>8,0
	Heavy metal concentration from 2021, mg/kg						
I	<120	<1,5	<100	<300	<50	<800	<1,0
II	120-150	1,5-5	100-130	300-500	50-70	<800-1500	1-1,5
III	>150	>5	>130	>500	>70	>1500	>1,5

Sludge management in a national level

Sludge is a wastewater treatment by – product (waste code is 190805). Where to use the sludge is a problem not only in Lithuania, but also in more developed countries. Worldwide there are no predominant ways of sewage sludge management – sludge can be incinerated, composted, also used for biofuel production, in agriculture, for energy crops (fast-growing green areas for direct use for biofuel production) and for damaged areas (quarries, landfills) recultivation. Therefore, when selecting sludge management methods, the country's ecological and economic situation is taken into account. In Lithuania we have 23 state projects sludge management facilities funded by EU: 12 sewage sludge digestion-drying plants, 2 drying facilities and 9 composting sites. Wastewater sludge treatment facilities capacity and locations are planned, taking into account the amount of sludge generated in the country.

According to Environmental Protection Agency statistical data (2017)[6], sludge managed in these ways:

- Used for fertilization and recultivation – 48,3%
- Used for composting – 38,7%
- Incinerated – 0,3%
- At landfills – 7,4%
- Other methods – 5,2%.

Sludge usage in a regional level (SC “Klaipedos vanduo” WWTP data)

The CHP (Combined Heat and Power) production as well as biogas’s digestates further utilization ensures the wastewater treatment process circularity’ principles implementation. However, some issues regarding heavy metals concentrations in the biogas residues are

[6] Source: Environmental Protection Agency:
http://vanduo.gamta.lt/files/Visuomen%C4%97s%20informavimo%20ataskaita_2019.pdf

indicated. The concentration of the Cr is the biggest in the Klaipeda wastewater treatment plant and can exceed the concentration up to 84 mg/kg (Fig. 2) due to the chromium (III, VI) amount in sewage of such industrial companies as dyes and pigments production as well as wood preserving and chrome plating. The fluctuation of the nickel concentration in the Klaipeda sewage depends on its compounds' usage for valves and heat exchangers, for nickel plating, color ceramics, batteries, and jewelry. Such toxic element as lead mostly comes with wastewater from paint, ceramic and batteries production, solder and pipes as well as from soils and streets. In addition, lowering the pH of wastewater can induce the higher concentrations of metals in the sewage. The heavy metals concentrations during the last three years (2014-2016) have tendency to decrease.

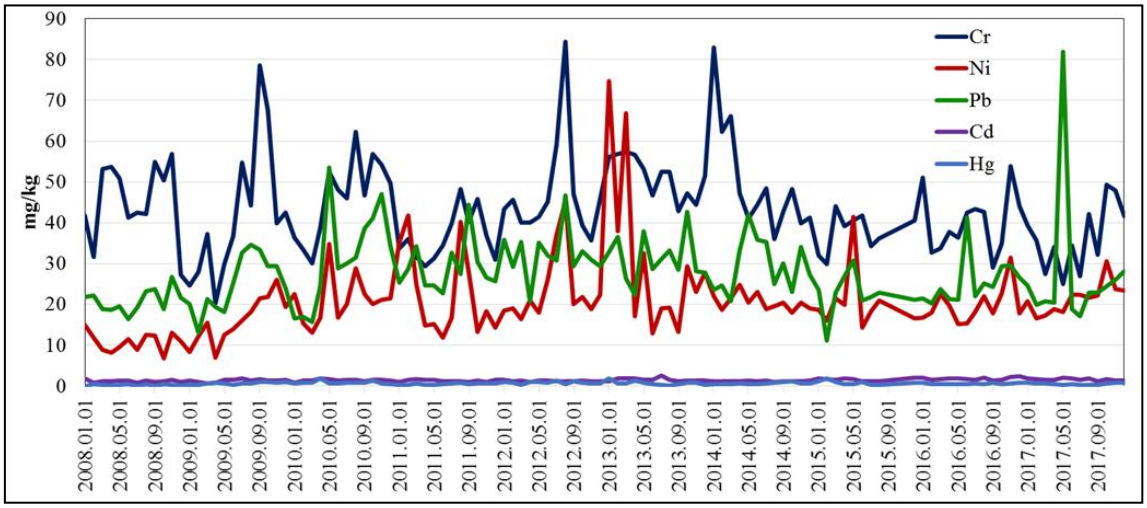

Fig. 2 Dynamics of some heavy metals concentration (mg/kg) in the sludge in 2008-2017

