KEY FIGURE DATA
FOR SLUDGE BENCHMARK

Benchmarking the Baltic Sea Region
in the project IWAMA – Interactive Water Management

IWAMA
Interactive Water Management

Interreg
Baltic Sea Region

EUROPEAN UNION
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DEVELOPMENT
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EU STRATEGY FOR THE BALTIC SEA REGION
FLAGSHIP

EVALUATING EFFICIENCY OF SLUDGE TREATMENT

Collecting key figure data from the wastewater treatment plants in the Baltic Sea Region

As a part of the Interreg BSR co-funded IWAMA project, a questionnaire about specific data was sent out to the municipal wastewater treatment plants (WWTPs) in the area. A total of 66 high-quality answers were collected from the region, which became the basis for a comparative benchmark about both the general inflow parameters and overall sludge treatment situation. The answers were collected from Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland, Belarus and Germany.

The overall WWTP influent parameters in the region varied more than expected, with a tenfold difference between the highest and lowest reported values. Around 60% of the reported values were inside the expected range, while the big variance could be partially explained by the different amounts of industrial wastewater accepted to the municipal WWTPs.

Anaerobic treatment was the most common sludge treatment technology used in the region with a total of 32 WWTPs applying said technology. In order to reach good end quality of the treated sludge, many WWTPs use the combination of multiple technologies – the 66 WWTPs in this array used a total of 99 treatment steps, an average of 1.5 treatment technologies per plant. A total of 11 WWTPs reported no sludge treatment at all, while some of them use an external company for sludge treatment.

Regionally the used treatment technologies differ a great amount, with, for example, incineration applied mainly in the South-Baltic region and composting and humification – mainly in the Baltic region. This was to be expected, as the national legislation towards sludge usage is very different, which greatly influences the chosen technologies. Other technologies – such as anaerobic – were common in all of the regions.

The regional use of the treated sludge thereby varies greatly as well, with Germany and Poland using incineration and ash landfilling for a great amount of WWTPs, while both Baltic and Nordic regions have greater emphasis on treated sludge being applied in agriculture, greenery or recultivation. These results are also influenced by the regional size-distribution of the WWTPs, with many smaller WWTPs not being able to produce high enough quality sludge to be applied due to problems with their treatment technologies. As the amount of sludge produced by those plants is usually very small as well, the sludge is often accumulated on the territory or landfilled. We recommend looking into alternative sludge treatment technologies for the small plants, as many of the common technologies (anaerobic treatment, drying, incineration) are not applicable there. Right now for WWTPs under 5000 PE, more than 90% of the sludge is accumulated and often not treated properly.

The quality of the treated sludge was mainly answered by the bigger WWTPs and therefore the overall situation seems very good. When assessing the heavy metal concentrations based on the current EU legislation only 2 plants were unable to achieve the limit set for cadmium, while no problems with other metals were reported. At the same time, if new heavy metal concentrations (as discussed by HELCOM) would be introduced, the problem with the heavy metal values will increase significantly, with 22 WWTPs potentially unable to reach the proposed cadmium limit values. While cadmium values are the biggest problem for WWTPs in the region, some plants would have problems with the proposed limits for chromium, mercury, lead and nickel as well. Thus, even though stricter heavy metal limits will lessen the burden set on environment, the local situation and availability of investment options should be considered before accepting the new values.

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1 INTRODUCTION

Interreg BSR co-funded project IWAMA started collecting data from wastewater treatment plants (WWTPs) around the region in autumn 2016, by sending out a comprehensive questionnaire about WWTP specific data to the recipient in the whole region. Information about general parameters, energy consumption and production, sludge treatment technologies and final usage of the sludge were asked. The project aimed to acquire a total of 50 answers from different countries in the Baltic Sea catchment area: Sweden, Finland, Estonia, Latvia, Lithuania, Russia, Belarus, Poland and Germany. By spring 2017 a total of 70 responses had been collected with varying amounts of data included. In this report the data from 66 WWTPs that managed to fill in the questionnaire with satisfactory quality is analysed, while due to many differences between the plants and used technologies, the specific samples of most of the criteria studied were smaller.

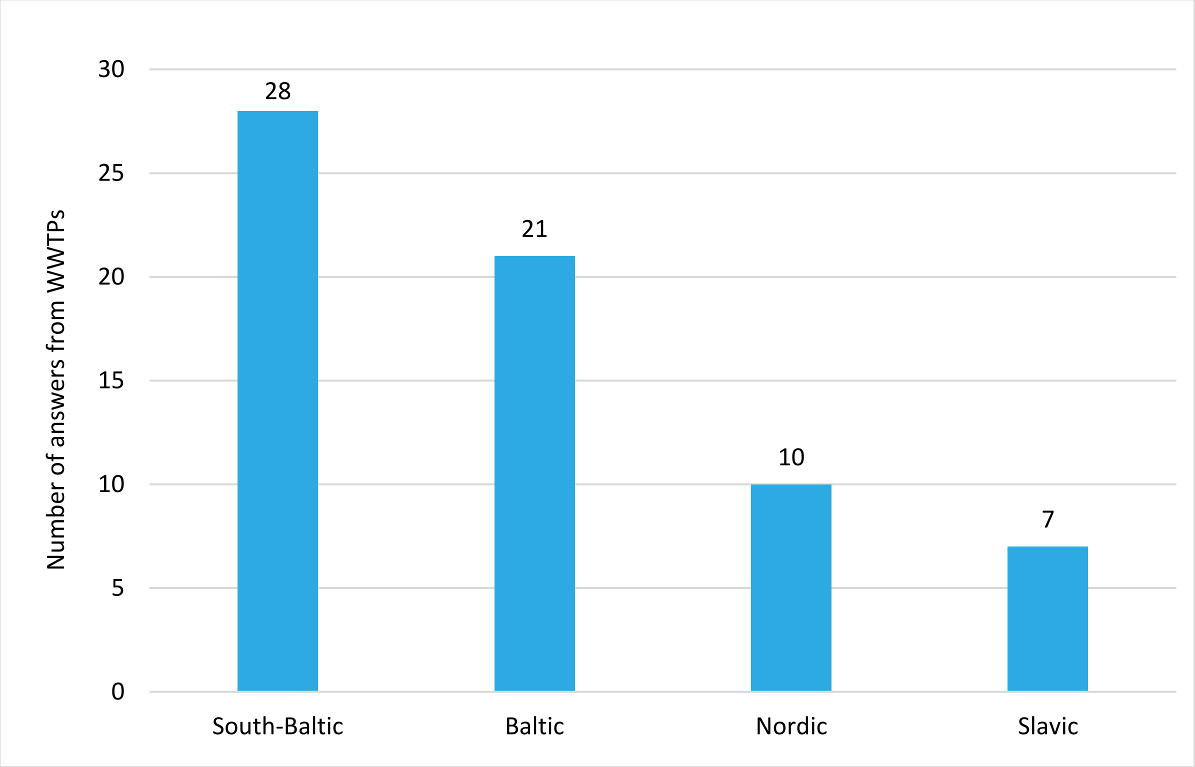
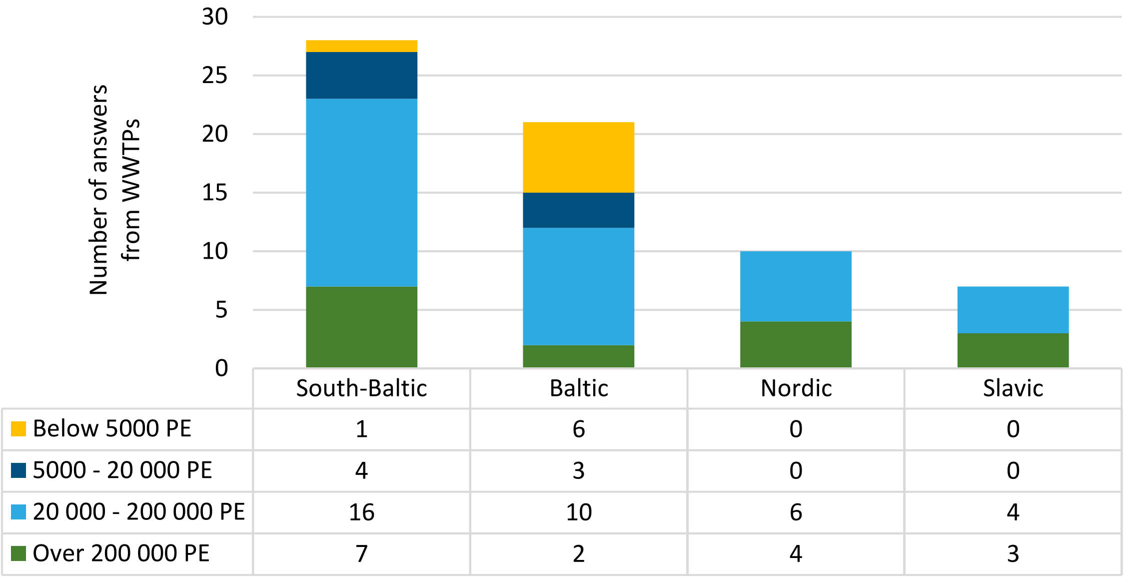


Figure 1 – Regional distribution of collected data.
Regions depicted as South-Baltic (Poland, Germany), Baltic (Estonia, Latvia, Lithuania), Nordic (Finland, Sweden) and Slavic (Russia, Belarus). Only good-quality responses included.

