Emissions from Baltic Sea shipping in 2012

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Key message

1. Total emissions from all vessels in the Baltic Sea in 2012 were 370 kt of NO_x, 84 kt of SO_x, 23 kt of PM, 34 kt of CO and 19.0 Mt of CO_2. **The emissions of all pollutants have decreased when compared to year 2011**.
2. Emissions, ship numbers and fuel consumption from IMO registered, large vessels showed a decrease with respect to 2011. (NO_x: 302 kt, -5.7 %, SO_x: 75 kt -5.5%, $PM_{2.5}$: 20kt, - 5.3%, CO: 24 kt, -2.7%, CO_2: 14.9 Mt, -5.5 %, fuel consumption: 4 800 kt, -5.5 %). Total number of IMO-registered ships was 8231 (-2.1%).
3. Activities from non-IMO registered traffic (presumably small boats) increased significantly with respect to 2011. The number of small boats was 8566, increase of 25.3% from 2011. Thus, **small vessels constitute more than half (51.0%) of the number of AIS transceivers in the Baltic Sea area**. The amount of small vessels, and their contribution to emissions, has been steadily increasing from 2006. In 2012, the overall contributions of small vessels to emissions are as follows NO_x: 18.3 %, SO_x: 9.9 %, CO: 27.6 %, CO_2: 21.5 %. The addition of AIS transceivers to small boats will increase the fraction of pleasure craft traffic included in emission calculations. The annual increase of small vessels included in AIS data will inevitably also increase the total emissions from the Baltic Sea shipping.
4. **Overall transport work (DWT*km) has increased by +3.5% while the number of vessels decreased at the same time**. Especially the containership segment continued to show a strong increase in transport work (+5.8 %, -7.7% in vessel numbers). Also tankers increased their transport work (+4.4 %, -3.1% vessels) while passenger ships showed a decrease of -3.8% in transport work and the fleet size decreased by 8.2%.

Results and assessment

The emissions of Particulate Matter and sulphur from Baltic Sea shipping have decreased steadily from 2010 because of the tightening SOx emission regulations of the MARPOL Convention in the Baltic Sea SECA area and EU sulphur directive requirements, which limit the fuel sulphur to 1.0% during voyages and to 0.1% during harbor stays, respectively. The development of the emissions from the Baltic Sea shipping during 2006-2012 is illustrated in Figure 1 and the geographical distribution of CO_2 emissions in 2012 is illustrated in Figure 2. Traffic separation to East-West and North-South lanes can be clearly seen in the heavily trafficked areas, like the Gulf of Finland, the Gotland Basins and the Southern Baltic Proper.