Zinc concentrations in the sludge have higher value than copper and sometimes can exceed the maximum available concentration for the sludge (Fig. 3). The decision to decrease zinc concentration at the primary its sources would have valuable positive impact on the final product of the sludge as fertilizer.

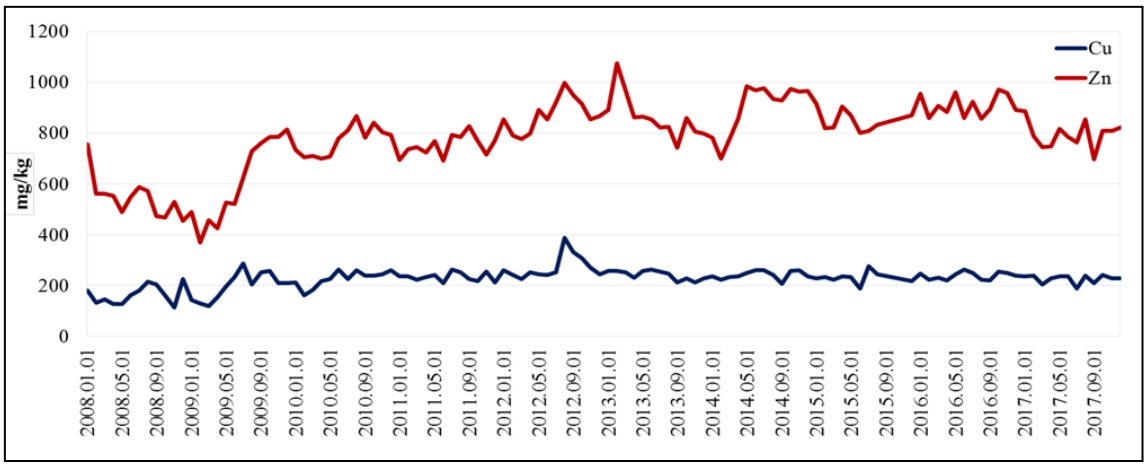

Fig. 3 Coper and zinc concentrations in the sludge dynamics in 2008-2017

The sludge content regarding such nutrients as nitrogen and phosphorus (Fig. 4) is important characteristic for the further application sludge as fertilizers for some kind of agricultural production, for animal's feeding and environmental greening. High amount of the nutrients could enrich the quality of the soil and ensure good vegetation properties of the landscape where the substrates with sludge would be used.