As seen from Figure 1 the regional distribution of the data was uneven, with most answers from two regions – South-Baltic (Poland and Germany; 28 responses included) and Baltic (Estonia, Latvia and Lithuania; 21 responses included). This might be due to more successful outreach in those countries, as both German Association for Water, Wastewater and Waste (DWA) and Estonian Water Works Association (EVEL) are partners in the IWAMA project with good connections to local and regional WWTPs. On the other hand, quality answers from the Slavic region (Russia and Belarus; 7 responses included) were a very positive surprise as the amount of plants in those countries connected to the Baltic Sea catchment area is quite low.

Another big variation can be seen from the regional size distribution of responding WWTPs (Figure 2). As the requirements, effluent limit values and therefore technologies differ greatly based on the size of a WWTP, four different size groups were outlined from the collected results. While all four regions had both medium-sized and large WWTPs (20 000 – 200 000 and larger than 200 000 by PE, respectively), answers from small and very small WWTPs were only collected from the South-Baltic and Baltic regions. The greatest difference is with the smallest size group (below 5000 PE), where 6 answers out of the total 7 came from the Baltic region, making conclusions about this size group very region-biased.



	South-Baltic	Baltic	Nordic	Slavic
🟨 Below 5000 PE	1	6	0	0
🟦 5000 - 20 000 PE	4	3	0	0
🟦 20 000 - 200 000 PE	16	10	6	4
🟩 Over 200 000 PE	7	2	4	3

Figure 2 – Size distribution of collected data by region.
Regions depicted as South-Baltic (Poland, Germany), Baltic (Estonia, Latvia, Lithuania), Nordic (Finland, Sweden) and Slavic (Russia, Belarus). Only good-quality responses included.

In the reported data, the yearly averages are mainly based on 2015 (earlier answers) or 2016. In specific cases, some data has been updated partially with results from 2017, mainly for WWTPs with new installations and investments done in 2016 or early 2017. We find that this variation in the collected data does not influence the results significantly, while using newer data helps reaching a better overview of the current situation.

2 QUALITY ASSESSMENT AND DATA VALIDATION

The overall quality and degree of completion of the received answers varied quite a lot for the whole region. This, however, was expected, considering the fact that most of the WWTP operators answered the questionnaire in English, as it was not translated to most of the native languages. The exceptions were Poland and the Slavic region, which had the opportunities to fill in the questionnaire in Polish and Russian respectively. While it helped operators understand some more specific questions and increased the quality of answers, the process of "to-and-back" translation posed other challenges, as technological language is complex and not always directly translatable.

To increase the quality of responses, additional questions and specifications were asked from most of the responders. Basic debugging was done by cross-checking the whole sample array amongst each other and highlighting possible overestimations or problems with units and mathematical transformations. Very common and simple problems with wrong units were fixed during the data checking, while more complex problems and empty data cells were sent back to the WWTPs for clarifications. The overall rate of communication was very good, with most WWTPs responding with answers within a week. The main round of clarifications was done in the beginning of 2017, while some of the problems were also discussed and solved during the IWAMA project Smart Energy and Sludge management audits conducted in spring 2017 at the project partner WWTPs. The communication also helped to develop a regional legislative background to better understand the answers collected from the region.

During the quality assessment and clarifications, some responses were removed from the sample due to either incomplete information, problems with communication or at the request of the WWTPs operator. A total of 4 WWTPs were removed from the general sample. In smaller and specific samples, only WWTPs lacking the specific technology or information about it were not included, any other reasons for eliminations were not applied.

3 BASIC WWTP CHARACTERISTICS

The collected sample of WWTP data in the Baltic Sea region represents many different treatment plants by size, technology used and inflow wastewater characteristics. In the first part of the benchmark, influent values to the WWTPs are shown on cumulative graphs, highlighting the distribution of influent concentration values of the main measured parameters: biochemical oxygen demand for 5 days (BOD_5), chemical oxygen demand (COD), total nitrogen (TN), total phosphorus (TP) and suspended solids (SS).

3.1. Biochemical Oxygen Demand (BOD_5)

The average influent BOD_5 concentrations were measured by 61 WWTPs, the lowest of the reported being 111 mg O_2/L and highest – 1323 mg O_2/L (Figure 3). The varying concentrations can be due to smaller WWTPs having septic tanks and pre-treatment systems installed on the influent supply line, before the water gets to treatment plant, or due to high volume of industrial wastewater inflow. The median value for the region was 345 mg O_2/L, with about 60% of the WWTPs having a BOD_5 concentration between 300 – 500 mg O_2/L. Too low BOD_5 concentration values might pose a problem in the treatment plant for traditional biological nitrogen removal processes and require extra organic carbon source loading to guarantee sufficient nutrient reduction in the biological treatment steps.

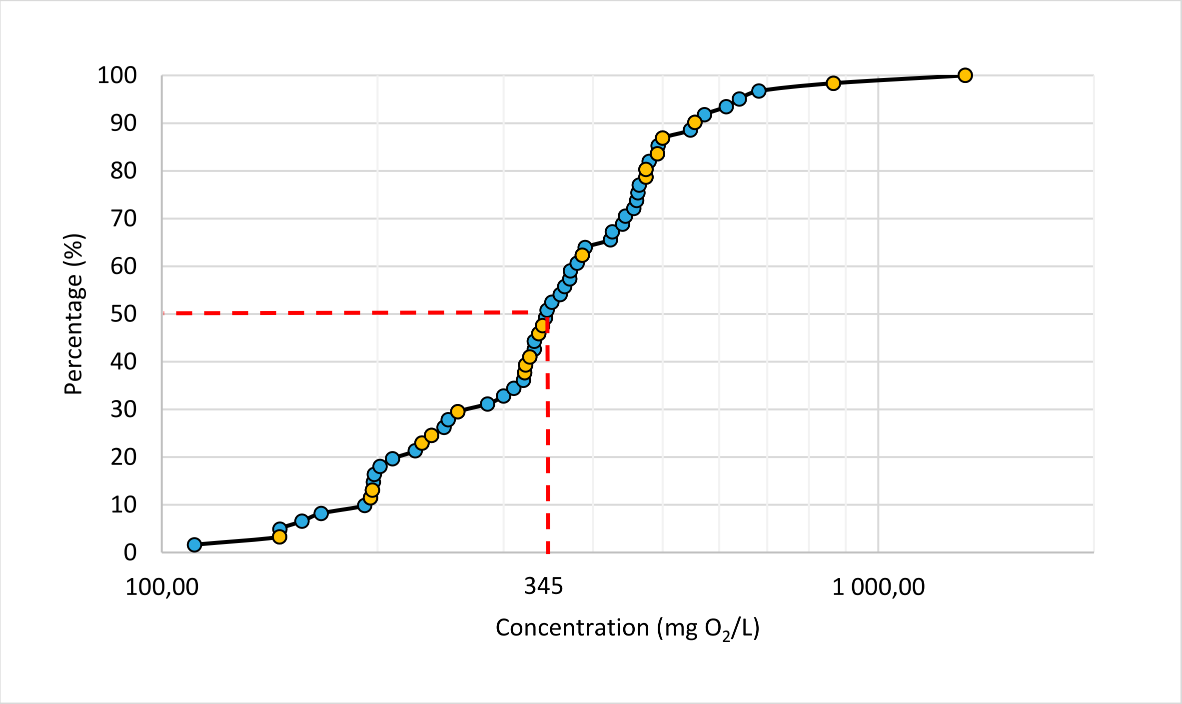


Figure 3 – Influent BOD concentrations in the region (61 WWTPs)
Shown on a cumulative frequency graph with percentages referring to total number of WWTPs in the sample. Blue markers represent all municipal WWTPs, yellow markers are shown for WWTPs having more than 20% (by volume) of their influent coming from industrial sources. The median value is highlighted by a red striped line.

