Baltic Sea 2020

WRS
Water Revival Systems

Improved phosphate input data for the Baltic Nest model

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December 2007

Summary

Within this study data on phosphorous loads from single households for each country around the Baltic Sea has been estimated. Estimations have been carried out for phosphorous loads from excreta and from laundry- and dishwashing detergents with the aim to calculate to what extent phosphorous in laundry- and dishwashing detergents contribute to outlets of phosphorous from single households to the Baltic Sea.

All countries that either border to the Baltic Sea or are included in the watershed area to the Baltic Sea are included in the study.

The estimations indicate that the share of phosphorous deriving from detergents varies between 5-43 % depending on the country studied. Some countries already has a ban on phosphorous in laundry detergents, which of course contribute to low shares. The reliability of the estimations vary from country to country. For Belarus, Russia and Ukraina it has been hard to do even estimations.

To be able to say anything about how much phosphorous from single households that reach the Baltic Sea other aspects as for example where the population is located has to be taken into account. Such factors have not been investigated within this study.

Contents

1 Background

One goal for the Baltic Sea 2020 foundation is to estimate phosphorous loads to the Baltic Sea from all the countries in the Baltic Sea watershed area. The figures will be used in the Baltic Nest model. The load of phosphorous from single households not connected to municipal wastewater treatment is one of the sources where reliable data for the model is missing to date. The identification of more reliable data regarding phosphates loads from single households will improve the decision-making concerning e.g. possible effects on reduced P load on the Baltic Sea of a ban on phosphates in laundry and dishwasher detergents.

1 Objective

The study at hand is a study with the aim to identify more reliable data for each country around the Baltic Sea concerning phosphates from single households outside the municipal wastewater jurisdiction. Areas of concern, for each country are:

- Phosphorous load per capita in different countries around the Baltic Sea
- Estimation of the share of phosphorous from laundry detergents and detergents for dishwashers
- On-site waste water treatment methods outside the municipal wastewater jurisdiction

All countries that either border to the Baltic Sea or are included in the watershed area to the Baltic Sea are included in the study. Countries that border to the Baltic Sea are, Sweden (EU), the Russian federation, Finland (EU), Estonia (EU), Latvia (EU), Lithuania (EU), Poland (EU), Germany (EU) and Denmark (EU). In addition Belarus, Czech Republic (EU), Norway, Slovakia and Ukraine are included in the watershed area (source: www.smf.su.se/havet/fakta/siffror.html).

1.1 Methodology

The study has been undertaken by:

- Sending e-mails with questions to different contact persons in the countries around the Baltic Sea and to the EU. Contact persons have been identified by calling key persons for example at the Swedish Chemicals Inspectorate, Swedish Society for Nature's Conservation, as well as drawing on contacts obtained through earlier work in the field of detergent phosphates and by searching on the Internet. About 60 persons have been contacted, either through e-mails or through phone calls.

- Reading reports recommended by contact persons in different countries and the EU.

- Calculations.

The report has been proof read by Dr Elisabeth Kvarnström, Stockholm Environment Institute and Jonas Andersson, WRS Uppsala AB.

2 Phosphorous load per capita in different countries

The phosphorus loads per capita differ between countries in the world due to (i) difference in food supply and eating habits, (ii) difference in the use of detergents, as well as (iii) the amount of phosphorus in detergents.

Wastewater from households can generally be seen as composed of two distinct different flows: (i) excreta (urine and faeces) and (ii) greywater.

Total P load = P load in excreta + P load in greywater

The P load in greywater consists of a "background value" of approximately 0,15[1] g P/cap,d (or 54,75 g/cap,y) and a value depending on the use of household chemicals and their content of phosphate.

To be able to calculate phosphorus loads from excreta, a method based on food consumption in different countries has been used. By using an equation presented at a conference in Lübeck, 2003[2], it has been possible to estimate excreted amounts of phosphorous per capita in different countries (chapter 2.1).

To estimate the phosphorous loads from detergents (hence the P load in greywater) data from different sources has been used; reports, e-mail contacts and phone calls. The reliability of these data differs a lot between different countries and for some countries it has not been possible to get any information at all.

2.1 Phosphorous load from excreta in different countries

By using figures from FAO (Food and Agriculture Organizations) statistics Jönsson & Vinnerås[3] have developed an equation for calculation of excreted amounts of phosphorus and nitrogen per capita and day. In their report they have used the equation for calculations in China, Haiti, India, South Africa and Uganda.

P = 0,011*(total food protein + vegetal protein)

By using this equation, excreted amounts of phosphorous has been calculated for the countries around the Baltic Sea. Figures from 2001-2003 have been used in the calculations. See also preliminary figures for the years 2002-2004 (table 2.1).

1 Vad innehåller avlopp från hushåll? Naturvårdsverkets rapport 4425. 1995.

2 Jönsson, H & Vinnerås, B. 2004. Adapting the nutrient content of urine and faeces in different countries using FAO and Swedish data. In: EcoSan – Closing the loop. Proceedings of the 2nd International symposium on Ecological sanitation, incorporationg the 1st IWA specialist group conference on sustainable sanitation. 7th-11th April 2003, Lübeck, Germany. Pp 623-626.

