GWP CEE Regional Study

Natural processes of wastewater treatment – actual status in CEE countries

(Questionnaire study)

prepared by

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Introduction

The Global Water Partnership (GWP), established in 1996 is an international network open to all organisations involved in water resource management sectors. The GWP mission is to support countries in the sustainable management of their water resources, to increase public awareness in countries, not only on the professional level, but also on ground education level. At the World Summit on Sustainable Development in 2002, the international community called on countries to prepare Integrated Water Resources Management (IWRM). Since then, GWP has offered substantial support to regions and countries that are trying to meet this goal.

Very important part of Sustainable Development Goals is sanitation in all of its aspects – water supply, treatment, re-use, etc. GWP in Central and Eastern Europe (GWP CEE) assumed its role in sanitation as very important and for prospective future for all the member countries. The activity on sustainable sanitation has become one of the priority topics in the GWP CEE mission. Cooperation and information exchange between GWP CEE member countries as well as between country experts is very valuable.

The first "GWP product" in the field of sustainable sanitation cooperation was the study entitled "Sustainable Sanitation in Central and Eastern Europe – addressing the needs of small and medium-size settlements" edited by Igor Bodík and Peter Ridderstolpe which was launched in 2007 in all GWP CEE country languages (downloadable on www.gwp.org). The study provided an overview of the sanitation conditions in CEE countries and offers sustainable sanitation solutions with a set of cases illustrating workable sanitation systems that could be scaled up across the region. In this region, which has gone through a decade transition and is now entering European Union, lack of sanitation has been limiting the efforts to improve equity, well-being, water quality and economic development. The GWP CEE study has identified a gap of 20-40% of rural population without sanitation policies as, in line with European Commission's priorities, the sanitation programs of many governments in the region do not deal with settlements up to 2000 people. This study attracted interest to sanitation and low-cost technology in the rural areas and stimulated endeavours for realisation of such solution.

The enormous increase of low-cost, small wastewater treatment plants (WWTP) in the GWP CEE countries during the last few years, initiated the ambitions to obtain the actual view of situation in natural wastewater treatment systems process, and to comprehend its technical, political and legislation status. On the other hand, it is important to summarise the countries' requirements for such kind of technologies. Such objective data could be helpful to prepare a guideline with practical information about requirements, operational results are demonstrated by case studies examples, technology limits, and other important issues.

Following these requirements, GWP CEE Task Force on "Sustainable Sanitation" together with national experts have prepared a questionnaire focused on actual status, future development, interest and possible application of natural WWTPs in the countries.

Questionnaire

The presented questionnaire was prepared by an expert team of GWP CEE in cooperation with Council Members of GWP CEE. The questions were focused on five main fields concerning water and wastewater management in the individual countries:

- Geographical information on the country,
- General wastewater management questions,
- Natural treatment system structure in the country,
- Policy and legal aspects of natural treatment systems in the country,
- Actual country problems (education, planning, financing...) of natural treatment systems.

Twenty-eight questions were formulated in the questionnaire and mailed to twenty GWP CEE country experts to get answers and comments. Unfortunately, despite the urgency, only nine experts filled the questionnaires that were received and evaluated. Answers from Poland, Lithuania and Moldova were not delivered.

The views received were evaluated by GWP CEE Tasks Force "Sustainable Sanitation" experts, as follows:

Igor Bodík – Slovak University of Technology Bratislava, Slovakia (questions 1-14)
Mykhailo Zakharchenko – Ukrainian Scientific Research Institute of Ecological Problems, Kharkov, Ukraine (questions 15 – 19)
Darja Istenič – Company Limnos, Ljubljana, Slovenia (questions 20 – 25)
Corina Boscornea – National Administration "Romanian Waters", Bucharest, Romania (questions 26 – 28)

Question 1

Name of the country

Twelve European countries from Central and Eastern European regionwere involved in the questionnaire study. The answers were elaborated by national country experts, as shown in the Table 1 (country abbreviation according to the Olympic country codes):

Table 1. List of participated countries and national experts.

Bulgaria	BUL	(Galia Bardarska)
Czech Republic	CZK	(Miloš Rozkošný)
Estonia	EST	(Ain Lääne)
Hungary	HUN	(Éva Deseö)
Latvia	LAT	(Sandra Krivmane)
Lithuania	LTU	
Moldova	MDA	
Poland	POL	
Romania	ROM	(Corina Boscornea)
Slovak republic	SVK	(Katarina Galbová, Igor Bodík)
Slovenia	SLO	(Darja Istenič)
Ukraine	UKR	(Mykhailo Zakharchenko)

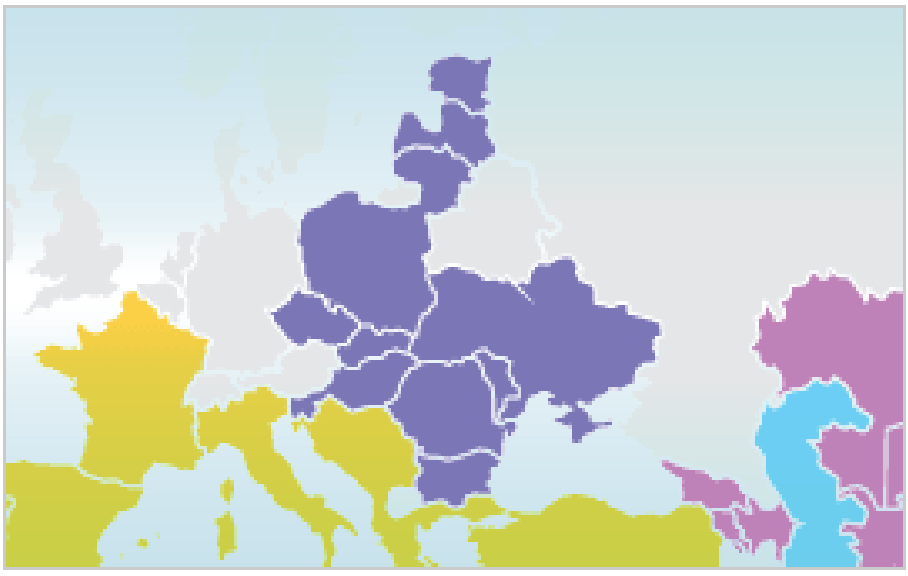


Figure 1. Geographical description of the CEE countries location.

The national experts from all the countries with the exception of Poland, Lithuania and Moldova have response to the questionnaire.

Question 2

Actual number of inhabitants in the country

Table 2		Country territory	Present population
		1000 km^2	Mil.
Bulgaria	BUL	111.0	7.4
Czech Rep.	CZE	78.9	10.5
Estonia	EST	45.0	1.3
Hungary	HUN	93.0	10.0
Latvia	LAT	65.0	2.1
Lithuania	LTU	65.0	3.2
Poland	POL	312.7	38.2
Moldova	MLD	33.6	3.6
Romania	ROM	238.4	21.4
Slovakia	SVK	49.0	5.4
Slovenia	SLO	20.3	2.1
Ukraine	UKR	603.7	45.6
Total	**CEE**	**1715.6**	**150.8**

Source: Eurostat (2012) and answers of national experts to questionnaire

Twelve GWP CEE countries represent an important part of European continent, covering about 16.3% of Europe's total territory (10.5 million square kilometres) and representing 20% of Europe's population. Among CEE countries, in terms of land and population, there are some small (Slovenia, the Baltic countries) and big countries (like Ukraine, Poland and Romania). Ukraine is the biggest country in CEE region with a territory of 603,700 km^2 and total population of 45.6 million inhabitants. The smallest CEE country is Slovenia (20,300 km^2) while Estonia is the least populated (1.3 million inhabitants).When compared with 2005 data, the current reports show there is a slight population decline in all the evaluated countries.

Question 3

Total number of settlements in the country

Table 3		Country territory	Present population	Number of settlements	Average population in settlement
		1000 km^2	Mil.	-	1000
Bulgaria	BUL	111.0	7.4	5302	1.40
Czech Rep.	CZE	78.9	10.5	6251	1.68
Estonia	EST	45.0	1.3	4671	0.28
Hungary	HUN	93.0	10.0	3152	3.17
Latvia	LAT	65.0	2.1	954	2.20
Lithuania	LTU	65.0	3.2	22153*	0.14
Poland	POL	312.7	38.2	40000*	0.96
Moldova	MLD	33.6	3.6	7062**	0.51
Romania	ROM	238.4	21.4	3558	6.01
Slovakia	SVK	49.0	5.4	2891	1.87
Slovenia	SLO	20.3	2.1	5970	0.35
Ukraine	UKR	603.7	45.6	29821	1.53
Total	**CEE**	**1715.6**	**150.8**	**131785**	**1.14**

Source: GWP CEE Study* (2005), internet available data for Moldova** and answers of national experts to questionnaire

It is evident from the data that the total number of settlements is high. The population of these settlements range from 140 to 6010 inhabitants, with the averageof1140 inhabitants. This value is very low and consequently, the specific sanitation costs per inhabitant are too high. Of course, the structure of settlement (population density), terrain slopes, and other factors also play a very important role.

Data from Romania and Latvia demonstrate the important changes in comparison with the data form 2005. The number of settlements significantly decreased: in Romania from 16043 (2005) to 3558 (2011) and in Latvia from 6300 (2005) down to 954 (2011). New approaches concerning the administrative delineation were taken in 2007, when Romania joined European Union, which significantly decreased the number of existing small settlements. Evidently, the economic potential for investments in the public sector, as well as social and geographical aspects have been taken into account for the administrative borders. In this respect, the large cities have metropolitan areas in which the former settlements with less than 2000 inhabitants are included. This statistical arrangement in new agglomerations could in the future increase the population connected to sewage and treatment systems and the government can expect higher EU-subsidies for sanitation systems in comparison with the former distribution of settlements.