3.2. Chemical Oxygen Demand (COD)

The average influent COD concentrations were measured by 57 WWTPs, the lowest of which was reported 320 mg O_2/L and highest – 2637 mg O_2/L (Figure 4). Again, this variation can be caused by many different factors, one of which is the amount of industrial wastewater inflow. The median value for the region was 771 mg O_2/L.

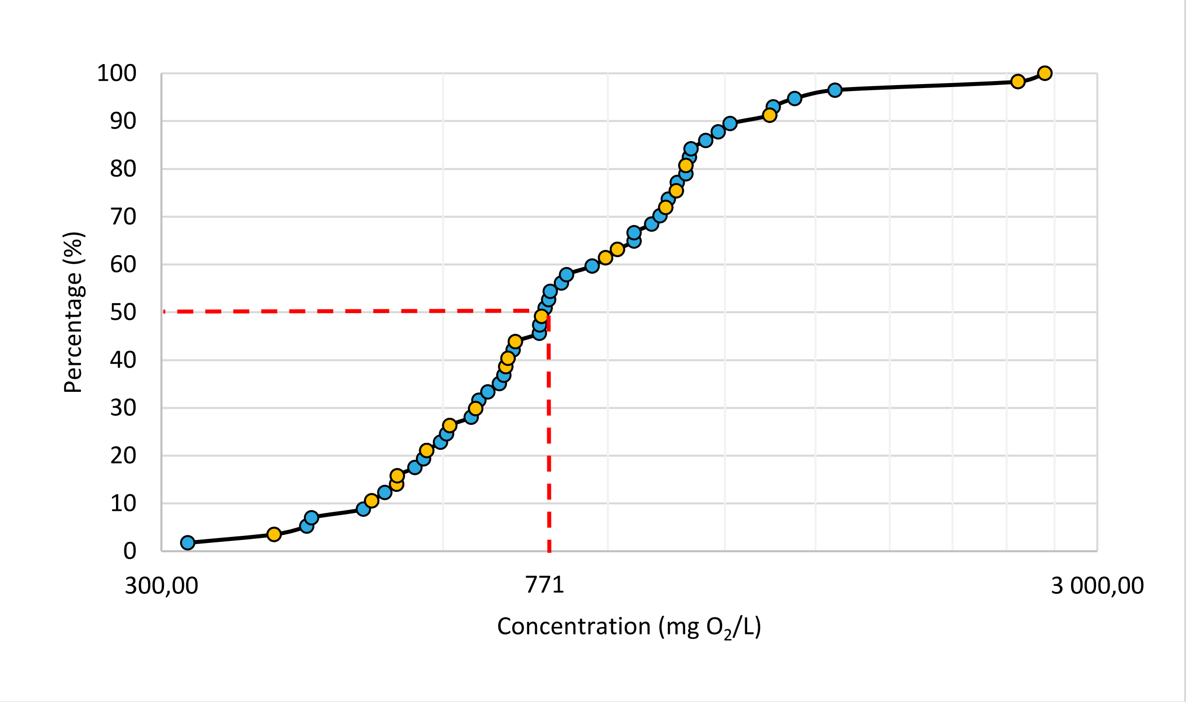


Figure 4 – Influent COD concentrations in the region (57 WWTPs)
Shown on a cumulative frequency graph with percentages referring to total number of WWTPs in the sample. Blue markers represent all municipal WWTPs, yellow markers are shown for WWTPs having more than 20% (by volume) of their influent coming from industrial sources. The median value is highlighted by a red striped line.

3.3. Total nitrogen (TN)

The average total nitrogen concentration in the influent was measured by 55 WWTPs. The lowest reported influent TN concentration was 8.4 mg N/L and the highest – 135 mg N/L. The median value from all the collected results was 68 mg N/L. When scrutinizing the data, two groups of WWTPs can be identified, one around 50-60 mg N/L and other around 80-90 mg N/L, which might show the effect of digester on the influent concentrations, as the reject water with very high nitrogen concentrations is often mixed with the influent.

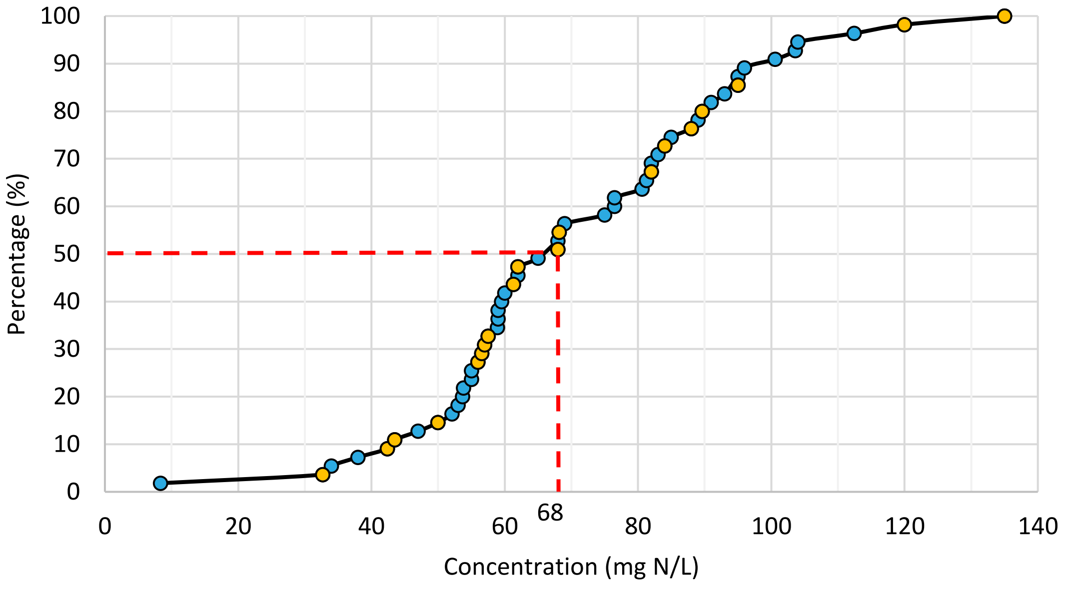


Figure 5 – Influent N concentrations in the region (55 WWTPs)
Shown on a cumulative frequency graph with percentages referring to total number of WWTPs in the sample. Blue markers represent all municipal WWTPs, yellow markers are shown for WWTPs having more than 20% (by volume) of their influent coming from industrial sources. The median value is highlighted by a red striped line.

3.4. Total phosphorus (TP)

The average total phosphorus concentration in the influent was measured by 59 WWTPs. The lowest reported influent TP concentration was 4.3 mg P/L and the highest – 22 mg P/L. The median value from all the collected results was 9.4 mg P/L. As phosphorus and phosphorus recovery is one of the currently trending topics, it is interesting to see how big the differences in various WWTPs can be. Higher influent phosphorus values quite often mean higher chemical demands as biological phosphorus removal cannot often reach that low concentrations and chemical precipitation is used to achieve those.