3 Jönsson, H & Vinnerås, B. 2004. Adapting the nutrient content of urine and faeces in different countries using FAO and Swedish data. In: EcoSan – Closing the loop. Proceedings of the 2nd International symposium on Ecological sanitation, incorporationg the 1st IWA specialist group conference on sustainable sanitation. 7th-11th April 2003, Lübeck, Germany. Pp 623-626.

Table 2.1 Calculated figures on excreted amounts of phosphorous in different countries based on FAO figures on food consumption.

Country	2001-2003 (provisional) (g/p,d) from protein	2002-2004 (preliminary)[1] (g/p,d) from protein	2001-2003 Share in total Dietary Protein Consumption[2] (%)	2001-2003 Protein from vegetables[3] (g/p,d)	2001-2003 Excreted amounts of P[4] (kg/p,year)
Belarus	87	94	54	40	0,51
Czech Republic	93	103	57	40	0,53
Denmark	110	110	65	39	0,60
Estonia	90	101	58	38	0,51
Finland	102	108	62	39	0,57
Germany	100	109	59	41	0,57
Latvia	83	96	52	40	0,49
Lithuania	110	125	53	52	0,65
Norway	107	124	61	42	0,60
Russian federation	91	98	49	46	0,55
Poland	99	106	50	50	0,60
Slovakia	77	84	50	39	0,46
Sweden	107	110	67	35	0,57
Ukraine	84	94	42	49	0,53

1) http://www.fao.org/faostat/foodsecurity/Files/FoodConsumptionNutrients_en.xls
2) http://www.fao.org/faostat/foodsecurity/Files/DietAnimalProductsProtein_en.xls
3) Calculated as (g/p,d from protein)*((100-(% from animal food))/100)
4) Calculated by the use of a formula from Jönsson, H., et al (2004)[4]: P= 0,011*(total food protein+vegetal protein)*365/1000

Calculations in table 2.1 show that the differences in excreted amounts of phosphorus per person and year between countries around the Baltic Sea are quite small. The largest difference occurs between Slovakia and Lithuania where the P excreted is almost 30 % lower in Slovakia than in Lithuania.

FAO´s preliminary figures for the years 2002-2004 indicate that the total protein consumption is increasing, and therefore a slightly higher amounts of excreted phosphorous is to be expected.

2.2 Phosphorous load from detergents in different countries

2.2.1 Assumptions on average phosphorus content in detergents

For most countries included in the report it has not been possible to find data on phosphorus content in laundry detergents or dishwashing detergents on their respective markets. For these countries assumptions have been made and used in the calculations for each country.

A report for the European Commission[5] states that phosphate based laundry detergents in EU contains about 25 % STPP (Sodium tripolyphosphate) and that STPP contains about 25 % P (phosphorous) and that P-free laundry detergents are generally zeolite-based. In absence of more specific data, these

4 Jönsson, H., Richert Stintzing, A., Vinnerås, B., Salomon, E. 2004. Guidelines on the use of urine and faeces in crop produktion. EcoSanRes Publication Series. Report 2004-2.

5 Floyd, P., Zarogiannis, P., Fox, K. 2006. Non-surfactant Organic Ingredients and Zeolite-based Detergents. Final report prepared for the European Commission. RPA. June 2006. (the original source is BUA (2003))

figures, an average content of 6,25 % P in phosphate based laundry detergents, has been used as a rule of thumb for the calculation of greywater-phosphorus per capita and year in different countries.

The commission-report also states that washing-up detergents (for washing-up by hand) generally are P-free whereas dishwashing detergents used for dishwashers generally are P-based. The report does not, however, state the actual percentage of phosphate in dishwashing detergents.

In Sweden, the content in dishwashing detergents varies between 14-48 % phosphate or 3,5-12 % phosphorus. If the figures of sold volumes are analyzed a mean value of the P content is 34 % phosphate, or 8,5 % phosphorus[6].

2.2.2 Phosphorus content in greywater per capita and year per country

In the commission-report[7], studies about the use of laundry detergents and dishwashing detergents per capita and year in different countries have been compiled. Table 2.2 is a copy of table 2.8 in the report (countries not relevant to this study are not shown) showing the use of laundry detergents and dishwashing detergents in different countries divided in P-based and P-free detergents. Figures in bold italics are estimations made by the authors of the commission report in absence of further data which implies that the figures presented for Estonia, Latvia, Lithuania are the most uncertain ones. To confirm that the figures in the study are the most accurate existing today, a contact has also been made with Sotirios Kiokias, Directorate General Enterprise and Industry at the European Commission.

Table 2.2 Extract from table 2.8.[8]

Table 2.8 Per capita Consumption of Laundry and Dishwashing Detergents (kg/cap, year)					
Country	Laundry[1]		Dishwashing		L&D Detergents[1]
	P-based	P-free	P-based	P-free	
Czech Republic	4.3	2.3	0.2	1.9	8.6
Denmark	1.1	4.4	1.6	1.1	8.2
Germany	0.0	6.8	1.7	1.1	9.6
Estonia	***2.7***	***0.7***	0.0	2.0	***5.5***
Latvia	***3.1***	***0.8***	0.0	1.7	***5.5***
Lithuania	***2.9***	***0.7***	0.1	1.7	***5.5***
Poland	8.2	1.4	0.1	1.6	11.3
Slovakia	3.3	0.6	0.1	1.5	4.5
Finland	0.5	4.7	1.6	1.1	8.0
Sweden	0.7	4.1	1.8	1.2	7.8
1) Figures in bold italics have been derived from assumptions presented above.					