Question 4

Number of settlements with less than 2000 inhabitants

Table 4		Country territory	Present population	Number of settlements	Number of settlements with < 2000 inhabitants	Ratio of settlements with < 2000 inhabitants
		1000 km^2	Mil.	-	-	%
Bulgaria	BUL	111,0	7,4	5302	4950	93,4
Czech Rep.	CZE	78,9	10,5	6251	5582	89,3
Estonia	EST	45,0	1,3	4671	4634	99,2
Hungary	HUN	93,0	10,0	3152	2372	75,3
Latvia	LAT	65,0	2,1	954	877	91,9
Lithuania	LTU	65,0	3,2	22153*	21800	98,4
Poland	POL	312,7	38,2	40000*	39000	97,5
Moldova	MLD	33,6	3,6	7062**	n.a.	n.a.
Romania	ROM	238,4	21,4	3558	702	19,7
Slovakia	SVK	49,0	5,4	2891	2491	86,2
Slovenia	SLO	20,3	2,1	5970	5867	98,3
Ukraine	UKR	603,7	45,6	29821	27188	91,2
Total	**CEE**	**1715,6**	**150,8**	**131785**	**115463**	**87,6**

Source: GWP CEE Study* (2005), internet available data for Moldova** and answers of national experts to questionnaire

The number of small settlements in the CEE countries is exceedingly high. More than 115 000 small settlements represent enormous potential for managing the operation of sanitation systems, as well as the high investment costs for sanitation in the future. The ratio of small settlements in individual countries is very different, as noted in Table 4. Evidently, the ratio is about or higher than 90%, although Romania and Latvia have atypically low ratios of small settlements (see comment to Question 3).

Question 5

Total number of inhabitants living in the settlements with less than 2000 inhabitants

Table 5		Country territory	Present population	Number of settlements	Number of settlements with < 2000 inhabitants	Population in settlements with < 2000 inhabitants	
		1000 km^2	Mil.	-	-	Mil.	%
Bulgaria	BUL	111,0	7,4	5302	4950	2,00	27,0
Czech Rep.	CZE	78,9	10,5	6251	5582	2,81	26,8
Estonia	EST	45,0	1,3	4671	4634	0,40	30,8
Hungary	HUN	93,0	10,0	3152	2372	1,71	17,1
Latvia	LAT	65,0	2,1	954	877	0,80	38,1
Lithuania	LTU	65,0	3,2	22153*	21800	1,17	36,6
Poland	POL	312,7	38,2	40000*	39000	14,7	38,5
Moldova	MLD	33,6	3,6	7062**	n.a.	n.a.	n.a.
Romania	ROM	238,4	21,4	3558	702	1,04	4,9
Slovakia	SVK	49,0	5,4	2891	2491	1,66	30,7
Slovenia	SLO	20,3	2,1	5970	5867	1,07	51,0
Ukraine	UKR	603,7	45,6	29821	27188	15,00	32,9
Total	**CEE**	**1715,67**	**150,8**	**115463**	**131785**	**42,36**	**28,1**

Source: GWP CEE Study* (2005), internet available data for Moldova** and answers of national experts to questionnaire

The settlements with less than 2000 inhabitants represent almost 30,0% of the overall population of people living in the CEE countries. In Slovenia, 51% of the population live in small settlements (the highest percentage of all CEE countries).Romania (4.9%) and Hungary (17.1%) are on the opposite part of the scale as detailed in the Table 5. These figures confirm that CEE countries have more or less rural character, however, with slowly decreasing tendencies.

The number of inhabitants living in small settlements in the CEE countries is also extremely high. It can be said that currently over 42 Million inhabitants are without access to public sanitation or are waiting for proper sanitation system solution. There will become a growing requirement in the near future and it is important to know and prepare appropriately to tackle the problem.

The population living in the settlements with less than 2000 inhabitants also plays an important role in water management. The European Directive 91/271/EEC on Urban Wastewater Treatment obliges the member states to build up and operate the biological stage of waste water treatment in all agglomerations with over 2000 inhabitants by 2015. Likewise, for less than 2000 inhabitants' agglomeration there are stipulated requirements for "appropriate treatment" (art.2). Discharges of waste water originating from agglomerations with less than 2,000 inhabitants without a sewage

system should, however, allow the receiving waters to meet the relevant quality objectives and the relevant provisions of other EU directives. Good example is the provision of Directive 2000/60/EC, establishing a framework for Community action in the field of water policy and Directive 80/68/EEC22 on the protection of groundwater against pollution caused by certain dangerous substances.As the important percentage of population in CEE countries lives in rural areas (much more than in Western Europe) it is necessary to take into account the sanitation of small settlements.

Question 6

Average water consumption in households

Table 6		Water consumption in households
		Liter/cap/day
Bulgaria	BUL	97
Czech Rep.	CZE	90
Estonia	EST	100
Hungary	HUN	110
Latvia	LAT	82
Lithuania	LTU	74*
Poland	POL	103*
Moldova	MLD	n.a.
Romania	ROM	128
Slovakia	SVK	83
Slovenia	SLO	110
Ukraine	UKR	290
Average	**CEE**	**115.2**

Source: GWP CEE Study* (2005) and answers of national experts to questionnaire

Domestic water consumption is defined as the quantity of water which is being actually used by private households, which is metered and has to be paid for. The domestic water consumption ranges from 74 l/cap.d in Lithuania and 82-83 l/cap.d in Latvia and Slovakia, which are extremely low levels of consumption, to 290 l/cap.d in Ukraine, which is very high consumption level, probably due to small private agricultural activities, irrational consumption, high water losses, lack of water consumption metering, and other factors. The remaining countries have comparable values of water consumption around 90–110 l/cap.d. The average value of water consumption in CEE countries is 115.2 l/cap.d (including Ukraine) and 97.7 l/cap.d (excluding Ukraine).

In general, a dramatic decrease of domestic water consumption has been observed over the last twenty years in all CEE post-socialist countries, mainly as a result of privatization of water companies and the increase of water costs. This fact can be pointed out on the example of the Slovak Republic where the water consumption decreased from 200 l/cap.d (year 1990) to 83 l/cap.d (2010) and the decrease tendency is permanent.

Question 7

Average water price (tap water supply + sewage treatment) in €/m^3

Table 7		Water consumption in households	Water price (with VAT)	GDP per capita ** (2010)	Water price per year per capita
		Liter/cap/day	€/m^3	€/cap	€/10^{3}cap/year /GDP
Bulgaria	BUL	97	0.87	5794	5.3
Czech Rep.	CZE	90	2.42	16740	4.7
Estonia	EST	100	2.33	13504	6.3
Hungary	HUN	110	2.5	11846	8.5
Latvia	LAT	82	1.24	9782	3.8
Lithuania	LTU	74*		10552	
Poland	POL	103*		11174	
Moldova	MLD	n.a.	n.a.	1618	
Romania	ROM	128	1.03	6933	6.9
Slovakia	SVK	83	2.31	14311	4.9
Slovenia	SLO	110	1.50	20751	2.9
Ukraine	UKR	290	0.46	2860	28.0
Average	**CEE**	**115.2**	**1.6**	**10489**	**10.68**

Source: GWP CEE Study* (2005), www.globalpropertyguide.com** and answers of national experts to questionnaire

The listed prices are calculated as an average of different water prices from different regions of the country. In some countries specific calculations are used; e.g. in Bulgaria water prices are calculated from drinking water supply with/without pumping + household wastewater collection + household wastewater treatment. Also wastewater treatment is subsidized by drinking water supply price (Ukraine). The water price in the individual CEE countries varies from 0.457 EUR/m^3 in Ukraine up to 2.5 EUR/m^3 in Hungary. When compared with the survey from 2005, the water prices were dramatically increased in Ukraine (0.15 → 0.46EUR/m^3) and in Czech Republic (1.4 → 2.42 EUR/m^3). In other countries no dramatic increase was recorded.

The last column in Table 7 shows the water price per capita, per year (365 x water consumption x water price/GDP per capita) related to the country´s GDP – demonstrates how expensive water in individual CEE countries is. From obtained results it is evident that the water price is very high in Ukraine (28.0 €/10^{3}cap/year/GDP), Romania and Hungary and the lowest in Slovenia.

It can be expected that the water price in CEE countries will increase in forthcoming years and it will probably reach the same price as in the wealthier parts of Europe (3–4 EUR/m^3). A decline in the water consumption can be expected mainly in rural areas.

Question 8

Actual ratio of inhabitants connected to public water supply in %

Table 8		Population connected to central water supply	Population without connection to central water supply
		%	Mil.
Bulgaria	BUL	99.1	0.07
Czech Rep.	CZE	93.1	0.72
Estonia	EST	91.0	0.12
Hungary	HUN	95.0	0.5
Latvia	LAT	75.0	0.53
Lithuania	LTU	76.0*	0.77*
Poland	POL	87.0*	4.97*
Moldova	MLD	n.a.	n.a.
Romania	ROM	55.7	9.48
Slovakia	SVK	86.6	0.72
Slovenia	SLO	88.0	0.25
Ukraine	UKR	70.0	13.68
Average/total	**CEE**	**83.3**	**31.81**

Source: GWP CEE Study* (2005) and answers of national experts to questionnaire

The connection of CEE countries inhabitants to public water supplies is relatively satisfactory and it can range above 75 %. The exceptions are Romania and Ukraine which have lower share of connection to the public water supply – 55.7 % and 70 %, respectively. Surprisingly high level of connection to water supply has Bulgaria – 99.1 % (In reality, are nearly all rural settlements in Bulgaria supplied by controlled public water resources and pipeline, as it is usual in other countries?). Connection values above 85% indicate that the most of country's urban population is fully supplied by central water systems and that there is a high share of rural population which is connected this way also. From this perspective it can be argued that public water supply is not the first priority for the development planners in the CEE countries (except of Moldova, Ukraine and Romania). Development priorities are shifting to the sustainability of water resources quantity and quality, drinking water quality requirements, etc.