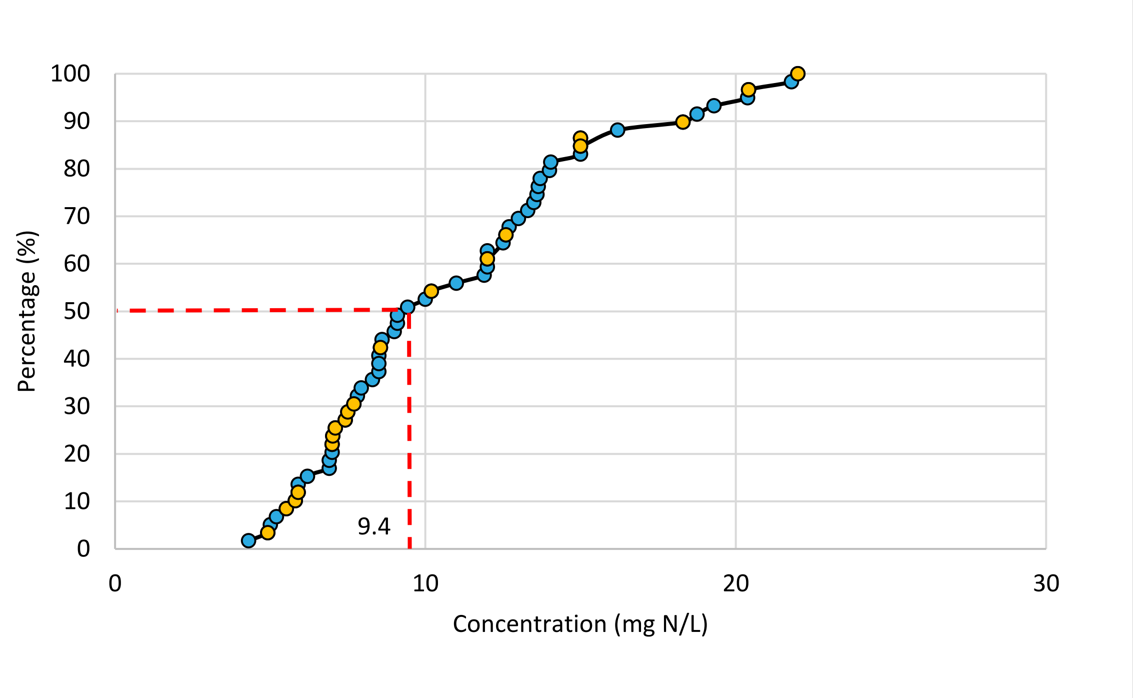


Figure 6 – Influent P concentrations in the region (59 WWTPs)
Shown on a cumulative frequency graph with percentages referring to total number of WWTPs in the sample. Blue markers represent all municipal WWTPs, yellow markers are shown for WWTPs having more than 20% (by volume) of their influent coming from industrial sources. The median value is highlighted by a red striped line.

3.5. Suspended solids (SS)

The average suspended solids concentration in the influent was measured by 53 WWTPs. The lowest reported influent SS concentration was 3.3 mg SS/L and the highest – 787 mg SS/L. The median value from all the collected results was 330 mg N/L. Out of all the common influent parameters, suspended solids concentrations had the greater variations, with minimal and maximal values reported differing more than 230 times. The difference can be partly due to the nature of the sewer system and pumping stations, with some municipalities using shredders in the sewage pumping stations in order to reduce the amount of clogging. From the highest concentration quartile (13 WWTPs) only 3 WWTPs had a higher inflow than 20% coming from industrial wastewater, therefore the linkage between high SS concentrations and high industrial wastewater amounts is very weak.

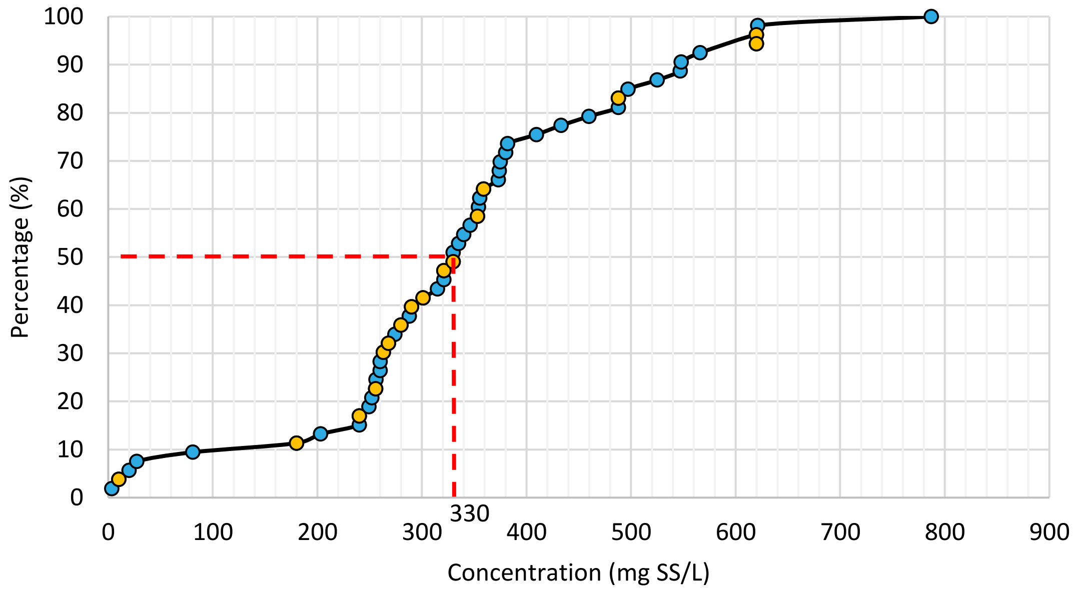


Figure 7 – Influent SS concentrations in the region (53 WWTPs)
Shown on a cumulative frequency graph with percentages referring to total number of WWTPs in the sample. Blue markers represent all municipal WWTPs, yellow markers are shown for WWTPs having more than 20% (by volume) of their influent coming from industrial sources. The median value is highlighted by a red striped line.

3.6. Average calculated simple sludge age

As average sludge age is a parameter not used by all WWTPs, the calculation was done based on other information reported (WW temperature, volumes of biological tanks, influent parameters) and according to the German DWA standard. The simple sludge age calculation does not take into account biological phosphorus removal. The simple sludge age can show the retention time of sludge in the biological treatment units and gives an estimation of how complicated the bacterial structures have grown to be. The high sludge age is linked to less biogas produced in a following anaerobic step and may have a negative effect on the sludge settling quality as well. Lower sludge age is linked to greater biogas production, while colder climate and seasons create a problem in biological nitrogen removal.

The simple sludge age was calculated from the data of 49 WWTPs (Figure 8), the lowest was 4.4 days and highest – 115.4 days. The regional mean value was 17.83 days, which is considered relatively low as an average in colder climates. Very low or very high sludge age values can either show problems in the biological treatment or problems with the related data. These outliers were kept in the data in order to show the need of life-long learning programs, further education and exchange among the wastewater treatment plant operators, which could improve the understanding on how to better run the treatment system or check the used data values in order to ensure their correctness.

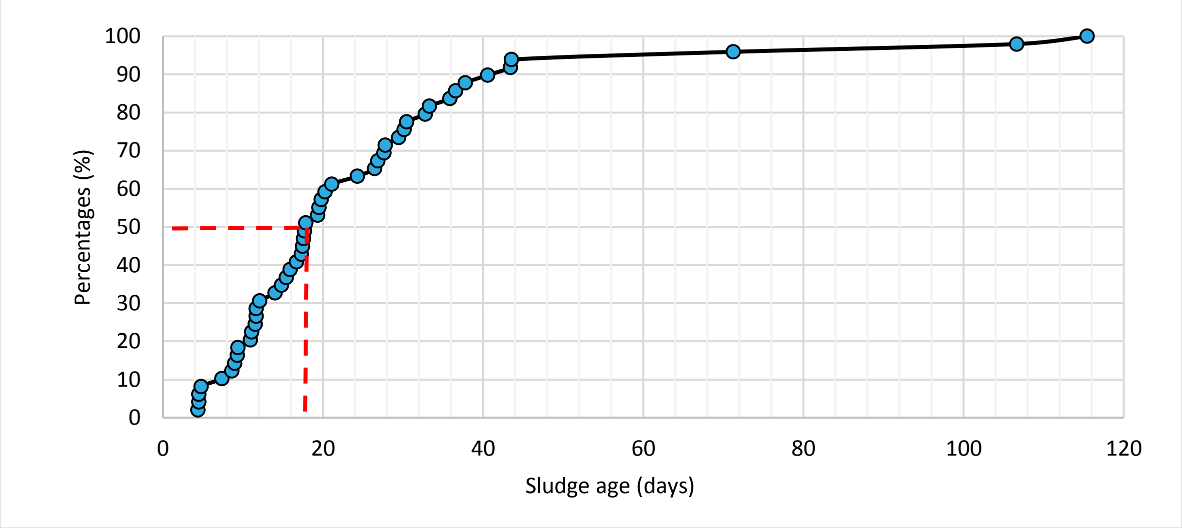


Figure 8 – Calculated simple sludge age in the region (49 WWTPs)
Shown on a cumulative frequency graph with percentages referring to total number of WWTPs in the sample. The median value is highlighted by a red striped line.

The dependence between simple sludge age and WWTP size was also checked while no relevant connection was derived. Both very big and very small plants had a low calculated sludge age, but as the sample size in those groups is relatively small, no dependencies can be proven.

4 SLUDGE TREATMENT

While wastewater treatment methods are mostly unified in the region, with specific traditional methods used in varying combinations and configurations, evaluating sludge treatment in the region is much more complicated due to a high number of varying technologies used. In the key figure questionnaire, 7 different sludge treatment methods were included with specific questions designed for each of the methods: anaerobic treatment, drying, incineration, composting (including post-composting), humification, external aerobic treatment and lime stabilization. Still, 12 treatment plants marked “Other” as their sludge treatment method, as it they could not categorize it into any of the existing groups. Therefore, the benchmarks for the regional sludge treatment cannot be shown as one unified figure and will be elaborated in the following sections.