Below follows a compilation of estimations on phosphate loads per capita and year from dishwashing detergents and laundry detergents per country.

Note that the contribution of phosphorous from shower- and bath products has not been included in this study. It should stand for very small amounts compared to sources from laundry- and dishwashing detergents.

Belarus

6 Kemikalieinspektionen. 2007. Fosfater i konsumenttillgängliga maskindiskmedel. Rapport från ett regeringsuppdrag. September 2007.

7 Floyd, P., Zarogiannis, P., Fox, K. 2006. Non-surfactant Organic Ingredients and Zeolite-based Detergents. Final report. June 2006. Prepared for the European Commission by the Risk & Policy Analysts Limited (RPA)

8 Floyd, P., Zarogiannis, P., Fox, K. 2006. Non-surfactant Organic Ingredients and Zeolite-based Detergents. Final report prepared for the European Commission. RPA. June 2006.

Belarus is missing in table 2.2 since it only includes countries in the EU. We have, unfortunately, not been able to find any other data sources for Belarus either.

Czech Republic
In the Czech Republic laundry detergents with a phosphorous content over 0,5 weight-% is banned since 1st July 2006[9].

With the assumption that the distribution of phosphate based detergents in table 2.2 is still relevant the *maximum* P-load from laundry detergents from private households in the Czech Republic could be calculated as:

P-load $_{\text{Czech Republic laudry det.}}$ = 4,3*0,005*1000 = **21,5** g P/cap,y.

This calculation assume that the 2.3 kg laundry detergents/cap, year, are zeolite based and therefore do not contribute to any phosphorous emissions at all.

To calculate the corresponding maximum load from dishwashing detergents we have assumed that "phosphate free" dishwashing detergents are based on fatty acids and therefore do not contribute to any phosphorous emissions at all. With this assumption the contribution of phosphorous could only originate from the 0.2 kg P-based dishwashing detergents used per capita and year (table 2.2). Values on average content of phosphorous in P-based dishwashing detergents in Czech Republic are missing. Therefore an average value of 8,5 % for Sweden has been used (chapter 2.2.1):

P-load $_{\text{Cz ech Republic dishwashing det.}}$ = 0,2*0,085*1000 = **17** g P/cap,y.

The total load from laundry and dishwashing detergents in the Czech Republic is calculated as:

P-load $_{\text{Czech Republic laundry \& dishwashing det.}}$ = 21,5 + 17 = **29** g P/cap,y.

Denmark
With the assumption that P-free laundry detergents are zeolite based and dishwashing detergents are based on fatty acids we have assumed that the contribution of phosphorous from laundry- and dishwashing detergents originate only from the 1.1 kg P-based laundry detergents and 1.6 kg P-based dishwashing detergents used per capita and year (table 2.2).

In absence of more specific data the rule of thumb for average P-content in P-based laundry detergents and dishwashers (chapter 2.2.1) has been used to calculate the contribution of phosphorous from detergents:

P-load $_{\text{Denmark laudry det.}}$ = 1,1*0,0625*1000 = **69** g P/cap,y

P-load $_{\text{Denmark dishwashing det.}}$ = 1,6*0,085*1000 = **136** g P/cap,y

The total load from laundry and dishwashing detergents in Denmark is calculated as:

P-load $_{\text{Denmark laundry \& dishwashing det.}}$ = 69 + 136 = **205** g P/cap,y

Figures on the consumption of different substances with a phosphorous content used in Denmark are presented in a Nordic database (www.spin2000.net). Unfortunately these figures are not very useful as a complement, since it shows the industrial and household use non-separated. Contacts with the Danish Product Register[10] have not led to any further clarifications.

9 Kemikalieinspektionen. 2007. Fosfater i konsumenttillgängliga maskindiskmedel. Rapport från ett regeringsuppdrag. September 2007.

10 Poul E Andersen, Arbeidstilsynet, VG, e-mail contact

Estonia
Notice that figures on the use of laundry detergents in Estonia, Latvia and Lithuania in table 2.2 are based on assumptions from the authors of the commission-report and are therefore very uncertain.

According to table 2.2 all dishwashing detergents in Estonia are phosphate-free.

By using the estimations in table 2.2 together with assumptions on average P content from the commission-report (chapter 2.2.1), the P-load per capita and year in Estonia could be calculated as:

The total load from laundry detergents in Estonia is calculated as:

P-load $_{\text{Estonia laundry det.}}$ = 2,7*0,0625*1000 = **169** g P/cap,y (alternative 1)

In 2003-2004 an extensive market study of all available laundry detergents and dishwashers for households was carried out in Estonia, Latvia and Lithuania. In the study[11], were Janis Brizga from Green Liberty in Riga was project leader, 72 different brands of laundry detergents were analysed due to their phosphorous content.

The study was also complemented with figures on the market shares of different brands in the three countries. Table 4.3 is a summary of market shares and phosphorous content in the different brands as of September and October 2003.

According to this study, 10 of the 11 most frequently used laundry detergents contained phosphorous.

Table 2.3 Market shares and P-content in different laundry detergents brands in Estonia in September and October 2003.