Generally, in all reported countries an increase of connection rate was measured in comparison to the last survey in year 2005. Very progressive development in this field was measured in Estonia (77 → 91%), however in Slovenia decrease was observed (92 → 88%).

Although percentage rates look quite positive, on the other hand, about 31.8 Million CEE inhabitants are not connected to central drinking water supply systems, mainly in Ukraine, Romania and Poland.

Question 9

Actual ratio of inhabitants connected to municipal wastewater treatment plants in %

Table 9		Population connected to central water supply	Population without connection to central water supply	Population connected to municipal WWTPs	Population without connection to municipal WWTPs
		%	Mil.	%	Mil.
Bulgaria	BUL	99.1	0.07	47.6	3.88
Czech Rep.	CZE	93.1	0.72	78.8	2.23
Estonia	EST	91.0	0.12	88.0	0.16
Hungary	HUN	95.0	0.5	72.5	2.75
Latvia	LAT	75.0	0.53	56.0	0.92
Lithuania	LTU	76.0*	0.77*	71.0*	0.93
Poland	POL	87.0*	4.97*	64.0*	13.75
Moldova	MLD	n.a.	n.a.	n.a.	n.a.
Romania	ROM	55.7	9.48	30.7	14.83
Slovakia	SVK	86.6	0.72	58.9	2.22
Slovenia	SLO	88.0	0.25	30.0	1.47
Ukraine	UKR	70.0	13.68	53.0	21.43
Average/total	**CEE**	**83.3**	**25.16**	**59.1**	**64.57**

Source: GWP CEE Study* (2005) and answers of national experts to questionnaire

The connection of CEE countries inhabitants to municipal wastewater treatment systems is significantly lower than water supply connection, but this is common for all developed countries. The average connection rate is high – near 60 % of CEE population is connected to wastewater treatment systems. Very high portion of connection have Estonia and the Czech Republic followed by Hungary (as a result of the upgrade of Budapest WWTP in the last years). However, it is unusual that Slovenia has had low connection rates comparable with Romania in regard to long term lack of biological stages of Slovenian WWTPs.

The situation is worse regarding the connection of inhabitants to WWTPs. Altogether, near 65 Million of CEE inhabitants discharge their wastewater directly into surface or underground water (except of a small percentage of inhabitants that accumulate their wastewaters in tight cesspools and then transport it to the nearest WWTPs). In the frame of EU funds it is expected that the negative situation in Bulgaria and Romania will be improved in the near future (plans and projects for large agglomerations are already prepared or being realised). However, the high fragment of rural population cannot be connected to the new wastewater systems financed by EU and will remain non-connected or continue to use decentralised wastewater systems.

Question 10

Actual ratio of inhabitants having no real possibility to be connected to the sewage and WWTP systems, because of enormous technical and economic difficulties to be overcome (expert estimation in %)

Table 10		Population connected to central water supply	Population without connection to central water supply	Population connected to municipal WWTPs	Population without connection to municipal WWTPs	Population without possibility to be connected to municipal WWTPs	
		%	Mil.	%	Mil.	%	Mil.
Bulgaria	BUL	99.1	0.07	47.6	3.88	20	1.48
Czech Rep.	CZE	93.1	0.72	78.8	2.23	5	0.53
Estonia	EST	91.0	0.12	88.0	0.16	6	0.08
Hungary	HUN	95.0	0.5	72.5	2.75	5	0.5
Latvia	LAT	75.0	0.53	56.0	0.92	10	0.21
Lithuania	LTU	76.0*	0.77*	71.0*	0.93*	10**	0.32
Poland	POL	87.0*	4.97*	64.0*	13.75*	20**	7.64
Moldova	MLD	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Romania	ROM	55.7	9.48	30.7	14.83	4.7	1.01
Slovakia	SVK	86.6	0.72	58.9	2.22	20	1.08
Slovenia	SLO	88.0	0.25	30.0	1.47	20	0.42
Ukraine	UKR	70.0	13.68	53.0	21.43	20	9.12
Average/total	**CEE**	**83.3**	**25.16**	**59.14**	**64.57**	**12.8**	**22.39**

Source: GWP CEE Study* (2005), Task group expert estimation** and answers of national experts to questionnaire

Real assessment of future possibilities of population connection to sanitation systems (including financial capacities of the country, ratio and distribution of population in rural areas, hydro-geological and landscape character of the country, etc.) could give prognosis of the portion of inhabitants without real chances to connection to sanitation systems (sewage and WWTP) in the next 20-30years. The country experts estimated these data in different ways. Very optimistic forecast was done for Romania (4.7 %), optimistic but acceptable forecast for the Czech Republic and Estonia and optimistic but hardly fulfilled view for Hungary, Latvia and Lithuania, up to pessimistic but real view in the rest of CEE countries.

Despite the uncertainty of the above mentioned forecasted data, it can be expected that more than 20 – 25 Million of inhabitants in CEE countries will have no possibility to be connected to municipal sewage and sanitation systems in the future. Consequently, it can be expected that just this part of CEE population would be served by decentralised or individual systems of wastewater treatment technologies in the next future. In regard to difficult financial situation, geographical problems with dispersed rural settlements and other problems the natural and extensive sanitation systems could introduce appropriate solution for this part of CEE population that is not covered by EU legislation and in this intend by EU fund support.

Question 11

Total number of all municipal wastewater treatment systems operating in the country

Table 11		Population connected to municipal WWTPs	Population connected to municipal WWTPs	Total number of all WWTPs in country	Average connected inhabitants on WWTP
		%	inhabitants	pcs	10^3inh/wwwt
Bulgaria	BUL	47.6	3505535	89	39.4
Czech Rep.	CZE	78.8	8263544	2188	3.8
Estonia	EST	88.0	1158520	863	1.3
Hungary	HUN	72.5	7242750	660	11
Latvia	LAT	56.0	1160880	1100	1.1
Lithuania	LTU	71.0*			
Poland	POL	64.0*			
Moldova	MLD	n.a.	n.a.	n.a.	n.a.
Romania	ROM	30.7	6582104	427	15.4
Slovakia	SVK	58.9	3203006	607	5.3
Slovenia	SLO	30.0	617251	269	2.3
Ukraine	UKR	53.0	24380000	2100	11.6
Average/total	**CEE**	**59.1**	**56113590**	**8303**	**10.1**

Source: GWP CEE Study* (2005) and answers of national experts to questionnaire

In CEE region more than eight thousand WWTPs are operating. In some of the countries plants with small capacities prevail (Latvia, Estonia). On the other hand, countries such as Bulgaria, Romania have very high values of connected inhabitants per one plant, i.e. these countries have mainly large plants in operation. Generally, there is no relation between number of operated WWTPs and connection to WWTPs in individual countries.

Question 12

Total number of small WWTPs with connection below 2000 inhabitants

Table 12		Population connected to municipal WWTPs	Total number of all WWTPs in country	Average connected inhabitants on WWTP	Total number of small WWTPs with < 2000 inh.	
		%	pcs	10^3inh/wwwt	pcs	%
Bulgaria	BUL	47.6	89	39.4	57	64.0
Czech Rep.	CZE	78.8	2188	3.8	1550	70.8
Estonia	EST	88.0	863	1.3	826	95.7
Hungary	HUN	72.5	660	11	270	40.9
Latvia	LAT	56.0	1100	1.1	1020	92.7
Lithuania	LTU	71.0				
Poland	POL	64.0				
Moldova	MLD	n.a.	n.a.	n.a.	n.a.	n.a.
Romania	ROM	30.7	427	15.4	82	19.2
Slovakia	SVK	58.9	607	5.3	382	62.9
Slovenia	SLO	30.0	269	2.3	190	70.6
Ukraine	UKR	53.0	2100	11.6		
Average/total	**CEE**	**59.1**	**8303**	**10.1**	**4377**	**52.7**

Source: GWP CEE Study* (2005) and answers of national experts to questionnaire

Altogether, there are more than four thousand small WWTPs operating in CEE countries which represent more than 50% of all plants. Small plants dominate in Estonia and Latvia (representing over 90 % of all plants), as well as in the Czech Republic and Slovenia. These countries are known for their long-term experience in small and natural WWTPs.

Very small (household) plants, with capacity below 50 p.e. (< 50 m^3/d in private houses, hotels, pensions, offices, etc.), were not included in the Table 12, although number of these plants are very high in some countries– in the Czech Republic there is more than 10 000 plants with more than 150 000 connected inhabitants, which represent an important part of population. A similar situation exists in the Slovak Republic.

Question 13

Total number of inhabitants connected to the small WWTPs with < 2000 p.e.