Differently from general statistics, in this section the South-Baltic region will be shown as Poland and Germany separately, as the amount of answers from both countries is great enough to show separate statistics. Other regions will be shown together, due to the fact less than 10 answers were acquired per country.

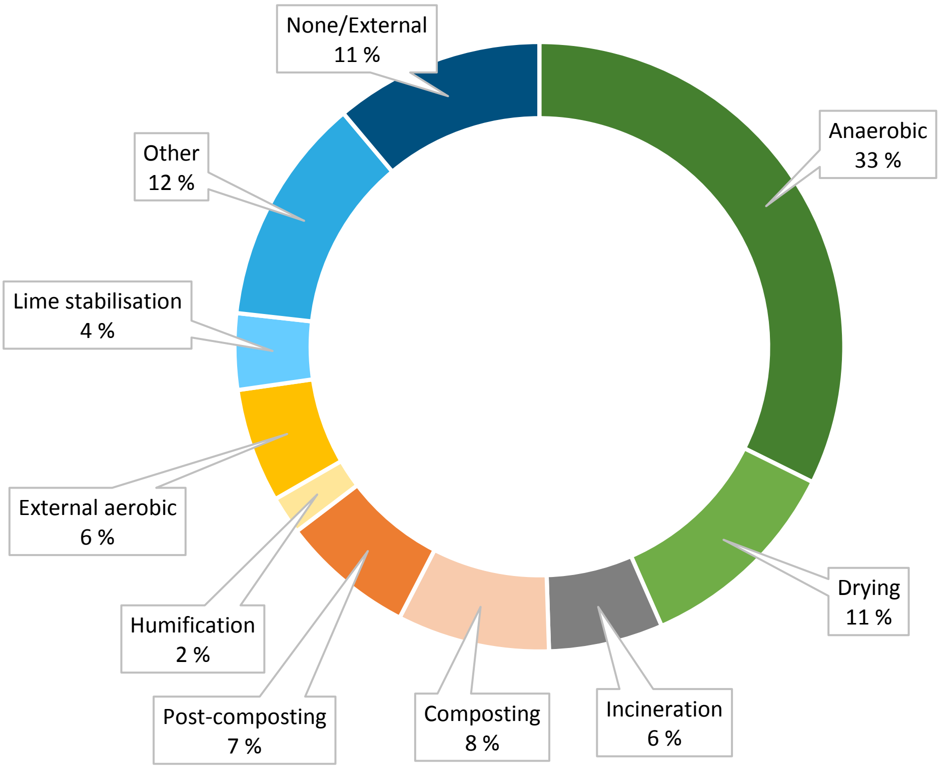


Figure 9 – Distribution of different treatment technologies in collected answers (66 WWTPs with a total of 99 technological steps)
Section “Other” shows treatment technologies that could not been included in any of the pre-existing categories, while “None/External” means sludge was either not treated at all or transferred to an outside company/treatment plant.

Out of 66 WWTPs that answered about their sludge treatment process, a total amount of 99 treatment steps were used as a sum – most of the larger WWTPs employ 2-3 step sludge treatment in order to ensure sufficient degradation, good quality of the end product and high energy retrieval. The overall distribution of the answers is shown on Figure 9, with the highest amount of differing answers about anaerobic treatment (32 WWTPs). Other processes in the sample array of WWTPs were applied much less frequently: "other processes" were used in 12 WWTPs, drying in 11 WWTPs, composting in 8 WWTPs, post-composting in 7 WWTPs, both external aerobic treatment and incineration in 6 WWTPs, lime stabilization on 4 WWTPs and humification in 2 WWTPs. A total of 11 WWTPs reported not having a sludge treatment at all, while some of them transported their sludge to an outside company or to another WWTP for treatment.

Based on the amount of collected answers about each of the technologies, only anaerobic treatment had enough data for a separate technological evaluation. Other treatment processes will be used in overall benchmarks and giving regional statistics without having a specific technological benchmark.

4.1. Regional use of treatment technologies

The countries and sub-regions in the Baltic Sea catchment area differ greatly based on many denominators – population density, landscape, economy, political system, history – with each of those factors influencing the countries or sub-regions as a whole. Therefore, big differences between the countries can be expected with sludge treatment not being an exception either (Figure 10). Treatment technologies more used in smaller plants are common in the Baltic region (composting, humification), while incineration is more used for large WWTPs in Poland and Germany. While some treatments are prevailing in one of the sub-regions or countries, anaerobic digestion is common in the whole region.

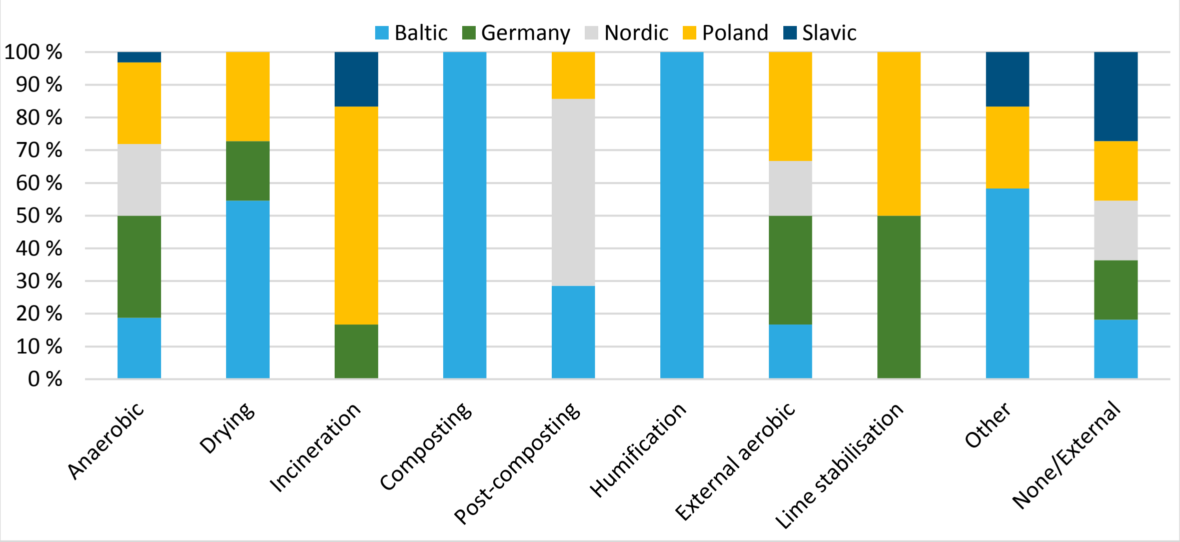


Figure 10 – Absolute regional use by technologies (66 WWTPs, 99 technological steps)
Each column represents all the answers gathered for the specific technological step with percentages of how many of the total answers came from which region. The figure does not take into account the number of answers for a specific technology.

From Figure 11 the wide usage of anaerobic treatment in almost all of the Baltic Sea sub-regions can be seen. As the sizes of WWTPs reporting from different regions varied greatly (Figure 2), these differences can also be seen for the technological usage. As the most of the very small plants (under 5000 PE) were from the Baltic region, 38% of the plants in the region using composting is not surprising. Though some of the differences seen on Figure 10 can be due to imperfection of the sample array of WWTPs, some very specific regional differences can still be identified. For example, as the Nordic countries have allowed application of fertilizers made from treated wastewater sludge, the use of post-composting as one of the treatment steps in 40% of the plants is expected. The same can be seen for none/external treatment, which is the highest in Slavic countries, where wastewater and sludge treatment systems are only now advancing to the regional average levels.