Brand	Company	P-content (%)	g/100 ml	Estonia market share (vol-%)	Estonia market share (weight-%)
Ariel	Proctor & Gamble	4	64	20,6	20,2
Bold	Proctor & Gamble	5	72	3,5	3,9
Bonux	Proctor & Gamble	4	67	16,6	17,1
Dosia	Reckittbenckiser	3	63	6,8	6,6
E	Cussons Polska S.A.	5	69	1,1	1,2
Ixi	Cottons Polska	4	48	2,6	1,9
Omo	Unilever Polska S.A.	5	64	6,6	6,5
Persil	Henkel	1	65	2,4	2,4
Perwoll Balsam magic	Henkel Austria	0	39	1,9	1,1
Rex	Henkel	3	64	8,0	7,9
Tide	Proctor & Gamble	4	74	14,6	16,6
Other brands			63[1]	15,2	14,7
Summary				100	100

1) The figure is an assumption calculated as a mean value from the 11 most popular brands presented in the table.

Calculations gives an average P-content in the 11 largest brands in Estonia of 4 (3,8) % and these brands account for 85,3 weight-% of the market.

11 Unpublished data from Janiz Brizga, Green Libery, personal message

Assuming that the 14,7 % other brands contain 4 (3,8) % P as an average, an alternative total P-load from laundry detergents in Estonia could be calculated as:

P-load $_{\text{Estonia laundry det.}}$ = 3,4**0,038*1000 = **129** g P/cap,y (alternative 2)

*) Estimations from the commission-report on the total use of laundry detergents

Janis Brizga was asked if there have been noticeable changes of the P content in laundry detergents for households since the study was undertaken in 2003 until today. The answer was that he thinks that the market shares probably have changed but not really the P content.

The figures in alternative 2 are somewhat lower than those in alternative 1 where an average P-content has been used in the calculations. Probably, alternative 2 is closer to reality since it is based on a market study carried out in Estonia.

Finland
With the assumption that P-free laundry detergents are zeolite based and dishwashing detergents are based on fatty acids we have assumed that the contribution of phosphorous from laundry- and dishwashing detergents originate only from the 0,5 kg P-based laundry detergents and 1.6 kg P-based dishwashing detergents used per capita and year (table 2.2).

In absence of better data the rule of thumb for average P-content in P-based laundry detergents and dishwashers (chapter 2.2.1) has been used to calculate the contribution of phosphorous from detergents:

P-load $_{\text{Finland laudry det.}}$ = 0,5*0,0625*1000 = **31** g P/cap,y.

P-load $_{\text{Finland dishwashing det.}}$ = 1,6*0,085*1000 = **136** g P/cap,y.

The total load from laundry and dishwashing detergents in Finland is calculated as:

P-load $_{\text{Finland laundry \& dishwashing det.}}$ = 31 + 136 = **167** g P/cap,y

Figures on the consumption of different substances with a phosphorous content used in Finland are presented in a Nordic database (www.spin2000.net). According to a contact[12] at STTV in Finland, the total use in 2005 of triphosphoric acid, CAS 7758-29-4, was 38 tonnes and the use of phosphoric acid, CAS 7664-38-2, was 611 tonnes (substances used for cleaning and washing). Unfortunately the figures represent the total use, both industrial and the use in households. The contact at STTV confirmed that it is not possible to get separate figures for household use only for Finland. Moreover, according to the Finnish regulation, only substances classified as dangerous have to be registered, so not all substances registered in Sweden are registered in Finland.

Germany
According to table 2.2 all laundry detergents in Germany are free from phosphorous so the contribution of phosphorous from laundry detergents ought to be close to zero.

The use of P-based dishwashing detergents is 1,7 kg/cap, year (table 2.2).

According to Dr Judy Libra[13] at the Federal Environment Agency in Germany laundry detergents are phosphate free since 1980´s and the P-content in dishwashing detergents in Germany is 12,5 %. By

12 Ritva Vuorinen, STTV (responsible for the national chemical supervision), Finland, e-mail contact

13 Dr Judy Libra, Federal Environment Agency in Germany, personal message

using these figures together with figures in table 2.2 the contribution of phosphorous from detergents in Germany could be calculated (alternative 1).

The total load from dishwashing detergents in Germany is calculated as:

P-load $_{\text{Germany dishwashing det.}}$ = 1,7*0,125*1000 = **213** g P/cap,y (alternative 1)

Dr Judy Libra also states that the amount of phosphorous in greywater is 657 g P/cap, year. This figure is very high and do not correspond with the calculations above. We strongly believe that the figure stated by Dr Judy Libra is not correct for greywater only. We have, however, not investigated further into that figure within this project.

According to Dr Judy Libra the organisation Industrieverband Körperpflege- und Waschmittel e.V. estimated that 26,000 tonnes P/year was used in Germany in 2004 in households for washing and cleaning products. The same year the total population in Germany was 82 501 000[14] inhabitants. An alternative (alternative 2) figure on phosphate contribution could be calculated by using these figures.

The total load from washing and cleaning detergents in Germany is calculated as:

P-load $_{\text{Germany washing \& cleaning det.}}$ = (26 000/82 501 000)*10^6 = **315** g P/cap,y (alternative 2)

Figures in the calculation in alternative 2 seem to also include phosphorous from cleaning products. Within this inquiry no further investigation about the distribution has been done.

Latvia

Please note that figures on the consumption of laundry detergents in Latvia are based on assumptions from the authors of the commission-report and therefore could be quite uncertain.