Table 12		Population connected to municipal WWTPs	Total number of all WWTPs in country	Average connected inhabitants on WWTP	Total number of small WWTPs with < 2000 p.e.		Population connected to small WWTPs < 2000 p.e.	
		%	pcs	10^3inh/wwwt	pcs	% on all	10^3 inh.	% on total connected
Bulgaria	BUL	47.6	89	39.4	57	64.0	n.a.	n.a.
Czech Rep.	CZE	78.8	2188	3.8	1550	70.8	1250	15.1
Estonia	EST	88.0	863	1.3	826	95.7	244	21.4
Hungary	HUN	72.5	660	11	270	40.9	225	3.1
Latvia	LAT	56.0	1100	1.1	1020	92.7	80	6.8
Lithuania	LTU	71.0						
Poland	POL	64.0						
Moldova	MLD	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Romania	ROM	30.7	427	15.4	82	19.2	36	0.5
Slovakia	SVK	58.9	607	5.3	382	62.9	200	6.3
Slovenia	SLO	30.0	269	2.3	190	70.6	n.a	n.a.
Ukraine	UKR	53.0	2100	11.6			n.a.	n.a.
Average/total	**CEE**	**59.1**	**8303**	**10.1**	**4377**	**52.7**	**2035**	**8.9**

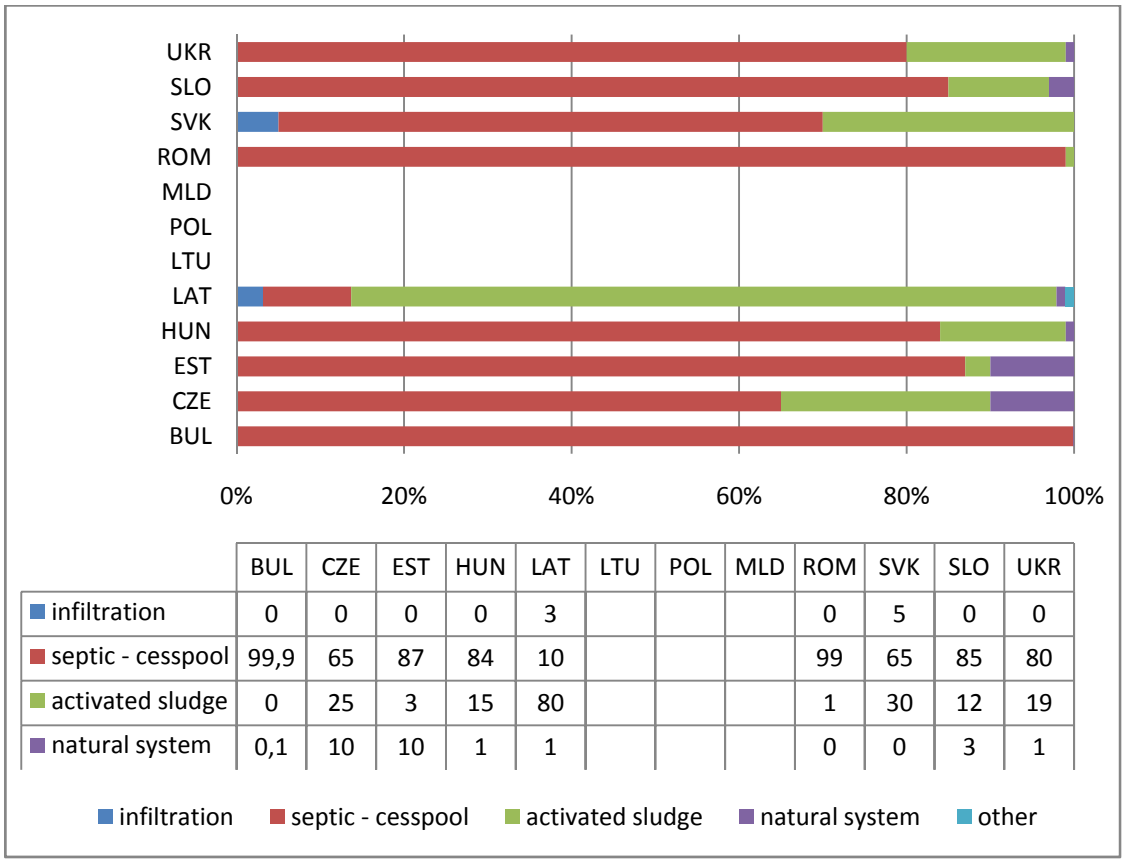
Source: GWP CEE Study* (2005) and answers of national experts to questionnaire

The data of the connection of population to small WWTPs (50 – 2000 p.e.) is not in accordance with state statistical reports in CEE countries. From the data obtained, it can be estimated that there are more than 2 Million inhabitants in CEE connected to small WWTPs. The important percentage of inhabitants connected to small WWTPs in relation with total country connection is in Estonia and the Czech Republic with 21.4 % and15.1 %, respectively. Small connection to small WWPTs is observed in Latvia (6.8 %), the Slovak Republic (6.3 %) and Hungary (3.1 %). Negligible rate of small plants is noticed in Romania (0.5 %).

Despite having over 2 Million inhabitants from rural CEE areas are connected to small WWTPs, and inhabitants of cities plus other rural areas connected to large WWTPs or to individual treatment systems, there still remain more than 30 Million inhabitants expecting solution of their sanitation problems in the future.

Question 14

What is the prevailing wastewater treatment system for decentralised small rural areas?



	BUL	CZE	EST	HUN	LAT	LTU	POL	MLD	ROM	SVK	SLO	UKR
infiltration	0	0	0	0	3				0	5	0	0
septic - cesspool	99,9	65	87	84	10				99	65	85	80
activated sludge	0	25	3	15	80				1	30	12	19
natural system	0,1	10	10	1	1				0	0	3	1

As evident by the analysis and the graph, dominating wastewater treatment systems are septic tanks and cesspools. With the exception of Latvia, all the CEE countries show that these techniques represent 65 – 100 % of used systems. This is a much undeveloped process of wastewater treatment (it represents only accumulation or pre-treatment of wastewater, not a full-valued treatment process). It should be noted that today around 75% of the rural population in the CEE countries use this type of incomplete treatment. In some areas of Central Europe cesspools serve as the pre-stage of wastewater treatment before the final discharge into the recipient system. These cesspools often overflow and they do not satisfy the elementary legislative requirements for wastewater treatment. Frequently, most of the old houses (20 year old and older) are equipped with cesspools, and it becomes very complicated (legislatively and technically) to achieve improvements.

The second most commonly used process of wastewater treatment in small and rural settlements is biological treatment – a sludge activation process. Activation is mostly used in the rural areas of Latvia, the Czech Republic and Slovakia. This process is more technically demanding but when it is correctly operated it usually fulfils all treatment requirements. In rural conditions activation process is usually represented by small WWTPs (more than 50 connected inhabitants) or by household

WWTPs (5–50 connected inhabitants). It is estimated that thousands of inhabitants mostly in CZE and SVK are connected to domestic (individual treatment systems) WWTPs, but there is no statistic evidence of these technologies.

Natural systems of wastewater treatment are used to a limited extent in the CEE region. There are countries with long-term good experience with this type of processes, e.g. Estonia, the Czech Republic, Hungary and Slovenia; but on the other hand there are countries with no experience of using natural wastewater treatment systems, e.g., Slovakia, Romania and Bulgaria.

In one way, this questionnaire pointed out that natural treatment systems are used very rarely in CEE countries, however, the conditions for application of extensive treatment technologies are very suitable when compared with Western Europe countries.

Question 15

Estimate the number of small municipal WWTP with natural treatment systems

Table 15		Infiltration/ percolation systems	Vertical/ horizontal flow reed bed filters	Natural lagoons /stabilisation ponds	Aerated lagoons
		pcs	pcs	pcs	pcs
Bulgaria	BUL	0	1/4	0	0
Czech Rep.	CZE	25	690	25/1	0
Estonia	EST	0	12/2	183/0	0
Hungary	HUN	0	10	16/6	0
Latvia	LAT	0	10	0	0
Lithuania	LTU				
Poland	POL				
Moldova	MLD				
Romania	ROM	0	0	0	0
Slovakia	SVK	5	5	0	0
Slovenia	SLO	0	80	0	0
Ukraine	UKR	1500/3	65	0	0
Total	**CEE**	**1533**	**879**	**231**	**0**

Infiltration or percolation systems are the oldest types of treatment systems for wastewater. Wastewater arrives into the small pools, covered with grass (sometimes with higher aquatic plants if the groundwater level is close). This treatment takes place during the process of slow movement of the water along the surface of the pool and in the thick part of the soil during the process of infiltration. These treatment systems are very popular in Ukraine, probably due to simple and low cost investment and operation requirements. On the other hand, many (hundreds) infiltration systems are also used in other countries as a secondary treatment step for small domestic WWTPs where there is no adequate aquifer (river) available.

Reed bed filters (often named as constructed wetland – CW) combine physical, chemical and biological treatment systems to remove pollution from wastewater. Treatment of wastewater within the CW occurs as the wastewater passes through the CW sand (gravel) medium in which plants are rooted. In subsurface-flow systems, the effluent may move either horizontally, parallel to the surface, or vertically, from the planted layer down through the substrate. Technologies of CWs are accepted as state-of-the-arts in the natural treatment systems. Czech Republic is the leader in the field of design and utilisation of these technologies, and not only in the CEE countries.

Natural lagoons and stabilisation ponds are also often used for small sources of wastewater or as a post treatment technology, but their treatment efficiency is evidently lower when compared with CW.

Question 16

Estimate the number of inhabitants connected to the small municipal WWTP with natural treatment systems

Table 16		Infiltration/ percolation systems	Vertical/ horizontal flow reed bed filters	Natural lagoons /stabilisation ponds	Aerated lagoons	Number of inhabitants connected to the natural WWTPs
		pcs	pcs	pcs	pcs	Inhabitants (10^3)
Bulgaria	BUL	0	1/4	0	0	0
Czech Rep.	CZE	25	690	25/1	0	120
Estonia	EST	0	12/2	183/0	0	9
Hungary	HUN	0	10	16/6	0	5
Latvia	LAT	0	10	0	0	5
Lithuania	LTU					
Poland	POL					
Moldova	MLD					
Romania	ROM	0	0	0	0	0
Slovakia	SVK	5	5	0	0	0,1
Slovenia	SLO	0	80	0	0	5
Ukraine	UKR	1500/3	65	0	0	343
Total	**CEE**	**1533**	**879**	**231**	**0**	**487**

The number of connected inhabitants to natural WWTP is quite different across CEE countries. Only one country has undoubtedly acceptable system of natural WWTP – the Czech Republic with more than 120 000 inhabitants connected to natural WWTPs. Ukraine has the highest number of connected inhabitants, but the used technology (infiltration or percolation systems) is not considered to be higher technical (treatment) standard technology. The rest of CEE countries have only marginal (or no) application of natural treatment systems.