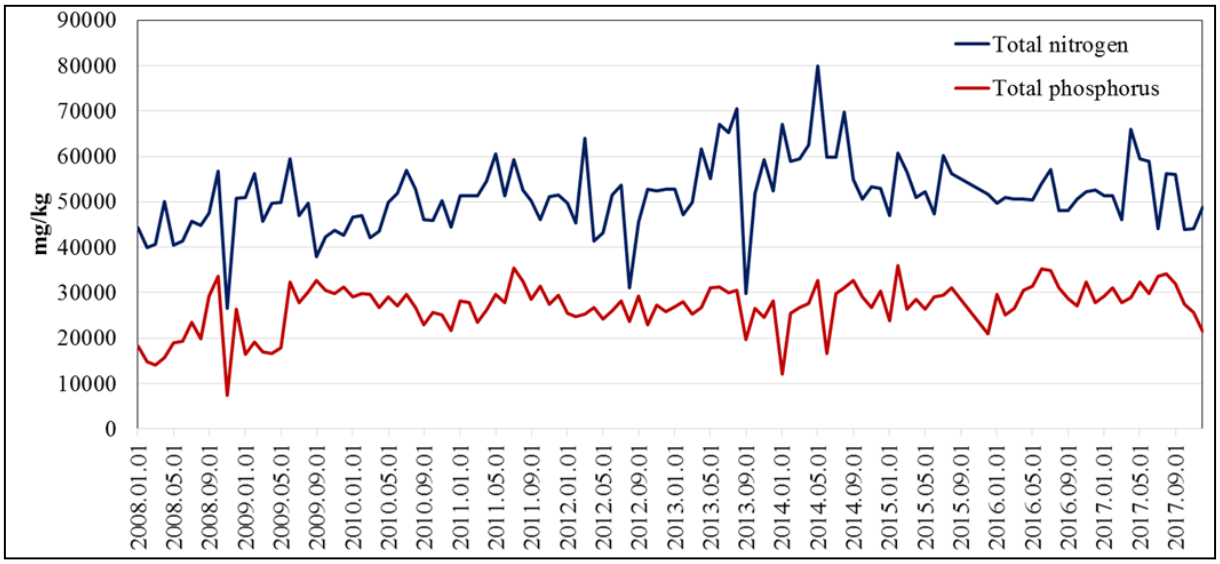

Fig. 4 Nutrients content in the wastewater sludge at the Klaipeda wastewater treatment plant

Table 11. Klaipeda WWTP sludge analysis (annual average values)

Annual average sludge analysis data (SC "Klaipedos vanduo" WWTP)												
Year	**Cr**	**Cu**	**Ni**	**Zn**	**Pb**	**Cd**	**Hg**	**N_{total}**	**P_{total}**	**Dry Material**	**Organic material**	**pH**
	mg/kg									**%**		
2013	51,44	241,75	31,14	864,50	31,36	1,59	0,72	55233,8	27340,7	26,16	65,49	8,53
2014	50,06	241,92	20,56	901,25	29,56	1,19	0,63	60761,2	26734,1	42,16	65,82	8,00
2015	37,57	231,22	20,83	849,89	22,41	1,55	0,80	53635,7	27944,7	88,31	64,83	7,09
2016	40,16	239,00	19,78	910,08	25,50	1,80	0,53	51260,3	30026,2	87,46	63,10	7,10
2017	36,32	225,67	21,50	793,67	27,34	1,60	0,51	52173	29447	89,72	63,90	7,20
Sludge Categories (LAND 20-2005)	**I**	**I**	**I**	**II**	**I**	**I,II**	**I**					

At the present time available sludge management methods for JSC "Klaipedos vanduo" WWTP would be:

- Disposal at composting sites. Currently dried sludge has been composting at JSC "Branda" composting site where compost is produced.
- Incinerate in Klaipeda waste incineration plant (JSC "Fortum Klaipeda").
- Incinerate in cement plant as a fuel, e.g. in the SC "Akmenes cementas" in north-east part of Lithuania. It is planned in the end of 2019.
- Fertilize energetic forests.
- To design and construct sludge incineration plant in WWTP, using the heat power for sludge drying process.

Remarks/conclusions

Sewage sludge treated as a waste in general, not as a product. Therefore, it leads to economic aspects, as e.g. WWTP companies needs to pay "gate fee" in the incineration plant, while producing sludge granules 11-12 MJ. According to the Ministry of Environment, opinion there is no standard for sludge fuel as a product. However, it is necessary to mention, that recently according to the new draft version of sludge compost's legislation will have criteria for the certification as a product. In some cases, this will simplify sludge compost usage.

Still there are companies discharging heavy metals to the city wastewater treatment's plant in amount exceeding the MAC (Maximum Allowable Concentration). Industrial companies are penalized, but from economic point of view for companies better to pay penalty then to install an innovative and effective treatment/equipment on their site.

"Psychological barriers" for sludge usage in agriculture. Even the companies preparing fertilization plans free, giving dried sludge free it is hard to find farmers/companies. Farmers are afraid of the smell as well.