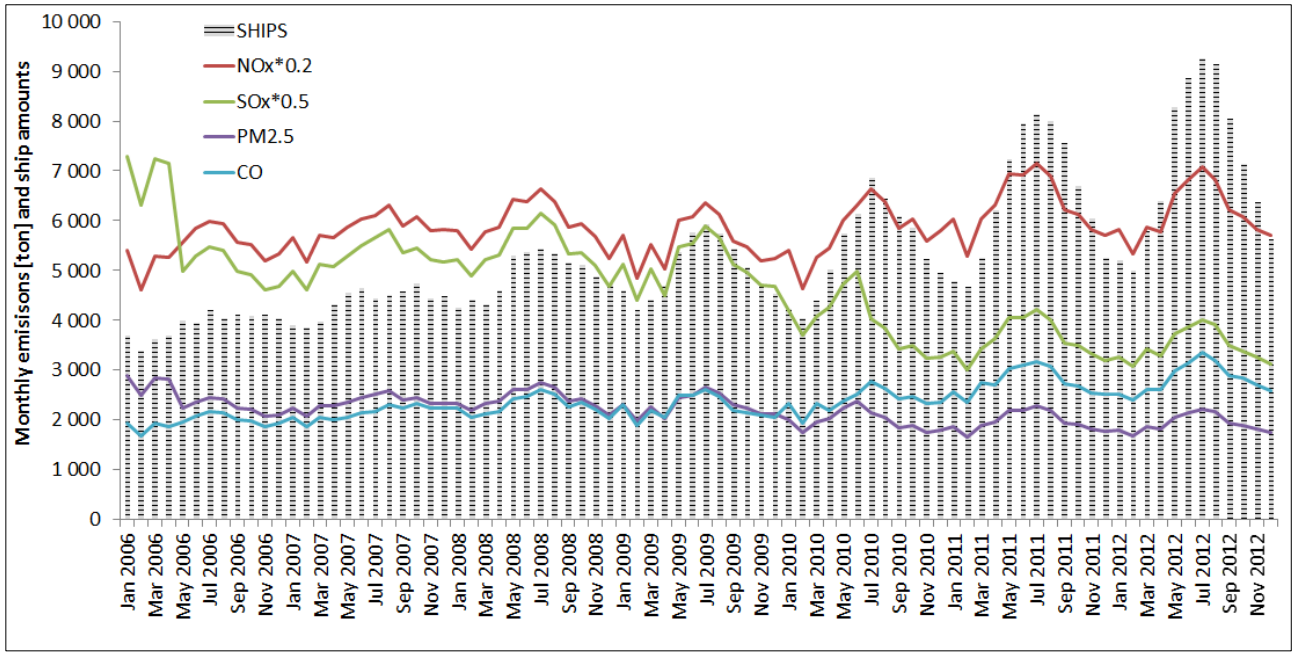

Figure 1. Evolution of monthly shipping emissions and the number of ships (all vessels with an AIS-transceiver).

Figure 2. Geographical distribution of CO_2 emissions from Baltic Sea shipping in 2012. The color scale describes the amount of CO_2 emitted in each map cell of 1.24 km^2.

A significant increase in the number of small vessels (2011: 6839; 2012: 8566, +25%) was observed. However, the contribution of small vessels to SO_x and PM are small, 10-14% but almost 30 % of the total

CO emitted comes from small boats. The number of vessels with an IMO number has decreased by 2% between 2011 and 2012. The summary of results is collected to Table 1. The increase of PM contribution from small vessels is significant (+20 %), whereas the PM emissions from large ships have decreased by -5.3%. The overall net effect during 2012 is negative and total PM emissions have decreased by -2.3 %.

Table 1. Summary of key results from Baltic Sea shipping in 2012

		NOx [t]	SOx [t]	PM2.5 [t]	CO [t]	CO2 [t]	Transport work 10^6 ton*km	Ships
2012	**All ships**	369 600	83 700	23 100	33 800	19 012 800	899 900	16 797
	IMO-registered	301 900	75 400	19 800	24 400	14 921 500	899 900	8 231
	non-IMO-registered	67 600	8 200	3 300	9 400	4 091 200	0	8 566
2011	**All ships**	377 000	86 500	23 700	33 200	19 239 700	869 800	15 247
	IMO-registered	320 100	79 800	20 900	25 100	15 796 700	869 800	8 408
	non-IMO-registered	56 900	6 700	2 700	8 100	3 443 000	0	6 839
2010	**All ships**	346 500	92 600	23 500	28 700	17 458 700	813 000	12 596
	IMO-registered	302 900	87 500	21 400	22 400	14 824 700	813 000	7 694
	non-IMO-registered	43 500	5 000	2 000	6 200	2 634 000	0	4 902
2009	**All ships**	336 000	122 300	27 500	27 000	16 684 600	773 300	11 661
	IMO-registered	298 500	109 600	24 400	21 500	14 437 300	773 300	7 768
	non-IMO-registered	37 500	12 600	3 000	5 400	2 247 300	0	3 893
2008	**All ships**	357 600	129 900	29 100	27 500	17 462 500	802 100	11 359
	IMO-registered	327 500	119 800	26 700	23 000	15 663 200	802 100	8 216
	non-IMO-registered	30 100	10 100	2 400	4 400	1 799 200	0	3 143
2007	**All ships**	350 800	126 700	28 300	25 700	16 850 900	807 500	10 041
	IMO-registered	327 500	118 900	26 400	22 300	15 462 900	807 500	7 984
	non-IMO-registered	23 300	7 700	1 800	3 400	1 388 000	0	2 057
2006	**All ships**	327 000	136 800	29 100	23 500	15 779 400	757 800	9 077
	IMO-registered	308 700	130 800	27 700	20 900	14 698 000	757 800	7 630
	non-IMO-registered	18 200	6 000	1 400	2 500	1 081 400	0	1 447