Question 17

Prevailing type of natural treatment systems in the country

Table 17		Infiltration/ percolation systems	Vertical/ horizontal flow reed bed filters	Natural lagoons /stabilisation ponds	Aerated lagoons
		%	%	%	%
Bulgaria	BUL	0	100	0	0
Czech Rep.	CZE	5	90	5	0
Estonia	EST	0	10	90	0
Hungary	HUN	0	80	20	0
Latvia	LAT	0	100	0	0
Lithuania	LTU				
Poland	POL				
Moldova	MLD				
Romania	ROM	0	0	0	0
Slovakia	SVK	50	50	0	0
Slovenia	SLO	3	95	2	0
Ukraine	UKR	95	1	4	0
Average	**CEE**	**17**	**60**	**13**	**0**

The figures in Table 17 confirm the data from Tables 15 and 16 – the constructed wetlands are the most used natural treatment system in the CEE countries. From the technological point of view this is acceptable, shows positive signs which will be a good starting point for future development of natural treatment systems in the CEE countries.

Question 18

Is there any specific legislation regarding emission limits for small WWTPs below 2000 (500/50) p.e.?

Table 18		BUL	CZE	EST	HUN	LAT	ROM	SVK	SLO	UKR
Legislation emission limits for small WWTPs below 2000 (500/50) p.e		no	yes	yes	yes	yes	yes	yes	yes	no
Concentrations (mg/l)										
< 2000 p.e.										
	BOD_5	--	30/60	15	50	50-70%	20	30/60	30	15
	COD	--	125/180	125	200	50-70%	125	135/170	150	80
	SS	--	40/70	25	75	<35	60	30/60	--	15
	$N\text{-}NH_4$	---	20/40	---	4	---	15	---	---	0.39
	Pt	---	--	1.5	4	---	2	---	---	---
	Sulphides	---					0.5	---	---	---
	Phenol/SD	---					0.3/2	---	---	---
<500 p.e.										
	BOD_5	---	40/80	15	80	Appropriate treatment	---	30/60	30	15
	COD	---	150/220	125	300		---	135/170	150	80
	SS	---	50/80	25	100		---	30/60	---	15
	$N\text{-}NH_4$	---	---	---	4		---	---	---	0.39
	Pt	--	---	1.5	4		---	---	---	---
<50 p.e.										
	BOD_5	--	---	---	---	---	---	40/70	30	15
	COD	--	---	---	---	---	---	--	150	80
	SS	--	---	---	---	---	---	---	---	15
	$N\text{-}NH_4$	--	---	---	---	---	---	---	---	0.39
	Pt	--	---	---	---	---	---	--	---	---

*/** in CZK and SVK represent 24h/maximum values

Legislative requirements for WWTP effluents with 500 – 2000 p.e. are almost comparable in all CEE countries (except of Bulgaria, where are no limits). Surprisingly, the most rigorous effluent requirements are in Ukraine for all groups of plants (BOD_5 = 15 mg/l, COD = 80 mg/l, $N\text{-}NH_4$ = 0.39 mg/l !!!). Ukrainian requirements (also for the smallest plants) are stricter then than those for WWTPs >100 000 p.e. in all other EU countries (!!!).Such parameter fulfilment is technologically almost impossible ($N\text{-}NH_4$ = 0.38 mg/l i.e. full nitrification!!!) for standard (activated sludge) plants. For natural treatment systems is rather unredeemable.

On the other hand, the least strict effluent legislation in all the groups is in Hungary (BOD_5 = 50 mg/l, COD = 200 mg/l). An interesting solution is applied in Latvia – there are requirements only for treatment efficiency (WWTP with 500 – 2000 p.e.) or "appropriate treatment" (WWTPs with 50 – 500 p.e.). However, 51% efficiency of BOD_5 treatment of the effluent i.e. about 100 – 150 mg/l is not done an appropriately.

Effluent discharge requirements for the smallest wastewater treatment plants exist only in Slovakia, Slovenia and Ukraine. Specific parameter requirements apply only in Romania (sulphides, phenols and synthetic detergents), but only for the plants with 500 – 2000 p.e.

Emission limit values for one-site wastewater treatment in single family houses, small businesses and settlements up to 300 p.e. will be implemented in 2020 following the requirements of HELCOM recommendation 28E/6 (valid for Baltic countries of CEE).

Question 19

Are there any specific legislation emission limits for small WWTPs below 2000 (500/50) p.e. for discharges into groundwater in your country?

Table 19		BUL	CZE	EST	HUN	LAT	ROM	SVK	SLO	UKR
Legislation emission limits for small WWTPs below 2000 (500/50) p.e. for discharges into groundwater		no	yes	no	yes	yes	no	yes	no	Construction to Aartificial Recharge
Concentrations (mg/l)										
< 2000 p.e.										
	BOD_5	---	30	Requirements should be not stringent than limits for > 2000 p.e.	--	--	--	--	--	15
	COD	---	130		---	--	--	--	---	30
	SS	---	30		---	--	--	--	---	---
	$N\text{-}NH_4$	---	20		0.5	--	--	--	---	---
	Pt	---	8		0.5 (PO_4)	--	--	-	---	---
Other emission limits	E.coli /Enterococcus (CFU/100 ml)	---	50000/ 40000		250 (SO_4) 50 (NO_3)	--	--	--	---	/10000
200 - 2000 p.e.										
	BOD_5	---	40	Requirements should be not stringent than limits for > 2000 p.e.	---	Appropriate Treatment, for SS <35 mg/l	---		---	---
	COD	---	150		---		---		---	---
	SS	---	40		---		---		---	---
	$N\text{-}NH_4$	---	20		---		---		---	---
	Pt	---	10		---		---		---	---
Other emission limits	E.coli /Enterococcus (CFU/100 ml)	---	50000/ 40000		---		---		---	--
<200 p.e.										
	BOD_5	---	40	---	---	---	---	20/40	--	--
	COD	---	150	---	---	---	---	---	---	---
	SS	---	40	---	---	---	--	20/40	---	---
	$N\text{-}NH_4$	---	20	---	---	---	---		---	---
	Pt	---	10	---	---	---	---		---	---

Four CEE countries have no specific limits for discharge of treated wastewater into soil/ groundwater, i.e. it is allowed (?) or underlined by special permits. The Czech Republic has detailed system for groundwater discharges (effluent requirements available also for natural treatment plant), but in any case such discharge from "large" small WWTPs (200 – 2000 p.e) into groundwater is questionable. Bacteriological limits are applied in the Czech Republic and also in Ukraine. Parameters in Hungary are very strict when it comes to nutrient removal (full nitrification and denitrification are unredeemable in natural treatment systems). The discharge into groundwater is allowed in the Slovak Republic only for plants under 20/50 p.e. and followed by positive results from geological survey. No specific legislation emission limits for small WWTPs below 2000

(500/50) p.e. for discharges into groundwater are in force in Romania, because direct discharges into groundwater of urban wastewaters are forbidden.

Question 20

The basic constraint rules for discharge of small WWTP effluents into the underground

The main limiting factor for discharge of treated water into the underground is a potential pollution of the groundwater and thus drinking water sources. A concern for groundwater pollution has been clearly annotated in all examined countries. The potential pollution of groundwater with wastewater is therefore mainly regulated through acts that define groundwater protection. In countries like Czech Republic and Slovakia it is necessary to provide a hydrogeological survey in order to enable WWTP discharge into the underground. While hydrogeological survey is an important review, giving the information on potential groundwater pollution, in case of small WWTPs for individual houses it can imply a considerable additional cost.

The recognized risk of groundwater pollution through discharge of treated wastewater, suggests a suitable performance of small WWTPs, a correctly designed discharge according to geological surveys, or more preferentially, a discharge into a watercourse.

Discharge of treated wastewater can be regulated also by the act of protection of sensitive water areas, like river catchments, karst and coastal areas. For example in Bulgaria, special demands for wastewater discharge are given according to protection of sensible water bodies of Danube and Black sea.

Of special importance is also protection of ground and surface waters in karstic areas, which cover significant surfaces areas in many CEE countries (Slovenia, Slovakia, Czech Republic, and Bulgaria). Due to limestone permeability and low residence time before entering the groundwater, discharges of polluted waters have greater impact when compared to non-karst areas. Special limitations on discharge from WWTPs should be given in those areas.

Question 21

National guidelines, norms and standards for design and operation of natural WWTPs

More than half of the countries examined lack any national guidelines of design and operation of natural WWTPs (Table 20). Despite relatively high number of natural WWTPs in Slovenia (80) and Ukraine (2000) there are no national recommendations for their construction. However, it has to be noted that all natural WWTPs in Ukraine are infiltration systems, while in Slovenia there are mainly constructed wetlands which need more sophisticated design and construction. Lack of national guidelines in Bulgaria and Romania is consistent with the fact that these countries have one and no natural WWTPs, respectively. National guidelines seem to encourage the construction of more complex natural WWTP such as vertical and horizontal flow reed beds. Accordingly, Czech Republic and Hungary have 60-80% of reed beds among their natural WWTPs. An exception is Slovenia with no national guidelines and 95% of natural WWTPs being reed beds indicate that data for elaboration of national guidelines are available; however there is no legal need for their publication.

Table 20. Subsistence of national guidelines, norms and standards for design and operation of natural wastewater treatment plants in CEE countries.