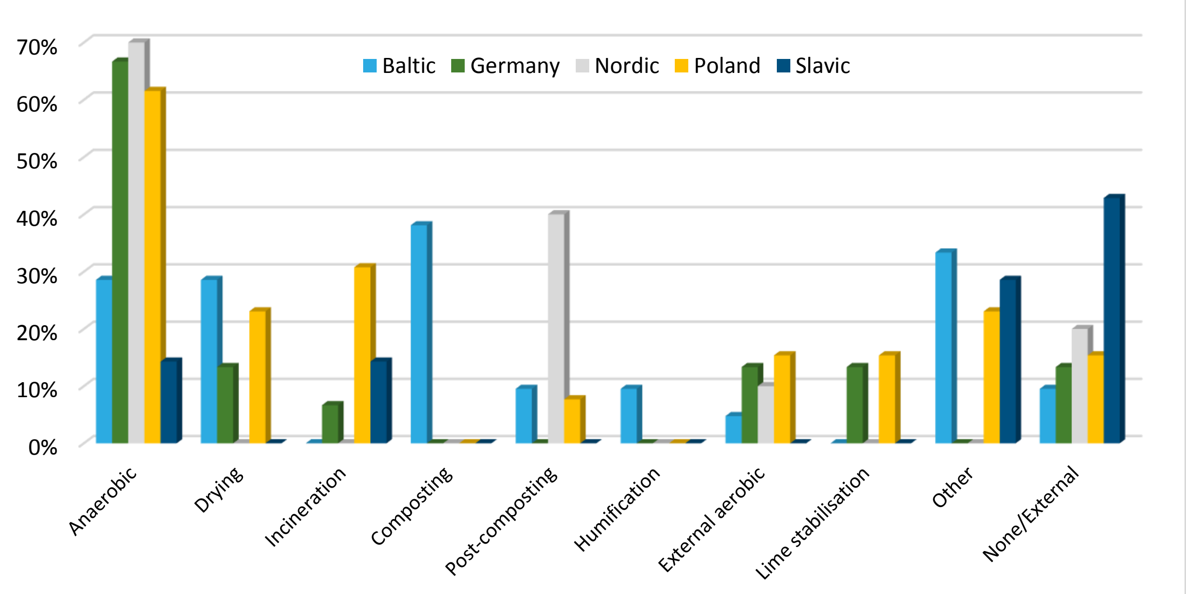


Figure 11 – Percentages of WWTPs in the region using specific technologies (66 WWTPs, 99 technological steps)
Represents how many regional WWTPs reported using the specific technology as one of their sludge treatment steps.

4.2. Sludge treatment technologies by WWTP size

Even though sludge treatment technologies used by the WWTP partially depend on the country or sub-region of their location, most influencing dependency is the size of WWTP (Figure 12). Though many technologies can be applied for various sizes (especially in combination with other technologies) post-composting, drying, anaerobic treatment and incineration are applicable and feasible only for bigger WWTP. While first three of the aforementioned technologies have the first application around 20 000 – 30 000 PE, incineration is considered financially feasible and thus applied only for WWTPs over 300 000 PE.

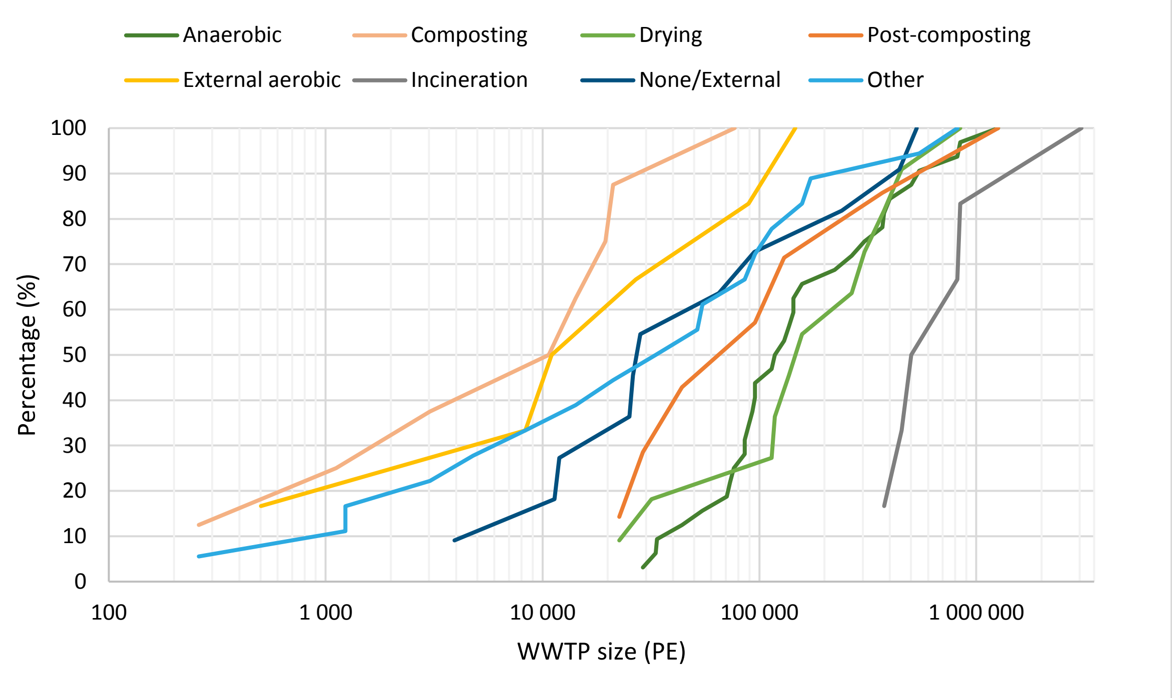


Figure 12 – Correlation between sludge treatment technologies and WWTP sizes in PE (66 WWTPs, 99 technological steps)
Shown on a cumulative frequency graph with percentages referring to total number of WWTPs in the sample. Lime stabilization, humification and external aerobic added to the "Other" section.

5 USAGE AND QUALITY OF THE TREATED SLUDGE

Based on the results gathered with the key figure data, not only great differences in sludge treatment processes and technologies were demonstrated, but the quality of the final sludge and its usage varied greatly as well. While this is often connected with each country’s specific legislation (whether direct use of treated sludge is approved, certification system in place and landfilling sludge forbidden), the differences are also visible within a specific country or sub-region.

A total of 62 WWTPs answered to inquiries about their treated sludge usage. In the key figure questionnaire 7 different options for treated sludge use were given, with direct use divided to three different categories – use in greenery, recultivation or agriculture. Non-direct use was also divided into three – sludge incinerated, landfilled or accumulated on territory. The final option included was external treatment, as many WWTPs in the region give their sludge to a secondary company or another WWTP to treat and do not know the final use of the treated sludge.

5.1. Regional differences of treated sludge use

The effect of different limits and legislation can be seen clearest when comparing the sludge use in different countries and sub-regions (Figure 13). While most of the treated sludge is finally incinerated in Germany, Poland and the Slavic region, this practice is mainly not used in the Baltic and Nordic regions. While both in the Baltic and Slavic regions a great amount of sludge is accumulated in the WWTP territory (mostly small WWTPs), in Nordic region 70% of the treated sludge is directly used, mostly in agriculture and greenery, but also in recultivation. Only a small percentage of the sludge is not directly used and landfilled, as most of the external treatment facilities in the country also produce certified fertilizers. While the total amount of WWTPs using treated sludge directly in agriculture is still highest in Germany, due to legislative changes (only small WWTPs can keep this practice) this will change in the coming years. At the same time the Baltic region is focusing on accepting different end-of-waste criteria in order for the sludge to be used directly (certification legislation for treated wastewater sludge was accepted in Estonia in summer 2017).

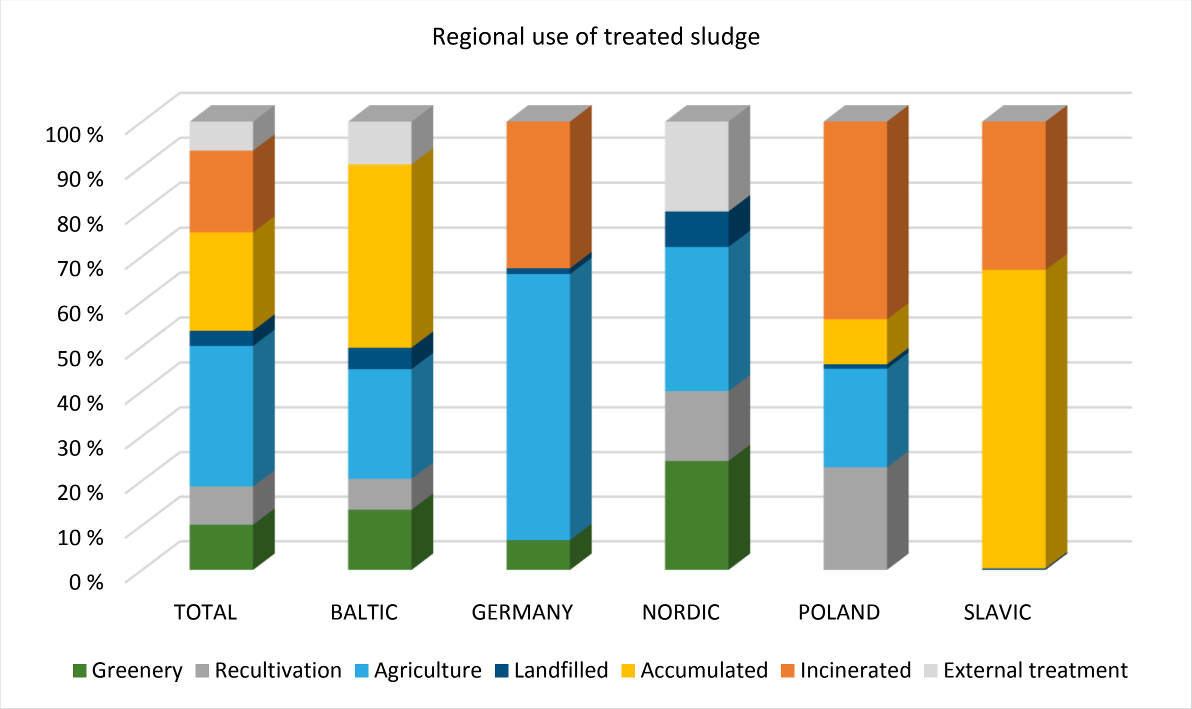


Figure 13 – Total and divided sub-regional use of treated municipal wastewater sludge
Each of the columns represents the total amount of answers from the specific region, thereby not reflecting the total volume of treated sludge.