According to table 2.2 all dishwashing detergents in Latvia are phosphate free. With this assumption the contribution of phosphorous would only originate from laundry detergents.

By using the estimations in table 2.2 together with assumptions on average P content from the commission-report, the P-load per capita and year in Latvia could be calculated as (alternative 1):

The total load from laundry and dishwashing detergents in Estonia is calculated as:

P-load $_{\text{Latvia laundry det.}}$ = 3,1* 0,0625 * 1000 = **194** g P/cap,y (alternative 1)

Table 2.4 shows figures on shares and P-content in laundry detergents used in Latvia. The figures derive from a market study that was carried out in Estonia, Latvia and Lithuania in 2003 (read more under Estonia).

14 Dr Judy Libra, Federal Environment Agency in Germany, personal message (data from Statistische Bundesamt for the year 2004)

Table 2.4 Market shares and P-content in different laundry brands in Latvia in September and October 2003.

Brand	Company	P-content (%)	g/100 ml	Latvia, market share (vol-%)	Latvia, market share (weight-%)
Ariel	Proctor & Gamble	4	64	17,1	12,5
Bold	Proctor & Gamble	5	72	2,7	1,7
Bonux	Proctor & Gamble	4	67	17,8	33,5
Dosia	Reckittbenckiser	3	63	10,4	10,1
E	Cussons Polska S.A.	5	69	1,5	1,5
Ixi	Cottons Polska	4	48	0,6	0,1
Omo	Unilever Polska S.A.	5	64	9,9	5,0
Persil	Henkel	1	65	5,1	3,0
Perwoll Balsam magic	Henkel Austria	0	39	1,2	0,6
Rex	Henkel	3	64	9,1	6,1
Tide	Proctor & Gamble	4	74	14,1	9,7
Other brands			63[1]	17,0	16,3
Summary				100	100

1) The figure is an assumption calculated as a mean value from the 11 most popular brands presented in the table

Calculations gives an average P-content in the 11 largest brands in Latvia of 4 (3,8) % and these brands account for 83,7 weight-% of the market.

Assuming that the 16,3 % other brands contain 4 (3,8) % P as an average, an alternative total P-load from laundry detergents in Latvia could be calculated as:

P-load $_{\text{Latvia laundry det.}}$ = 3,9**0,038*1000 = **148** g P/cap,y (alternative 2)

*) Estimations from the commission-report on the total use of laundry detergents

The figures in alternative 2 are somewhat lower than those in alternative 1 where an average P-content has been used in the calculations. Probably, alternative 2 is closer to reality since it is based on a market study carried out in Latvia.

Lithuania

Note that figures on the consumption of laundry detergents in Lithuania are based on assumptions from the authors of the commission-report and therefore could be quite uncertain.

With the assumption that P-free laundry detergents are zeolite based and dishwashing detergents are based on fatty acids we have assumed that the contribution of phosphorous from laundry- and dishwashing detergents originate only from the 2,9 kg P-based laundry detergents and 0,1 kg P-based dishwashing detergents used per capita and year (table 2.2).

In the absence of more specific data the rule of thumb for average P-content in P-based laundry detergents and dishwashers (chapter 2.2.1) has been used to calculate the contribution of phosphorous from detergents (alternative 1):

P-load $_{\text{Lithuania laundry det.}}$ = 2,9*0,0625*1000 = **181** g P/cap,y

P-load $_{\text{Lithuania dishwashing det.}}$ =0,1*0,085*1000 = **9** g P/cap,y

The total load from laundry and dishwashing detergents in Lithuania is calculated as:

P-load $_{\text{Lithuania laundry \& dishwashing det.}}$ = 181 + 9 = **190** g P/cap,y (alternative 1)

Table 2.5 shows figures on shares and P-content in laundry detergents used in Lithuania. The figures derive from a market study that was carried out in Estonia, Latvia and Lithuania in 2003 (read more under Estonia).

Table 2.5 Market shares and P-content in different laundry brands in Lithuania in September and October 2003.

Brand	Company	P-content (%)	g/100 ml	Lithuania, market share (vol-%)	Lithuania, market share (weight-%)
Ariel	Proctor & Gamble	4	64	12,8	16,7
Bold	Proctor & Gamble	5	72	1,5	3,0
Bonux	Proctor & Gamble	4	67	32,7	18,2
Dosia	Reckittbenckiser	3	63	10,5	10,0
E	Cussons Polska S.A.	5	69	1,4	1,6
Ixi	Cottons Polska	4	48	0,2	0,4
Omo	Unilever Polska S.A.	5	64	5,1	9,7
Persil	Henkel	1	65	3,0	5,0
Perwoll Balsam magic	Henkel Austria	0	39	1,0	0,7
Rex	Henkel	3	64	6,2	8,9
Tide	Proctor & Gamble	4	74	8,6	15,9
Other brands			63[1]	10,5	10,0
Summary				100	100

1) The figure is an assumption calculated as a mean value from the 11 most popular brands presented in the table

Calculations gives an average P-content in the 11 largest brands in Lithania of 4 (3,8) % and these brands account for 90,0 weight-% of the market.