Country	BUL	CZE	EST	HUN	LAT	ROM	SVK	SLO	UKR
Guidelines, standards	no	yes	yes	yes	no	no	yes	no	no
Nr. of natural WWTPs (prevailing type)	1 (reed bed)	690 (reed bed)	183 (lagoons)	10 (reed bed)	10	0	10 (reed bed and infiltration)	80 (reed bed)	2000 (infiltration)

National guidelines are present in Czech Republic, Estonia, Hungary and Slovakia. They take different legal forms and differ in technical details or regulations. The technical standards enforced in Czech Republic few years ago, provide design, construction and operation details for different small WWTPs. Similarly in 2010, Hungarian government published a detailed guideline on selection of individual wastewater treatment including instructions on design and operation. In Estonia there are several guidelines for small wastewater treatment systems selection, design and operation. The latest guideline was published just recently in 2011with the support of GWP. In contrast, Slovak standard for small WWTPs is much older (1992) and describes natural systems only marginally.

Question 22

General attitude (positive, negative, neutral) regarding the natural wastewater treatment systems

- **Overall attitude (Institutions, legislation, market, experts)**

Despite significant market opportunities in CEE countries and internationally recognized scientists in the field of natural wastewater treatment systems, there is not enough legal and institutional support for wider application of natural WWTPs. The barriers are mainly represented by specific municipalities and water treatment decision makers who are not inclined to natural treatment systems. Institutional barriers are more evident in countries which do not have nationally accepted guidelines and instructions for natural WWTPs implementation like in Slovakia, Slovenia, Romania and Bulgaria; however they are also present in Czech Republic where there is extensive number of already implemented natural systems, technical standards and numerous experts in the field of natural treatment systems.

Nonetheless there are also examples of positive institutional and legal attitude or opportunities for building natural wastewater treatment systems in different countries. There are reinforcements from local authorities in Estonia, in specific places in Czech Republic and Slovenia and support from international funds in Latvia.

With the beginning of the implementation of natural WWTPs in a specific area, institutional and legal barriers which have not been known before may arise. Therefore in the countries with less natural WWTPs (e.g. Romania) there are sometimes less barriers identified compared to the countries with already established complex natural treatment systems (e.g. Slovenia). However, in Bulgaria, where natural WWTPs are at the initial stages, the general attitude is negative in institutional and legal basis and only neutral in expert and market level. The negative attitude in institutional and expert level should be first tackled by education in natural treatment systems' performance and examples of good practices from abroad, as it will be discussed later.

In general it seems like the attitude of institutions, legal framework and experts towards natural treatment systems is more influenced by personal believes and market pressure rather than by scientific results, which should have stronger say in adopting decisions on wastewater treatment.

- **Market**

Concerning the number of small settlements in the CEE region, natural characteristics and the problem of wastewater treatment there is a potentially very large market for distribution and implementation of natural wastewater treatment systems in the region. In general, countries proclaim there are market opportunities rather than barriers for trading the natural WWTPs.

However, the companies offering natural wastewater treatment systems compete with retailers of modular or compact systems. The retailers of compact systems dominate in the markets in Slovenia,

Slovakia and Romania and are known as skilled sellers. The competition between companies offering compact and natural systems is biased in favour of compact systems. The latter namely offer a finished product which can be immediately purchased, installed and used, while an implementation of a natural treatment system presents a service of designing, planning and construction of systems that differ to a certain extend for every single user. Therefore the compact and natural treatment systems presenting a product and a service, respectively, demand different marketing strategies.

Due to their uniformity, modular systems in Slovenia may gain a technical standard which enables dispensation of system's performance monitoring. Technical standards for reed beds are not accepted, resulting in obligatory monitoring of a reed bed performance and consequently higher costs and work demands for an end user. This sets a direct legal barrier for broader application of natural treatment systems and a marketing advantage for compact systems.

Another possible reason for the prevalence of companies selling modular treatment systems is the orientation of general public and decision makers towards technological solutions and suspiciousness to the performance of natural systems. Experiences from Slovenia have shown that the main profile of a client purchasing natural treatment system is an ecologically aware person with higher education or on the other hand a modest farmer living in close connection with nature.

Natural systems are usually promoted as simple systems which do not need sophisticated technological equipment for their performance. Due to their advertised simplicity, they are often being constructed by local enthusiasts. If the country has no or not detailed national guidelines, the design, implementation and performance of the system is in the hands of the local initiator. They may lack appropriate technical knowledge and experience, or may simplify the system too much. Those systems therefore rarely perform efficiently and portray a negative image for other natural systems and their skilled and experienced designers. Moreover, those situations can severely affect further implementation of natural treatment systems in the region. Examples like these are reported from Slovak Republic and Slovenia and indicate the necessity for detailed national guidelines and promotion of good examples in building natural treatment systems.

- **Experts**

In general experts have a positive attitude towards natural wastewater treatment systems. Notably in Czech Republic and Estonia there has been a long term tradition of research and education on natural treatment systems in several universities and research institutions. Likewise in Slovenia there are several study programmes offering insight in performance and benefits of natural treatment systems and there are two research groups working with constructed wetlands. Students can also learn on natural treatment systems in Latvia and there is enough human capacity reported in Romania. Concerning education on natural treatment systems, discouraging situation is reported only from Slovakia, where due to the bad examples of natural WWTPs the subject is interesting neither for research nor for studies.

Higher benevolence of experts to natural wastewater treatment systems compared to legal authorities and water managers can indicate that the use of natural treatment systems is still in the phase of transfer from science to the market and that there is a need for awareness raising in the policy sector. There should be a transfer of up-to-date information on characteristics of natural

treatment systems from experts to decision makers. Additionally, examples of good practices should be demonstrated especially in countries with low number of natural treatment systems and no adopted national guidelines. This would actually include all countries involved in the study except Estonia and Czech Republic which seem to have the most developed systems for implementation of natural treatment system and support on institutional, legal and expert level.

The interest of expert community to natural wastewater treatment systems in different countries can be compared through the number of scientific papers dealing with the topic described per country (Figure2). Data were gained from Science Direct database and include papers that have a desired country in affiliation and selected words in the title, abstract or keywords. The majority of the scientific papers on natural wastewater treatment systems since 1991 have been published in Czech Republic, followed by Estonia and Slovenia. In general, the most search results were obtained on the term constructed wetlands, with the exception of Romania, where there is no paper dealing with constructed wetlands, but there are a few papers referring to natural treatment as such.

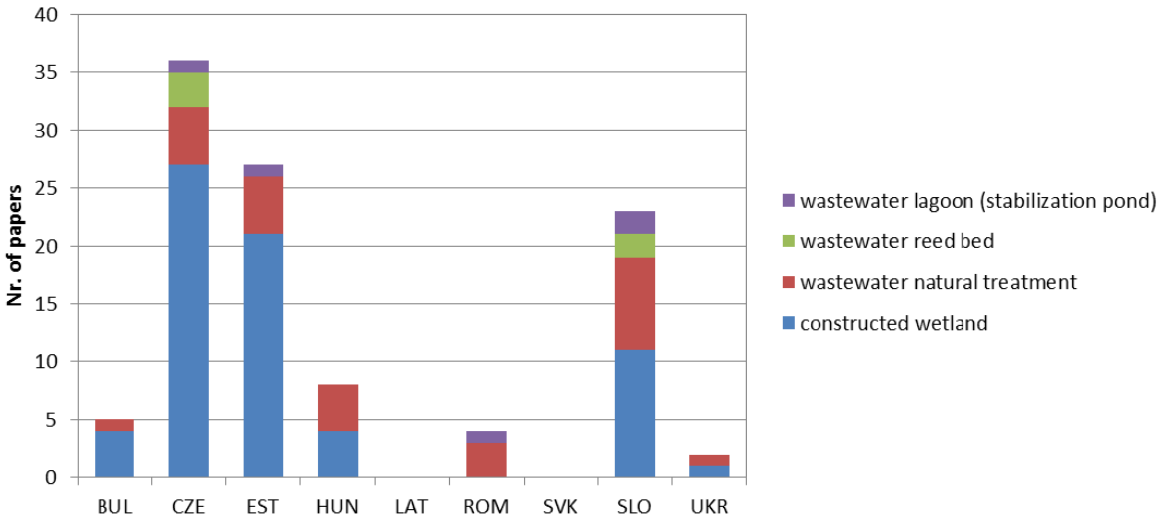


Figure 2: Number of scientific papers at Science Direct database published by countries according to key words. Data since 1991 until 2012 are gathered.

Question 23

Basic problems of wide application of natural processes for wastewater treatment in the country

Problems for wider application of natural wastewater treatment systems arise consequently from institutional or legal barriers mentioned in question 22. Despite the fact that natural treatment systems are familiar to expert community for a couple of decades now and are successfully implemented in Western Europe, the unawareness is still the main problem for wider application of those systems in CEE (Table 21). Four out of nine countries have reported on unawareness on different levels and types. In Hungary, the examples of good practice are not presented well, in Slovakia and Slovenia there is a lack of information and awareness on the existence of such systems at national level and there is no interest from national authorities and investors in Ukraine. Although other countries do not report on lack of awareness as a basic problem towards wider implementation of natural treatment system, it does not mean that they do not deal with that problem at all. Institutional barriers reported in Czech Republic might also indicate lack of information and knowledge on natural treatment on the institutional level.

The lack of information on natural treatment systems in CEE indicates a need for awareness rising campaigns and the transfer of knowledge from experts to national and local authorities, entrepreneurs and general public. Effective awareness rising could be brought up in cooperation with educational institutions, national experts and institutions like GWPCEE which would carry out fruitful communication and information projects.

Besides the lack of knowledge on natural treatment systems, negative experiences are a draw back for wider application of those systems to a greater extent. Negative examples of natural wastewater treatment systems are reported from Czech Republic, Slovakia and Hungary, which is interesting since all of the three countries have adopted national guidelines for implementation of natural WWTPs. This indicates that the insufficient information has been included in the guidelines for successful design and operation of natural WWTPs. However, the failure could also be caused by the lack of experience or knowledge of the specific designer, constructor or maintenance provider. On the other hand, in Estonia and Slovenia which also have higher numbers of natural WWTPs, bad experiences are not reported as a main reason for wider application of natural systems. Detailed guidelines (in Estonia) and sufficient experience of systems constructors could be the reason for successful implementation of natural treatment systems in those two countries.