While the regional picture presented by the collected key figure data tables is showing explainable trends, the results are also influenced by the size of the WWTPs in the regions and the technologies used for sludge treatment. It should also be taken into account that key figures were often filled in by the regional front-runners and WWTPs connected to the partners or associated partners of the Interreg BSR or EU financed projects and may have an overall better quality of technology and newer investments to the sludge treatment.

5.2. Final sludge use methods by WWTP size

The results of treated sludge use by WWTP size groups are presented by Figure 14. As previously mentioned in many papers and regional reports, one of the more problematic points for proper wastewater sludge treatment are the very small WWTPs. As most good quality sludge treatment technologies and the investments into constructing those are only financially feasible for medium and large-scale WWTP, the sludge from small WWTPs is often accumulated on their territory and not used at all. As this practice is not sustainable in longer perspective, other options need to be found in order to solve the problem at the current time. Often the decision to accumulate the sludge is not based on bad treated sludge quality, but rather on the insufficient number of tests to understand the concentrations of nutrients, pathogens and heavy metals.

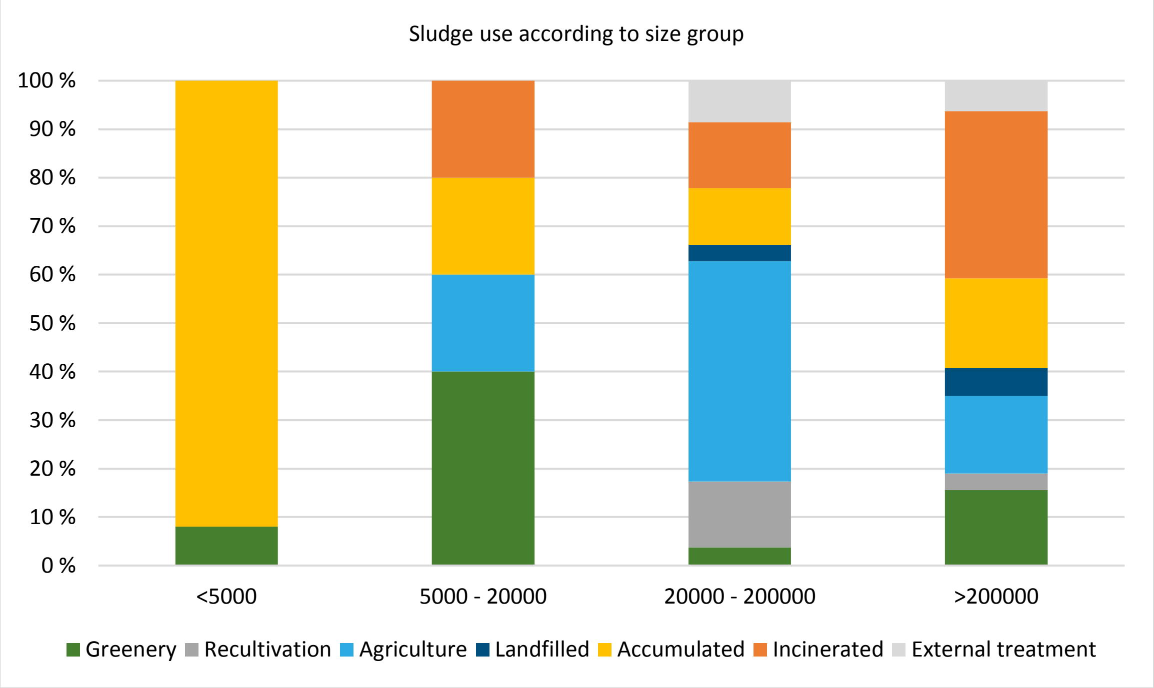


Figure 14 – Treated municipal wastewater sludge usage by different WWTP size groups
Each column represents the total amount of answers gathered from the WWTP size group, thereby not reflecting treatment amounts in mass or volume.

The situation is better with the WWTPs in the second size group (5000 – 20 000 PE), where almost 60% of treated sludge is directly applied. As sufficient sludge treatment may be too expensive or unobtainable for those plants as well, the dewatered or dried sludge is often transported to a bigger WWTP for incineration (about 20% of the sludge). Some smaller WWTPs are still accumulating sludge on their territory, while this practice is slowly changing.

The third size group (20 000 – 200 000 PE) has the largest amount of WWTPs applying their sludge directly (over 62%), while both incineration and accumulation are used for more than 10% of the cases. External treatment by another company is also an option that is used, as this makes operating a treatment plant easier and shifts the responsibility for good quality sludge treatment.

For WWTPs over 200 000 PE, incineration is becoming the most widely used option, mainly due to the amounts of treated sludge produced daily. Though around 30% of the large treatment plants still apply their sludge directly, the proportion compared to the second and third size groups is halved. As one of the products of incineration is ash, the landfilling and accumulation of the ashes is one of the topical issues for many larger plants, especially due to the new approaches to phosphorus recycling.

5.3. Final sludge use based on treatment technology

When comparing the use of treated sludge with treatment technologies, another interesting side and parallels can be seen (Figure 15). The final uses of sludge treated with anaerobic digestion or drying vary greatly, which is to be expected as both are often used as intermediary steps in combination with other technologies. The uses of sludge treated with known final technological steps – like incineration, composting, humification – is much more streamlined. Naturally, most of the incinerated sludge is disposed of, with the small amount of residue ash being often landfilled. The small amount of sludge used in recultivation from incineration is due to maintenance of technology and interruptions in the incinerators work, which creates the need for other possibilities for treated sludge.