Relatively high sludge compost insertion to the soil cost, as it is necessary to have equipment because sludge should be spread quickly. Fertilizers do not need this condition. Farmers prefer to choose mineral fertilizers that only need to be poured on the fields.

High operational cost for sludge drying in the biggest cities. Recently, Lithuania has started to consider the possibility of advanced sludge recovery to the final product technological schemes, such as the sludge2energy system where sludge incineration heating energy will be used for sludge drying.

V. POLAND (Goleniow)

Municipal sewage sludge is subject to Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste, the so-called Waste Framework Directive, which sets out the principles for the management of waste, including municipal sewage sludge, from the moment it is regarded as waste.

European Union's legal regulations regarding management of sewage sludge include primarily the Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture, the so-called Sewage Sludge Directive, which results in significant restrictions for the agricultural and natural use of sludge.

Polish Legislation review

Polish national regulations concerning the processing and final management of municipal sewage sludge constituting waste are laid out in the Waste Act of 14 December 2012 and the Regulation of the Minister of the Environment of 6 February 2015 on municipal sewage sludge.

These legal acts specify the conditions, frequencies and types of sediment and soil testing to be carried out before using sludge, as well as the obligations of the landowners and producers of sludge. It is also possible to use stabilized municipal sewage sludge for manufacturing fertilizers or plant cultivation aids, as laid out in the Act on Fertilizers and Fertilization of 10 July 2007 (Dz. U. 2018, item 1259) and the Regulation of the Minister of Agriculture and Rural Development of 18 June 2008 on the implementation of certain provisions of the Act on Fertilizers and Fertilizations (Dz. U. of 2008 No. 129, item 76). These laws lay down the conditions for marketing products manufactured from municipal sewage sludge and explain how to obtain authorizations for placing a product on the market via obtaining independent opinions of the competent research institutes.

The Waste Act defines how to properly classify sewage sludge into appropriate groups, subgroup and types of waste, in accordance with the Regulation of the Minister of the Climate of 2 January 2020 on Waste Index (Dz. U. of 2020 , item 10). The classification is carried out by the waste producer. If a sewage sludge has been subject to stabilization, i.e. biological, chemical, thermal or other treatments aiming to reduce the susceptibility of municipal sewage sludge to mineralization (rotting), such sewage is classified under code 19 08 05 - *stabilized sewage sludge*. Sewage sludge classified as above can be recycled above ground.

The Waste Act introduces a number of provisions governing the handling of municipal sewage sludge, for instance the ban on storing sewage outside of the manufacturing site; in addition it introduces the proximity principle which prevents the use of municipal sewage sludge outside a voivodeship, unless that the distance between the origin of waste and a facility in another voivodeship is shorter than the distance to a facility located in the same voivodeship. That Act also lays down the principles and conditions for recovering municipal

sewage sludge above ground or introducing the sewage into the soil for the following purposes:

1. For agricultural purposes, i.e. the cultivation of all commercial crops, including crops intended for the production of forage.
2. For cultivating plants intended for composting.
3. For cultivating of non-food crops and for the production of forage.
4. For the rehabilitation of land, including agricultural lands.
5. Adaptation of land to specific needs resulting from waste management plans, spatial development plans or decisions on development and land use conditions.

The provisions in question set out in detail the conditions for the use of municipal sewage sludge for the above purposes. Municipal sewage sludge may be used on land provided that it meets the requirements specified in the Waste Act and in the Regulation of the Minister of the Environment of 6 February 2015 on municipal sewage sludge (Dz. U. of 2015, item 257);

The condition for using municipal sewage sludge is acting in compliance with the maximum limits of permissible heavy metal content in the sludge, as well as with the permissible content of Salmonella bacteria and live intestinal parasite eggs. The regulation also sets the limits for heavy metal content in the surface layer of the land on which municipal sewage sludge is to be applied.