Assuming that the 10 % other brands contain 4 (3,8) % P as an average, an alternative total P-load from laundry and dishwashing detergents in Lithuania could be calculated as:

P-load $_{\text{Lithuania laundry \& dishwashing det.}}$ = 3,6[1]*0,038*1000 + 0,1[1]*0,085[2]*1000 = **145** g P/cap,y (alternative 2)

1) Estimations from the commission-report on the total use of laundry detergents
2) The same estimation as for dishwashers in alternative 1

The figures in alternative 2 are somewhat lower than those in alternative 1 where an average P-content has been used in the calculations. Probably, alternative 2 is closer to reality since it is based on a market study carried out in Lithuania.

Norway
Norway is missing in table 2.2 since it only includes countries in the EU.

The highest legal amounts of phosphorous in laundry detergents, detergents washing-up detergents liquids for cleaning in Norway is 0,2 weight-% P. The highest legal P content in dishwashing detergents are 4% P and powder based cleaning agents are 2,5%[15]. According to the Norwegian

15 Kemikalieinspektionen. 2006. Fosfater i tvätt- och rengöringsmedel. Förutsättningar för ett nationellt förbud och förslag på åtgärder. Rapport från ett regeringsuppdrag.

Pollution Control Authority[16] 90% of the dishwashing detergents are phosphate-free. The conclusion is that the emissions of phosphorous via laundry detergents and dishwashing detergents and other cleaning agents from private households in Norway ought to be low.

On the other hand the recommended standard values given by the Norwegian Pollution Control Authority[17] are:

P-load $_{\text{Norway laudry det.}}$ = **29,2** g P/cap,y

P-load $_{\text{Norway dishwashing.}}$ = **73,0** g P/cap,y

P-load $_{\text{Norway shower-bath/handwashing.}}$ = **7,3** g P/cap,y

The total* load from laundry and dishwashing detergents in Norway is calculated as:

P-load $_{\text{Norway laundry \& dishwashers det.}}$ = 29,2 + 73,0 = **102** g P/cap,y

*) The contribution from shower and bath has not been included in the total figure since it is missing for the other countries in this study.

Poland
In Poland laundry detergents with a phosphorous content over 6 % is forbidden[18].

With the assumption that the distribution of phosphate based detergents in table 2.2 is still relevant the *maximum* P-load from laundry detergents from private households in Poland could be calculated. The rule of thumb in 2.2.1 has been used for figures on content of phosphates in dishwashers.

P-load $_{\text{Poland laudry det.}}$ = 8,2*0,06*1000 = **492** g P/cap,y

P-load $_{\text{Poland dishwashing det.}}$ = 0,1*0,085*1000 = **8,5** g P/cap,y

This calculation assume that P-free laundry detergents are zeolite based and P-free dishwashing detergents are based on fatty acids and therefore do not contribute to any outlets of phosphorous at all.

The total load from laundry and dishwashing detergents in Poland is calculated as:

P-load $_{\text{Poland laudry \&dishwashing det.}}$ = 492 + 9 = **501** g P/cap,y

The result from a market study[19] carried out in 2003-2004 in Estonia, Latvia, Lithuania, as mentioned earlier, showed that at least 9 of the 72 different brand that were analysed were imported from Poland. One of these brands was phosphate free and the other brands contained from 2 up to 5 % phosphorus. It is interesting that none of the exported Polish laundry detergents contained more than 5 % P. This indicate that the contribution from laundry detergents is lower than 492 g P/cap, year.

Russia
Russia is missing in table 2.2 since it only includes countries in the EU.

Within this study we have been able to find very few data from Russia. Maybe the VAK market study from Estonia, Latvia, Lithuania and Poland, were laundry detergent products were analysed, could

16 Berit Eyde Kjuus, Norwegian Pollution Control Authority, personal message

17 "Forurensningsregnskap for avløpssektoren". Statens forurensningstilsyn. Veiledning 1996:02.

18 Kemikalieinspektionen. 2006. Fosfater i tvätt- och rengöringsmedel. Förutsättningar för ett nationellt förbud och förslag på åtgärder. Rapport från ett regeringsuppdrag.

19 Janiz Brizga, personal message

give a hint about the phosphorous content in laundry detergents in Russia. Of the 10 products with the highest P content, five were Russian products.

For two of the products, it was not possible to identify the original country of production. Only one of the 72 analysed products with 0 % P was from Russia. 14 of the 72 products were produced in Russia. Thus, it could be suspected that Russian laundry detergents to a large extent could have quite high phosphorus contents.

Slovakia
With the assumption that P-free laundry detergents are zeolite based and dishwashing detergents are based on fatty acids we have assumed that the contribution of phosphorous from laundry- and dishwashing detergents originate only from the 2,4 kg P-based laundry detergents and 0,1 kg P-based dishwashing detergents used per capita and year (table 2.2).

In absence of more specific data the rule of thumb for average P-content in P-based laundry detergents has been used to calculate the contribution of phosphorous from laundry detergents:

P-load $_{\text{Slovakia laudry det.}}$ = 2,4*0,0625*1000 = **150** g P/cap,y

P-load $_{\text{Slovakia dishwashing det.}}$ = 0,1*0,085*1000 = **9** g P/cap,y

The total load from laundry and dishwashing detergents in Slovakia is calculated as:

P-load $_{\text{Slovakia laundry\&dishwashing det.}}$ = 150 + 9 = **159** g P/cap,y.

Sweden
The amounts of phosphorus containing substances in laundry detergents by the year 2004 in Swedish households was 3448,6 tonnes (table 2.6).