The importance of negative experiences indicates that there is a need for demonstration of good examples of natural wastewater treatment systems. The demonstration of best practices is not of major importance only in Czech Republic, Hungary and Slovakia, but also in countries with no or scarce natural treatment systems such as Bulgaria, Latvia, Romania and Ukraine. Moreover, in those countries demonstration of different technologies of natural wastewater treatment could have significantly higher impact compared to the countries with existing bad experiences.

Table 21: Basic problems for wider application of natural wastewater treatment systems reported by country.

Problem	BUL	CZE	EST	HUN	LAT	ROM	SVK	SLO	UKR	Sum
Unawareness										4
Negative experiences										3
Lack of land (surface)										3
Institutional barriers										2
Natural conditions										2
Lack of legislation										1
Marketing										1

As an important barrier towards wider application of natural treatment systems, experts from Latvia, Romania and Slovakia also report lack of sufficient land or surface area for implementation of these systems. It is known that constructed wetlands, lagoons and similar technologies demand bigger surface areas compared to activated sludge processes. Smaller settlements without wastewater collection and treatment are mainly positioned in agricultural areas, where the land is used for food production and thus it is economically ineligible to use larger areas for wastewater treatment. Another constraint in land surface could appear in hilly or mountainous areas, where there are not enough flat surfaces for simple construction of natural treatment systems.

The concern of lack of land for natural treatment systems indicates a need to develop more effective systems with less surface demand. An example is vertical flow constructed wetland compared to horizontal flow wetland – the latter needs 3 to 5 times bigger area for similar treatment efficiency. Besides, the use of land for different purposes has to be economically evaluated. Natural wastewater treatment systems have lower construction, operation and maintenance costs compared to compact systems. This has to be taken in mind when evaluating the land and WWTP costs. In areas where food production is not the main purpose of land use, the natural wastewater treatment systems with biomass production should be evaluated (e.g. willow systems).

Similar like land limitations also specific natural characteristics obstruct implementation of natural treatment systems. Estonia is especially facing severe winters and cold summers which do not present favourable conditions for natural WWTPs. Similar problems limit the application of natural WWTPs also in the highlands of Romania. Besides this, Estonia is facing large surfaces of high groundwater levels which appear in much more limited extend in other countries.

As a key problem in expansion of natural WWTPs Czech Republic and Slovakia also report on institutional barriers. The latter can be unofficial character and most probably arise from personal opinions of decision makers, who lack the information on natural WWTP performance and are persuaded from the bad examples of natural WWTP which appeared in those countries.

In Slovenia as a constraint in wider application of natural treatment system also insufficient marketing of those systems has been pointed out. The problem of market offer of natural WWTPs has already been discussed in question 22 and points out the strong competition with retailers of compact treatment systems.

Question 24

Is there available national literature on design, construction and operation of the natural WWTPs?

This question focuses on handbooks, guides, textbooks and other published materials referring to natural wastewater treatment systems. Scientific papers have been discussed in question 22 and national guidelines in question 21.

In all the countries except Bulgaria and Slovakia there is available literature on natural wastewater treatment systems in national languages. Most of all, Czech Republic has a long standing list of books published from 1985 until 2012 dealing with wastewater treatment, including natural systems. Moreover, there are detailed guidelines for implementation and operation of horizontal flow constructed wetland which were elaborated in 2008; however, unfortunately, they were not adopted by the Ministry of Environment as national guidelines.

In Estonia, there are three major books or guidelines referring to the decision on specific wastewater treatment systems in scattered areas, implementation of natural treatment methods and wastewater treatment in small settlements in general, respectively. Similarly, in Hungary there is an environmental and technical guidebook for small individual WWTP published in 2005.

In Latvia, Romania and Slovenia, there are handbooks and guidelines dealing with wastewater treatment in general or wastewater treatment in small settlements, however a specific literature in the form of textbooks or guidelines referring only to natural treatment systems is missing. Despite this, specific chapters on natural treatment systems can be found also in the general literature. In Slovenia natural wastewater treatment systems are mainly presented through webpage and brochures of a company dealing with constructed wetlands. The company also published two books on natural self-treatment capacity of ecosystems and two conference proceedings. Conference proceedings and project reports present an important literature on natural treatment systems also in Romania.

Similar to Slovenia, in Ukraine the most information on natural treatment systems can be found on the webpage of the companies implementing constructed wetlands.

Question 25

Which type of literature would be helpful to support natural treatment systems application?

Despite the fact that literature on natural treatment systems exists in majority of investigated countries, all countries expressed clear request of all the three types of literature suggested in the questionnaire:

- Technical or technological guideline on how to design, construct and operate natural WWTP, which would also be suitable for university lecturers and students;
- Case studies from real application of natural WWTP in different European countries;
- Informative book on general principles of natural treatment systems for decision makers and other non-experts in the field of wastewater treatment.

The need for technical guideline on design and construction of natural WWTP in the countries with existing national guidelines indicates a need for inclusion of more detailed and specified data on construction procedure, operational characteristics, loading rates and maintenance instructions. Because of the general awareness rising on the environment pollution, life cycle assessments and long term goals of using the materials from cradle to cradle, technical guidelines should be extended over the limits of solely description of wastewater treatment system. The guidelines should as well include at least basic technologies and management of the sludge from the mechanical pre-treatment, biomass produced in the system and reuse of treated water. This important expansion of guidelines pointed out in the questionnaire by Czech expert, would however, be useful for all countries.

The technical guidelines would gain additional credibility with the presentation of good and bad examples in the implementation of specific technologies across the world. Examples of good and bad design, dimensioning, loading as well as concrete results on the performance of certain natural WWTP should be presented.

Besides the technical guidelines and case studies there is also an interest in informative literature with general principles on the natural treatment systems which would be useful for decision makers. This kind of literature would also increase the awareness on natural WWTP and decrease the lack of information pointed out in question 23. The informative literature would reach wider public for which the expert technical guidelines are too sophisticated.

Question 26

Further planning for wastewater treatment from settlements below 2,000 inhabitants

All CEE countries have highlighted real legislative, financial and technical concerns regarding the implementations and/or improvement of the wastewater treatment in settlements bellow 2,000 inhabitants. A planning perspective for wastewater pathways and treatment in these settlements, such as national strategies programmes and action plans should take into account the specific geographical, social, economical and technical conditions in each country, as well as the European and national requirements.

The idea is to reduce the wastewater discharges from sources covering those on-site wastewater systems which receive domestic or similar wastewater from households, small businesses or settlements outside urban wastewater collection systems (non centralized systems) in order to improve the access to the sanitation / treatment and to assure an adequate protection of the environment from the adverse effects of the wastewaters. Both pathways are taken into account for further planning - onsite small natural WWTPs and non – centralized systems such as individual adequate systems (IAS). Moreover, the provision and maintenance of an adequate level of wastewater infrastructure is essential for the economic and social development of rural areas and for the achievement of balanced regional development.

Generally, the mechanism for planning perspective follows the "up-bottom" approach. The strategies and national programmes for water/wastewater sector are elaborated and approved by competent national authorities (ministries of environment, regional development, agriculture, etc.). The action plans are developed and implemented by the regional authorities, municipalities, water services operators and local authorities along with the involvement of public.

For example, every region in the Czech Republic has had a regional water/wastewater development plan since 2002, including local or municipal offices ensuring that water services are under the control of region councils. Other countries have national or operational programmes for infrastructure development of water/wastewater management in settlements less than 2000 inhabitants (Bulgaria, Latvia and Slovenia). Estonia, Romania, Hungary and Slovakia have integrated these aspects in the river basin management plans according to the requirements of the Water Framework Directive 2000/60/EC. The programme of measures for compliance has been established in the river basin management plans (2010) which cover also the scattered areas and settlements with less than 2,000 inhabitants. The review of river basin management plans should be done by the end of year 2015. There is a particularly the case in Ukraine where only municipalities are responsible to develop plans and ensure wastewater treatment systems for small settlements.

In Bulgaria and Romania, almost 3 Million people - 1 Million in Romania (4.8%) and 2 Million (27.2%) in Bulgaria, live in settlements with less than 2,000 inhabitants which usually do not have any wastewater collection and/or treatment systems and are not obliged to provide it until the deadline for implementation of the Urban Wastewater Treatment Directive 91/271/EEC (2018 for Romania and 2014 for Bulgaria). However, the measures included in the river basin management plans are not addressing sufficiently the issues of lacking sanitation and wastewater treatments in these settlements. In Romania, by achieving the targets in the River Basin Management Plans, 657,000 inhabitants of agglomerations with less than 2,000 i.e. will become beneficiaries of wastewater treatment systems, with an estimated amount of 545 Million Euro. For the settlements without any sewerage systems in Bulgaria (268 settlements with population less than 2,000 i.e., with about 305,000 inhabitants) the estimated cost is 109 Million Euros. Thus, the further national priority is to build on the medium term, the water/wastewater infrastructures for the human agglomeration with more than 2,000 i.e. as required by UWWTD.

Few neighboring sea countries have integrated in their plans the provisions of the international agreements, respectively the Convention on the Protection of the Marine Environment of the Baltic Sea Area – Helsinki Convention (1992). The countries within the Baltic Sea basin (whole area of Latvia, Lithuania, Estonia and Poland, minor parts of the Czech Republic and Ukraine, and a negligible part of Slovakia) work under coordination of the Helsinki Commission (HELCOM) to protect the marine environment from all sources of pollution, based on the intergovernmental co-operation between countries and the European Community. There is the HELCOM Baltic Sea Action Plan applied, which represents an ambitious programme to restore the good ecological status of the Baltic marine environment by 2021. The implementation of the HELCOM Recommendation 28E/6 requires the countries with settlements up to 300 inhabitants equivalents (i.e.) to take measures for on-site wastewater treatment system for all wastewaters and on-site holding tank or the cesspool with transportation to a the nearest treatment of wastewaters at a municipal wastewater treatment plant. Also certain value limit for emissions and level of treatment had been agreed in the frame of this Recommendation.