Before application, the sludge must be tested. The frequency of testing depends on the load of the plant and is not less than:

- 6 months at a treatment plant up to 10,000 p.e
- 4 months at a treatment plant between 10,000 and 100,000 p.e
- 2 months at a treatment plant over 100,000 p.e

Representative sample sludge is taken for testing. The sample is obtained by mixing individual samples taken at the same time at different sites. The number of individual samples depends on the amount of sludge to be tested:

- 10 - in case of sewage sludge volume of up to 50 m^3
- 15 - in case of sewage sludge volume between 50 m^3 and 100 m^3
- 30 - in case of sewage sludge volume exceeding 100 m^3

The required volume of individual samples must be collected in a single container and thoroughly mixed. Approximately 2 kg of solid or 5 liters of liquid sewage should be taken for examination.

Testing of sewage sludge must be performed in certified laboratories and includes:

- pH;
- dry matter content;
- organic matter content in dry sludge;
- total nitrogen content, including ammoniacal nitrogen content;

- total phosphorus content;
- calcium and magnesium content;
- heavy metal content in dry sludge;
- Salmonella presence;
- Number of eggs of intestinal parasites *Ascaris sp., Trichuris sp. and Toxocara sp*.

The most important parameters determining the suitability of the sludge for use in agriculture is the absence of biological contaminants and concentration of heavy metals not exceeding the maximum values presented in the table 12 below.

Table 12. Maximum permissible content of heavy metals in municipal sewage sludge

No.	**Metals**	**for agriculture and for the rehabilitation of land**	**for the rehabilitation of land for non-agricultural purposes**	**for the adaptation of land to specific needs resulting from waste management plans, spatial development plans or decisions on development and land use conditions, for cultivating plants intended for composting, for cultivating of non-food crops and for the production of forage**
1	Cadmium (Cd)	20	25	50
2	Copper (Cu)	1000	1200	2000
3	Nickel (Ni)	300	400	500
4	Lead (Pb)	750	1000	1500
5	Zinc (Zn)	2500	3500	5000
6	Mercury (Hg)	16	20	25
7	Chromium (Cr)	500	1000	2500

The presence of Salmonella and live intestinal parasite eggs prevents the use of sludge in agriculture and for land reclamation for agricultural purposes. The total number of live intestinal parasite eggs of *Ascaris sp., Trichuris sp., Toxocara sp.* in 1 kg of dry matter, sediments for applied research in agriculture and for land reclamation for agricultural purposes must be 0. For land reclamation, i.e. the adaptation of land to specific needs resulting from waste management plans, land-use planning or planning decisions, for the cultivation of compost crops, for the cultivation of crops not intended for consumption and for the production of fodder - the maximum permissible number is 300.

Sewage sludge must not be used on soils exposed to heavy metal contamination. Before using waste sludge, is necessary to carry out soil testing in order to assess the baseline status of the soil and to further monitor it. Soil quality is tested on a sample taken from the top layer from a

depth of 25-30 cm. One sample represents a maximum area of 5 ha. A representative sample is obtained by mixing 25 samples taken from areas regularly distributed over a parcel. The Act on Municipal Sewage Sludge lays down the maximum permissible concentration of heavy metals in the soil (Table 13) when using sewage sludge, depending on the agronomic category of the soil.

Table 13. Allowable concentrations of heavy metals in the soil when using sewage sludge based on the agronomic category of the soil.

No.	**Metals**	**Allowable concentrations of heavy metals in the soil when using sewage sludge based on the agronomic category of the soil**		
		Light	**Medium**	**Heavy**
1	Cadmium (Cd)	1	2	3
2	Copper (Cu)	25	50	75
3	Nickel (Ni)	20	35	50
4	Lead (Pb)	40	60	80
5	Zinc (Zn)	80	120	180
6	Mercury (Hg)	0,8	1,2	1,5
7	Chromium (Cr)	50	75	100

In addition to the heavy metal content of soil samples, the pH and phosphorus assimilability are determined, as sewage sludge must not be used for soils with a pH lower than 5.6.

The maximum permissible amount of sewage sludge to be used in agriculture and for land reclamation for agricultural and other purposes is presented in Table 14. In addition, the amount of sewage sludge to be used should be determined in a way which ensures that the maximum permissible contents of heavy metals as per Table 13 will not be exceeded.