Table 2.6 Total amounts of phosphorous containing substances used in laundry- and dishwashing detergents used in Swedish households in 2004[20].

CAS-number	Product	Total (tonnes)	Professional use (tonnes)	Quantity for use in private households (tonnes)
7758-29-4	Laundry detergent	3809,4	378,3	3431,1
7758-29-4	Dishwashing detergent	2008,1	219,5	1788,5
13573-18-7	Dishwashing detergent	88,0	31,6	56,4
13573-18-7	Laundry detergent	21,1	3,6	17,5

STTP (that contains 25 % P) account for the main part of the phosphorus containing substances. The population the same year was 9 011 392 inhabitants giving the load of phosphorus from laundry detergents:

P-load $_{\text{Sweden laudry det.}}$ = (3431,1+17,5)*0,25*10^6/9 011 392 = **97** g P/cap,y

In Sweden, 6886 tonnes of dishwashing detergents were sold by the year 2005. Of these 6244 tonnes contained phosphorus with a total amount of 2108 tonnes phosphate or 527 tonnes of phosphorus[21]. The population the same year was 9 047 752[22] inhabitants.

20 Åsa Thors, Swedish Chemicals Agency, personal message

P-load $_{\text{Sweden dishwashing det.}}$ = $(527*10^6)/9\ 047\ 752$ = **58** g P/cap,y

The total load from laundry and dishwashing detergents in Sweden is calculated as:

P-load $_{\text{Sweden laundry \& dishwashing det.}}$ = 97 + 58 = **155** g P/cap,y

This value can be compared with the recommended values for content of phosphorous in wastewater from single households in Sweden given by The Swedish Environmental Protection Agency. They recommend the use of a standard value between 0,15 – 0,6 g/cap,d, corresponding to 55 – 219 g/cap,y. The lowest level (0,15) is recommended when only phosphate free household products are used. The conclusion is that the calculated value is within the Swedish recommended standard values.

Ukraine
Ukraine is missing in table 2.2 since it only includes countries in the EU. Within this study no figures from other sources has been found as well.

2.3 On-site waste water treatment methods

In this chapter, the use of different waste water treatment methods for households not connected to a public sewer system is summarized. Figures on the kind of treatment methods are often very uncertain. Also note that figures have been found for some of the countries in this study while others are missing. Within this study we have not been able to find figures or information about all countries.

In Germany, 3 753 000 (5 %) of the population is not connected to a public sewer system. Of those 948 000 (25 %) have a holding system and 2 769 000 (74 %) have some kind of small wastewater treatment systems. According to the federal wastewater regulations from 2002 all small wastewater treatment plants must comply to the same requirements as all wastewater treatment plants for < 1000 pe. The regulations are only regarding COD (150 mg/l) and BOD (40 mg/l). Most small systems in Germany are waterborne and many of these wastewater treatment plants are old, especially in East Germany. These systems need to be upgraded to fulfil the new regulations[23].

About 25 million people in the rural areas of the CEE-countries are not connected to centralized wastewater treatment systems[24].

In Poland the most typical solution for households not connected to a wastewater treatment plant are cesspools. Sewage is taken to the wastewater treatment plants by trucks[25].

In Slovakia, 84 % of the treatment methods for private households are represented by cesspools. These are often leaking and normally only emptied when the tank is full of suspended solids. The use of dry toilets is very unusual in Slovakia so normally a mixed sewage is treated from private households[26].

About 14.3 million inhabitants living in rural areas in Ukraine are not connected to centralised sanitation services. The decentralised systems are represented by pit latrines or septic tanks that might

21 Kemikalieinspektionen. 2007. Fosfater i konsumenttillgängliga maskindiskmedel. Rapport från ett regeringsuppdrag. September 2007.

22 www.scb.se

23 Dr Judy Libra, Federal Environment Agency in Germany, personal message

24 Bodík, I. 2007. Current Status of Water Supply and sanitation in the GWP CEE countries. Sustainable sanitation in central and eastern Europe. Addressing the needs of small and medium-size settlements. Edited by Igor Bodík and Peter Ridderstolpe. Global Water Partnership Central and Eastern Europe.

25 Katarzyna Roszkowska, Secretary for Helsinki Convention, Chief Inspectorate for Environmental Protection
personal message

26 Dr. Igor Bodík, assoc. prof., Slovak Univerity of Technology, Slovakia, personal message

be used by single households or by several households[27]. According to expert estimates, about 0,9 billion m^3 (or 20% of the overall amount) of municipal wastewater are accumulated annually in septic tanks and pit latrines, that are outside governmental control and regulation.