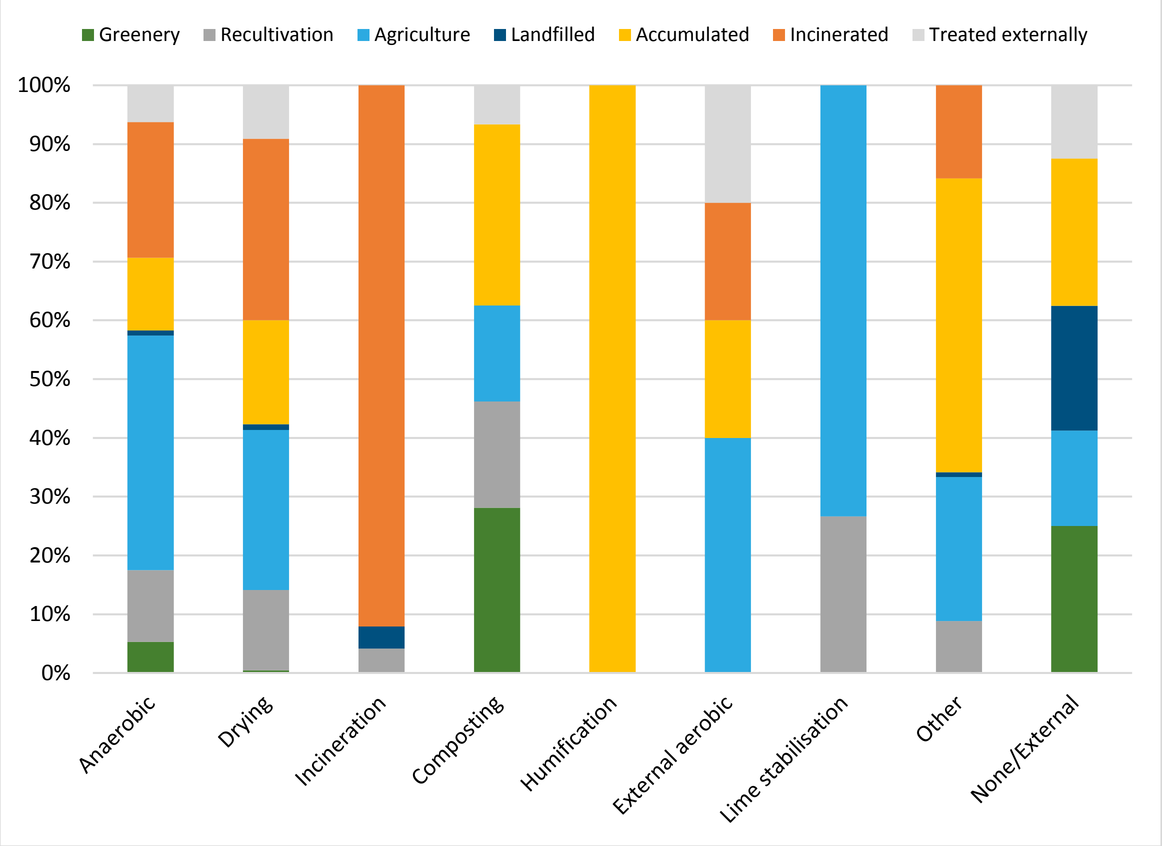


Figure 15 – Treated municipal wastewater sludge usage compared to treatment technologies used in WWTPs.
Each of the columns represents the total amount of answers about the specific technology, thereby not reflecting the total volume of treated sludge.

The composted sludge is for 62% of the WWTPs applied directly, most commonly in greenery, while about 30% of the sludge compost is accumulated in the territory due to problems with either the quality of the product or national legislation. While composting is technologically quite a simple process, the complicating factor for open-air composting in the region is the climate. Achieving sludge compost with good stabilization is therefore often a problem even for larger WWTPs and getting rid of the low-quality compost in an environmentally safe way is a challenge.

When looking at the smaller treatment technologies like humification and lime stabilization, the uses are very streamlined – possibly due to a very low number of answers gathered for the specific technologies. Still, it is an evident problem that while the sludge from lime stabilization is 100% applied directly and mostly in agriculture, the treated sludge from humification is currently not used at those specific WWTPs at all. As both are viable strategies for small WWTPs, the different use is a problem which should be further studied, as a treatment technology leading to no potential application is not feasible long-term.

While accumulation of the treated sludge is connected to almost all of the treatment technologies (besides incineration and in our sample lime stabilization), landfilling the sludge is in most cases only connected to landfilling incineration ash. There are still some WWTPs that do not treat their sludge at all (besides thickening or dewatering) and landfill the total amount of produced sludge – a practice that is strongly discouraged by both EU and HELCOM, and strictly forbidden in most of the countries in the region. In many cases these WWTPs lack the option for bigger investments or are using the practice due to the lack of knowledge of better solutions – a fact that must be remedied in order to completely end the potentially disastrous practice.

5.4. Quality of the treated sludge

One of the main components that limit the potential use options of the treated sludge are the concentrations of heavy metals. While these are definitely not the only risk factors, many potentially harmful substances are not measured in the sludge, while others are known to be degraded during extensive thermal treatment and not considered as a danger. The data for hygenisation collected with the key figure data was unfortunately lacking – only 8 WWTPs had separate hygenisation equipment and a total of 10 WWTPs tested the amount of pathogens in their treated sludge regularly. If we consider composting, drying and incineration as technologies during which hygenisation is guaranteed, a total of 34 WWTPs ensured the microbiological safety of their treated sludge – thus only about 50% of the gathered answers.

Answers for heavy metal concentrations were more common as 50 WWTPs submitted their annual average concentrations of Cr, Cd, Pb, Cu, Ni, Hg and Zn. The concentrations were compared with current EU limit values for application in arable land and HELCOM 2013 proposal for new recommendations (Figure 16).

Parameter	**Limit in directive (mg/kg DS)**	**Limit in recommendation (mg/kg DS)**
Cd	20-40	1
Cu	1 000 – 1 750	900
Ni	300 – 400	50
Pb	750 – 1 200	100
Zn	2 500 – 4 000	2 500
Hg	16 – 25	1
Cr	-	300

Figure 16 – Current EU limits for allowed heavy metal concentrations on treated municipal wastewater sludge for using on arable land, compared with proposed recommendations by HELCOM.
The proposed limits were taken out of the final recommendation, while they are already the basis of some countries specific limits written into new and upcoming legislation.

For comparison with the actual average heavy metal result acquired from WWTPs in the region, the lowest range values from the EU directive were used together with newly recommended values. Overall results showed that only 2 plants in the region were unable to achieve all of the EU directive lowest values – one WWTP from the Nordic region and one from the Slavic region, were over the limit value for Cd (Figure 17). When comparing the concentrations with newly recommended limits, the situation is much more dire – a total of 5 different heavy metals could be a problem for different WWTPs in the region, with the most problematic element is again cadmium. Out of 50 answers almost half of the WWTPs could not reach the recommended value of 1 mg Cd/kg DS, with the biggest problems in the Baltics and Poland. As a certification system is used and therefore limit values are already stricter in the Nordic countries, the problems with new recommendations are not significant – showing how potentially stricter values in local legislation can lead to safer situation in the future.

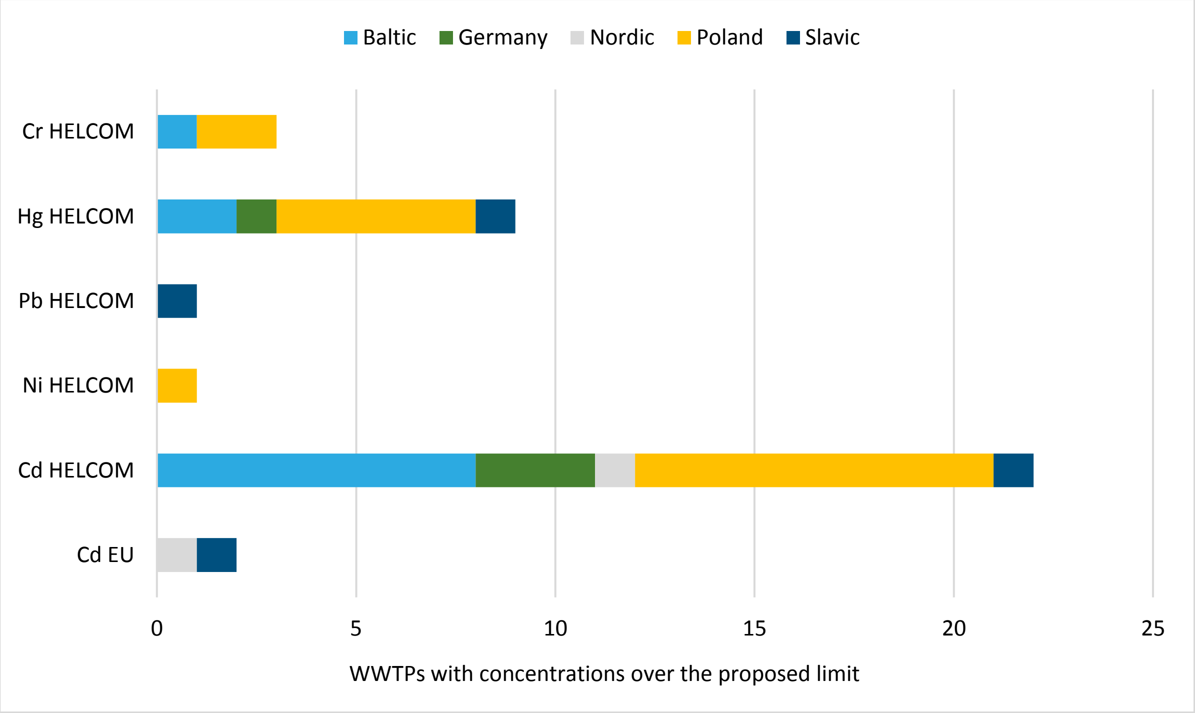


Figure 17 – Comparison of average heavy metal concentrations in treated municipal wastewater sludge from 50 WWTPs in the Baltic Sea region with current EU directive lowest limit values and newly recommended values proposed by HELCOM.
The HELCOM proposed values were left out of the final version of the recommendation while they are still basis for new and upcoming legislation in many countries in the Baltic Sea region.

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IWAMA project aims at improving wastewater management in the Baltic Sea Region by developing the capacity of the wastewater treatment operators and implementing pilot investments to increase the energy efficiency and advance the sludge handling.

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KEY FIGURE DATA FOR SLUDGE BENCHMARK

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