Table 14. Allowable concentrations of heavy metals in the soil when using sewage sludge based on the agronomic category of the soil.

Purpose	**Application during the year**	**1x application per 2 years**	**1x application per 3 years**
Agriculture	3 Mg dry mass/ha	6 Mg dry mass/ha	9 Mg dry mass/ha
Reclamation of land for agriculture			
Reclamation of land for non-agricultural purposes,	15 Mg dry mass /ha	30 Mg dry mass /ha	45 Mg dry mass /ha

Purpose	Application during the year	1x application per 2 years	1x application per 3 years
Adaptation of land to specific needs resulting from waste management plans, land use plans,			
Cultivation of crops intended for composting,			
Growing of non-food and non-feed crops.			

It must be stressed however, that using sludge classified as waste under code 19 08 05 is not always possible due to strict legal regulations, because it may contain high levels of heavy metals and biogases in quantities that disqualify using it as fertilizer in agriculture. A possible solution for using sewage sludge which does not meet the aforementioned requirements is utilizing composted sludge.

Composting is a microbiological process based on processing of organic waste. The process occurs under aerobic conditions and leads to partial mineralization and humification of organic matter. An important element in the composting process is the composition of the compost mixture, especially in chemical, biological and mechanical terms, in order to obtain a stable and environmentally safe product. Composting methods are most frequently used in sludge management due to the specific properties of sludge:

- in a triangular, movable pile;
- in a static pile with or without aeration;
- in drums;
- in containers.

Composting using one of the aforementioned methods produces fertilizer which meets the criteria for being placed on the market under the laws on fertilizing and fertilization.

The Polish market for fertilizers is regulated by the provisions of the Fertilizers and Fertilization Act of 10 July 2007. (Dz. U. of 2007, No. 147, item 1033), Regulation of the Minister of Agriculture and Rural Development (Dz. U. of 2009, No. 224, item 804) and implementing rules:

- Regulation of the Minister of Agriculture and Rural Development of 18 June 2008 (Dz. U. No. 119, item 765).
- Regulation of the Minister of Agriculture and Rural Development of 8 September 2010 (Dz. U. No. 183, item 1229).

The main aim of the legal regulations is to ensure that fertilizers offered and used for agricultural purposes meet high quality standards and their use is safe for the environment, as well as human and animal health. The following fertilizers can be distinguished in accordance with the Act on Fertilizers and Fertilizing:

- mineral;
- natural;
- organic, organic-mineral;
- products for improving properties of soil;
- plant cultivation aids.

Each of these groups of fertilizers is governed under varying rules for introducing to the market. In Poland, it is permissible to sell domestically manufactured fertilizers certified by the Minister of Agriculture and Rural Development, as well as fertilizers produced or admitted to trading in other EU countries.

Permits for placing on the market are granted in order to protect the interests of the agricultural producers (persons purchasing the fertilizer or agent) and to protect the environment, human and animal health. The following components are subject to assessment:

- quality (chemical and physicochemical properties);
- the fertilizer value of the product;
- the impact of the product on the environment, human and animal health, manufacturing technology and raw materials used, the sanitary condition of the product, the heavy metal content and veterinary requirements.

The criteria for the health status assessment include testing for Salmonella bacteria, live intestinal parasite eggs (*Toxoxoxara sp., Ascaris sp., Trucharis sp.*), Enterobacteriaceae bacterial count (up to 1000 ykt/1g of fertiliser) - in the case of fertilisers containing animal by-products.

The total content of heavy metals together with the requirements for components is strictly defined (Tables no. 15, 16, 17) for organic and organic-mineral fertilizers.

Quality requirements are not specified for products used to improve soil characteristics. Manufacturers declare the quality parameters that demonstrate the ability of a product to improve its physical, chemical, biological, etc. properties.