Table 2.7 Share and number of people not connected to a public wastewater treatment plant and the distribution of different treatment methods. The share of population not connected to a public WWTP and the distribution of different treatment methods has been extracted from a diagram.[28]

Country	Present population (Mil.)	Share of population not connected to public WWTP (%)	Number of inhabitants not connected to a public WWTP[1]	% cesspools or septic tank[2]	% activated Sludge[3]	% natural Treatment[4]	%other
Czech Republic	10,2	20	2,04 Mil.	75	20	3	2
Estonia	1,3	23	300 000	10	55	30	5
Latvia	2,3	25	575 000	75	5	5	15
Lithuania	3,4	29	986 000	40	40	5	15
Poland	38,2	41	15,662 Mil.	80	15	5	-
Slovakia	5,4	45	2,43 Mil.	84	16	-	-
Ukraine	47,7	67	31,959 Mil.	70	10	10	10

1) The share of inhabitants not connected to a public WWTP has been multiplied with the total number of inhabitants in each country
2) A cesspool is an accumulation tank not a full value treatment method. Cesspools very often overflow and the method do not fulfil legal requirements on wastewater treatment.
3) Activated sludge (or biological treatment) has (when used correctly) a potential to fulfil treatment requirements. These systems are often used for agglomerations of 5-50 households or more.
4) Natural wastewater treatment systems in the CEE countries are mainly represented by constructed wetlands, sand-soil-reed beds, macrophyte filters, lagoons and wastewater irrigation systems

2.4 Conclusions

Table 2.8 is a summary of the estimated phosphate loads from laundry- and dishwashing detergents. The table also includes estimated values of to what extent phosphates in laundry and dishwashing detergents contribute to the total phosphorous load from households. Note that values on phosphorous content in laundry detergents for Czech Republic and Poland are based on maximum values due to regulations.

27 Tsvetkova, A. Korchemlyuk, M., Shchokina, V., Berezhna, Y. 2006. Co-operation for sustainable Rural Development: Drinking Water Supply, Eco-sanitation, Organic Agriculture. Funded by MATRA Program of the Dutch Ministry of Foreign Affairs.

28 Bodík, I. 2007. Current Status of Water Supply and sanitation in the GWP CEE countries. Sustainable sanitation in central and eastern Europe. Addressing the needs of small and medium-size settlements. Edited by Igor Bodík and Peter Ridderstolpe. Global Water Partnership Central and Eastern Europe.

Table 2.8 Estimations on the use of phosphorus in laundry and dishwashing detergents in private households per capita and year

Country	Laundry detergents (g P/cap, y)	Dishwashing detergents (g P/cap,y)	Total use L&D (g P/cap,y)	Excreted amounts P (g P/p,y) (from table 2.1)	Share from L&D[1, 2] (%)
Belarus	No data	No data		510	No data
Czech Republic	21,5[4]	17	28,5	530	5
Denmark	69	136	205	600	24
Estonia	129-169	0	129-169	510	19-23
Finland	31	136	167	570	21
Germany	0	213-315	213-315	570	25
Latvia	148-194	0	148-194	490	21-26
Lithuania	134-181	9	145-190	650	17-21
Norway	29[3]	73[3]	102	600	13
Poland	492[4]	9	501	600	43
Russia	No data	No data		550	No data
Slovakia	150	9	159	460	24
Sweden	97	58,2	155	570	20
Ukraine	No data	No data		530	No data

1) Note that the contribution of phosphorus from other sources are not included (eg from bath- and shower products etc). This contribution is probably negligible.
2) A background value in greywater (chapter 2) of 55 g/p,y has been included
3) These figures are probably lower today
4) Estimations are based on the maximum allowable phosphorous content in laundry detergents

Figures on phosphorus load from private households compiled in this study are to a large extent uncertain. For most countries assumptions have been made since most countries do not accumulate statistics for these substances.

According to calculations within this study, the distribution of phosphorous from detergents is highest in Poland. It is important to notice that calculations for Poland are based on the highest allowable amounts in laundry detergents. The amounts of laundry detergents used per capita and year were, according to table 2.2 also much higher than in other countries within this study. It would be a good idea to further investigate what lies behind such figures beore using them. On the other hand, Poland is a country where almost half the population, about 15,7 million people) are not connected to a public wastewater treatment plant so the contribution of phosphorous from single households ought to be high.

Germany has the second highest loads. The higher value is based on information about average phosphorous load on 12,5 % in dishwashing detergents from the Federal Environment Agency. When comparing figures for Germany with the other countries it is important to notice that for most other countries, included in this study, assumptions have been made that the content of phosphorous in dishwashing detergents is the same as in Sweden, thus 8,5 %. In Germany about 95 % of the population is connected to a public sewer system. That makes about 3,75 Million people dependent on small scale wastewater treatment.

No figures on phosphorous loads from detergents have been found for Belarus, Russia and Ukraine. It is likely that the load from these countries is high. Some indications for Russia can be given by figures on phosphorous in laundry detergents exported from Russia to Estonia, Latvia and Lithuania, see chapter 3.2.2. In Ukraine almost 70 % of the population is not connected to a public wastewater treatment plant. For Belarus and Russia no corresponding figures have been found but there are

reasons to believe that both these countries have a high amount of inhabitants not connected to a public wastewater treatment plant.

3 Proposed further activities

In this study no consideration has been taken to the real emissions from single households outside the municipal jurisdiction since it only includes phosphorous outlets when the emission arise. Hence, we do not know how much of the per capita emission, investigated in this study, that reach a recipient within the watershed of the Baltic Sea. To generate such knowledge, it is important to make investigations of how the distribution of people with on-site treatment looks like within the Baltic Sea watershed, since estimations on the contribution of phosphorous to the Baltic Sea from each country are very much dependent on where the population is located.

The discharges of phosphorous to the Baltic Sea are dependent on a number of factors:

- Treatment facility standard
- Where the population is located
- Distance to nearest watercourse
- Type of soil and its thickness
- Etc.

All these factors are important to further investigate to be able to say anything about the amounts of phosphorous from single households that reaches the Baltic Sea.