Question 27

Financial funding for operation, construction and/or improvement of small-scale wastewater treatment

Generally the financial support for construction, improvement and operation of small-scale wastewater treatment in settlements below 2,000 inhabitants comes from certain European funds, governmental budget and local budget, but also from the budget of the household owners.

A subsidy (also known as a subvention) is a form of financial assistance paid to an individual, a business or an economic sector in order to achieve certain policy objectives. For example, a subsidy can be used to support a service that cannot recover its full costs (e.g. through tariffs), which is a common problem in the water and sanitation sector. Subsidies may also be given to encourage activities that would otherwise not take place, e.g. a more sustainable sanitation technology. Subsides flow from government or via government (in the case of official development assistance) and sometimes through international or national non-governmental organizations (EVANS et al. 2009).

As the settlements with less than 2,000 inhabitants are not covered by the Urban Wastewater Treatment Directive (91/271/EEC) requirements related to the centralized collecting and treatment systems, they are often not eligible for getting financial support by the EU (Cohesion funds) in order to set up an adequate sanitation and wastewater systems. Other European financial sources such as the financing schemes for regional state aid under European Commission Regulation no.1628/2006 can support investments for rehabilitation/construction of waste water treatment plants from small settlements. Also other financial sources, for example European Agricultural Fund for Rural Development (Priority Axis 3, measure 3.2.2) under Rural Development Fund Regulation (EC) 1698/2005 and European Regional Development Fund under Regulation (EC) 1080/2006 can be applied.

Regarding the individual collection and treatment systems, the household owners support the cost for investments, operating and maintenance of individual adequate systems (IAS).

Regularly, operating and maintenance costs for waste water plants are covered by tariffs or charges. If exceptions exist (subsidy), these can often be justified by social reasons, but taking into account that the important public function of providing water services requires careful assessment for each case in question. The objective of this assessment is to decide if a significant rise in water tariffs can be justified. In fact this means that the principle of "full cost recovery" has to be weighed against social and economic interests, public health interests and social policy objectives. In the case of the *sanitation* and the *water management,* subsidies for operating system are not very common, but many utilities have to be subsidized as they cannot recover the full costs of their services from the users.

In all the CEE countries with the exception of Ukraine, no subsidies for the operation and maintenance of small-scale waste water treatment are in place, the costs are covered by the public water services and household owners. While the operation of sewerage/waste water treatment is no longer being subsidized, the subsidies for investments are covered by other sources. In conclusion, the operation/maintenance costs were fully covered by users through tariffs, but a large part of capital costs were covered through subsidies from the public authorities. Later the problem will occur with the payment of real wastewater tariffs because of low affordability in the rural area. More than 10% of inhabitants in Slovakia, Slovenia, Bulgaria and Latvia have no real possibility to be connected to the sewerage systems and small natural WWTPs because of enormous technical and economic difficulties which need to be overcome.

Question 28

Operating services for small WWTPs in settlements below 2,000 inhabitants

Generally, all types of operating services are used by the countries, depending on specific conditions. The local authorities or municipalities assure the operating services, taking into account that a license for WWTPs and sewerage system operation is required. In some cases the municipalities delegate the operating services to the water service operators which are members of water works associations. There are also public – private partnership situations if private services in this field exist in a country.

The actual situation in countries shows that the small WWPTs in settlements below 2,000 inhabitants are mainly operated by local authorities, municipalities and water service operators (Romania, Czech Republic, Estonian Republic, Latvia and Hungary). In Ukraine the only operating service suppliers are municipalities. In other cases, such as Slovenia, all types of operating services are present and none of them is predominant. Likewise, in Slovakia the combination – public-private partnership services is slightly more used.

Concerning the individual collecting and waste water treatment (IAS), the operating services in the countries are a mix between municipalities, water operators or private companies. Technical services for individual waste water collection and treatment systems are provided by the private companies, in terms of consultancy, equipment supply, maintenance and technical assistance. Pumping out and transport of wastewaters collected from individual collection systems are ensured through fee-based contracts for both the public water services (municipalities or water operators) and private companies.

Conclusions

Presented questionnaire study was prepared with an aim to receive actual and real information about status of wastewater treatment system in twelve CEE countries with focus on rural areas and on small WWTP below 2000 p.e. The received results pointed out that the CEE countries sanitation systems are deficiently developed with different level of sanitation development across the CEE countries. These differences result from different historical (political) development, economic and legislation standard in the past. Nevertheless, these countries belong to the most developed European economics with a very positive perspective for the future. More than 150 Million of inhabitants in CEE countries represent a very interesting potential for future development.

The CEE settlements with less that 2000 inhabitants represent almost 30% of the overall number of persons living in CEE countries. These figures confirm that CEE countries have more or less rural character, however, with slowly decreasing tendencies. The number of inhabitants living in small settlements in the CEE countries is also extremely high. Over 42 Million of inhabitants mainly without access to public sanitation are nowadays waiting for a proper sanitation system solution. This requirement will be an ever-growing in the future and it is important to know and to prepare appropriate steps for progressive realisation.

Except of Ukraine, all reported countries are members of EU, which plays a very important role in sanitation development. Some specific parameters of sanitation development have been permanently increasing during the last years. Connections on public water supply systems have reached the average of 83,3%. However, some CEE countries have sanitation connection comparable to the most developed countries – more than 90 % of inhabitants have central water supply.

Problem (or challenge for us) seems to be a lower connection to sewage and wastewater treatment systems – only close to 60 % of inhabitants is connected to biological treatment system. Even worse are the absolute figures – altogether, more than **60 Million of CEE inhabitants are not connected to treatment systems** (mainly in Ukraine, Romania and Poland). We can expect that more than 20 – 25 Million of inhabitants in CEE countries will have no possibility to be connected to municipal sewage and treatment sanitation systems in the future. Consequently, it can be expected that this part of CEE population would be supplied by decentralised or individual systems of wastewater treatment technologies. In regard to difficult financial situation, geographical problems with dispersed rural settlements and other problems, the natural and extensive sanitation systems could introduce appropriate solution for this part of CEE population that is not covered by EU legislation and in this intend by EU fund support. Despite the fact that there are over 2 Million inhabitants from rural CEE areas connected to small WWTPs, and that the inhabitants of cities and some rural areas are now connected to large WWTPs or to individual treatment systems, there still remain more than **30 Million inhabitants** expecting solution of their sanitation problems in the future.

The dominating systems of wastewater treatment in CEE countries are septic tanks and cesspools. This is a very imperfect process of wastewater treatment (it is only accumulation or pre-treatment of wastewater, not a full-valued treatment process). It should be noted that today around 75% of rural population in the CEE countries uses this type of inferior treatment. These cesspools very often

overflow and they do not fulfil the elementary legislative requirements for wastewater treatment. On the other hand, the natural treatment systems are very rarely used in CEE countries, despite the fact that the conditions for application of extensive treatment technologies are very suitable in comparison with Western Europe countries. The number of connected inhabitants on natural WWTP is quite different across of CEE countries. Only one country has a undoubtedly acceptable system of natural WWTP – the Czech Republic with more than 120 000 inhabitants connected to natural WWTPs. Ukraine has the highest number of connected inhabitants, but the used technology (infiltration or percolation systems) is not considered as a technology with a higher technical (treatment) standard. The rest of CEE countries have only marginal (or no) application of natural treatment systems.

Legislative requirements for WWTP effluents with 500 – 2000 p.e. are almost comparable in all the CEE countries (except of Bulgaria, where are no limits). The most strict effluent requirements are in Ukraine in all load groups of plants (BOD_5 = 15 mg/l, COD = 80 mg/l, N-NH4 = 0.39 mg/l !!!). Ukrainian requirements (also for the smallest plants) are more strict then the requirements for WWTPs >100 000 p.e. in all other EU countries (!!!).Such parameter fulfilment is from technological point of view almost impossible (N-NH4 = 0.38 mg/l i.e. full nitrification!!!) in standard (activated sludge) plants, and unredeemable for natural treatment systems.

Despite the fact that natural WWTPs are well established in some countries of CEE, there are national guidelines, significant number of scientific papers and market demands, there are still problems for their wider application in the region and cost-effective improvement of the wastewater treatment. There is a need for awareness rising, especially in the countries with non existing or bad examples of natural treatment systems and a need for a specific literature. Despite the fact that there is a significant amount of literature on natural wastewater treatment systems in English published in western Europe and US, its echo could not be seen in implementation of those systems in CEE. This indicates the need for taking measures on a local level and increasing awareness in all levels through education courses.

For the infrastructure development and improvement for settlements with less than 2,000 inhabitants, infrastructures for both water supply and sewage/waste water treatments are needed. The result of further actions will produce a direct positive impact on the population's health condition and development of the areas. This will also reduce the disparities between rural and urban areas.

Environmental legislation and funding instruments only establishes objectives and do not prescribe options (non centralized or centralized technologies) or approaches. Some specific conditions of rural areas require different solutions and consequently different amount of investments are needed for settlements below 2,000 inhabitants, mainly due to the particular technical solutions required. The wastewater management does not have to be complicated or expensive and the technical solutions should have low costs for operating and maintenance in order to be widely accepted.

Gradual implementation of the work seems to be necessary, due to the low affordability of the rural population; otherwise a fast implementation would lead to a rapid increase of the water service tariffs. In case that the municipalities do not yet have enough financial resources for required investments, existing subsidy schemes will be considered necessary for the future. Diversification

of financial sources such as the use of the governmental and local budget, EU funds, loans and public-private partnerships, etc. can also be an approach for development of projects.