Table 15. Permissible heavy metal content in fertilizers (per 1 kg of dry mass)

Chromium (Cr)	100 mg
Cadmium (Cd)	5 mg
Nickel (Ni)	60 mg
Lead (Pb)	140 mg
Mercury (Hg)	2 mg

Table 16. Requirements for the contents of organic fertilizers

Fertilizer form:	
dry	**liquid**
at least 30% organic matter and/or at least: .3% (m/m) N 0.2% (m/m) P2O5 0.2%(m/m) K2O	at least: 0.3% (m/m) N 0.2% (m/m) P_2O_5 0.2%(m/m) K_2O

Table 17. Requirements for organic and mineral fertilizer contents

Fertilizer form:	
dry	**liquid**
at least 20% organic matter and/or at least: 1% (m/m) N 0.5% (m/m) P2O5 1%(m/m) K2O	at least: 0.5% (m/m) N 0.2% (m/m) P_2O_5 0.5%(m/m) K_2O

Fertilizer value assessment is carried out experimentally on test plants (agricultural crops) under strict conditions of field or pot experiments. The yield-forming activities, the influence of fertilizer on the quality of yield, and the influence of soil fertility are subject to assessments.

All tests, from fertilizer sampling to testing, are carried out by bodies and laboratories accredited in the EU. On the basis of the results obtained, tests and evaluations, the quality requirements are evaluated and the fertilizer value of the institute is evaluated: -IUNG -PBI, Institute of Pomology and Vegetation, Forest Research Institute. Opinions on the impact on human health, the Institute of Rural Medicine, the impact on animal health - PIW-PIB, the

impact on the environment - Instytut Ochrony Środowiska (Institute for Environmental Protection).

After completing the study and collecting all opinions, a complete application must be submitted to the Ministry of Agriculture and Rural Development for a permit to place the fertilizer / agent on the market.

Authorization shall be granted for an unlimited period, may be withdrawn if the fertilizer does not comply with the conditions laid down in the authorization or if it is established on the basis of new facts that it is likely to endanger human or animal health or adversely affect the environment. The quality of marketed products is controlled by the Inspection of Commercial Quality of Agricultural and Food Products.

The processing of municipal sewage sludge constituting waste requires a relevant waste processing permit or an integrated permit covering waste processing. The Waste Act exempts from the obligation to obtain a waste processing permit a person owning the land area on which municipal sewage sludge is used for the following purposes: in agriculture, for the cultivation of plants intended for the production of compost, for the cultivation of plants not intended for consumption and for the production of fodder. The responsibility for the correct use of municipal sewage sludge lies with the producer of the sludge and is therefore obliged to obtain the permit. By transferring stabilized municipal sewage sludge to a natural person for use on the soil, the treatment plant continues to be responsible for the proper use of this waste. Municipal sewage sludge may be transferred to the landowner for use only by the sludge producer.

VI. CONCLUSIONS AND RECOMMENDATIONS

Our common understanding among the STEP project partners based on an ecological approach is that sludge from WWTPs:

- is a valuable biomass and as much as possible of the nutrients in the treated waste water should be collected in the sludge/as little as possible of nutrients, organic matter and chemicals in the treated waste water should pass onto the recipients.
- Should, if possible, be used as fertilizer in agriculture, so the valuable nutrients are recycled, and the carbon in the sludge is built into the soil, instead of quickly released as CO_2.
- Should, if possible, be digested to produce biogas /energy, thus replacing fossil fuels.

The EU framework legislation and the national legislations, is generally ensuring a safe and sustainable use of sludge as fertilizer, and based on our work in the STEP – project we want to point out that:

- Accumulated scientific evidence in general points to, that there are no adverse effects of using sludge from WWTP's in agriculture. The fate of certain persistent substances needs to be further clarified, both regarding the amounts in sludge and the fate in the ecosystem, e.g. PFAS.
- Barriers to the use of sludge from WWTP's as fertilizer in agriculture is sometimes psychological.
- Extremely strict National Limit Values can also be a barrier (e.g. copper in Sweden), and could be reviewed.
- Use of heavy metals and persistent chemicals in different products should be further restricted (e.g. cadmium in artists paints).