[‡] *Transport work of vessels (DWT*km) with an IMO number. Small vessels are not included. The transport work estimate is based on the methodology described in the second IMO GHG study (IMO, 2009).*

The number of small vessels has increased strongly during the study period. In 2006, about 15% of the AIS transmitters were installed in vessels which did not have an IMO number. Today, the share of small vessels is more than 50% and it is expected to increase further. This emphasizes the need to differentiate the emissions contribution of small vessels from that of the large ships. It is probable that analysis of emission results of large vessels better reflect the economic development of the region as well as the impact of policy changes regarding marine fuel oil quality.

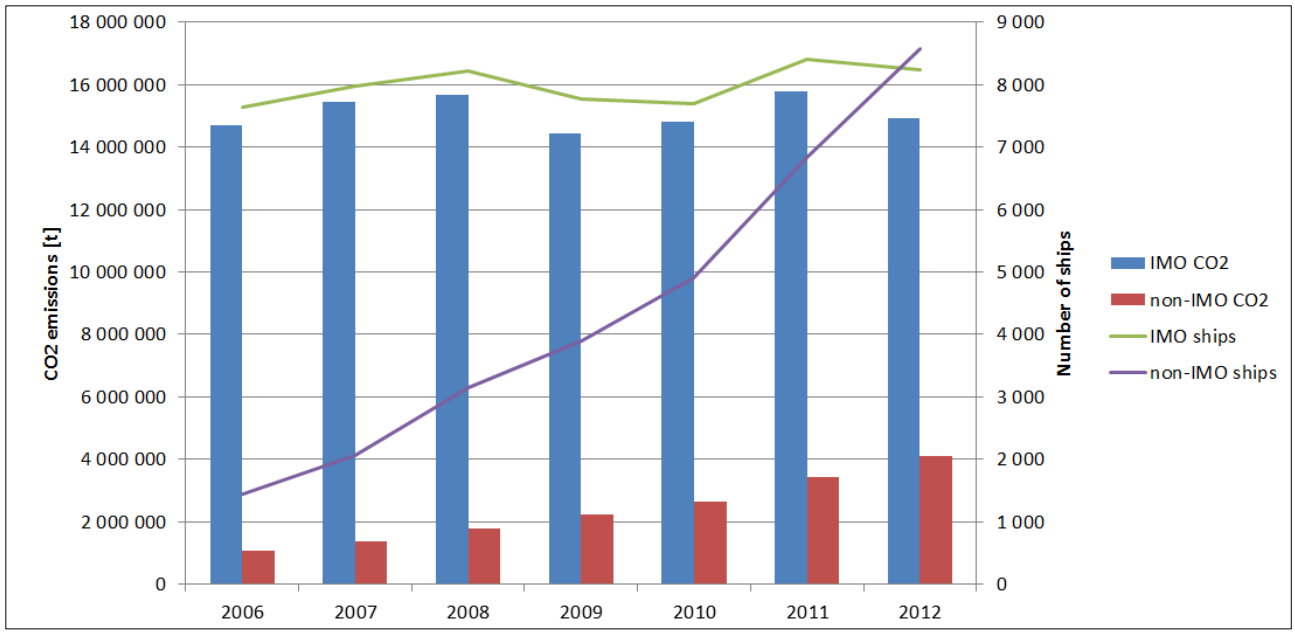

Figure 3. Contribution of small and large vessels to CO_2 emissions and to total number of ships during 2006-2012.

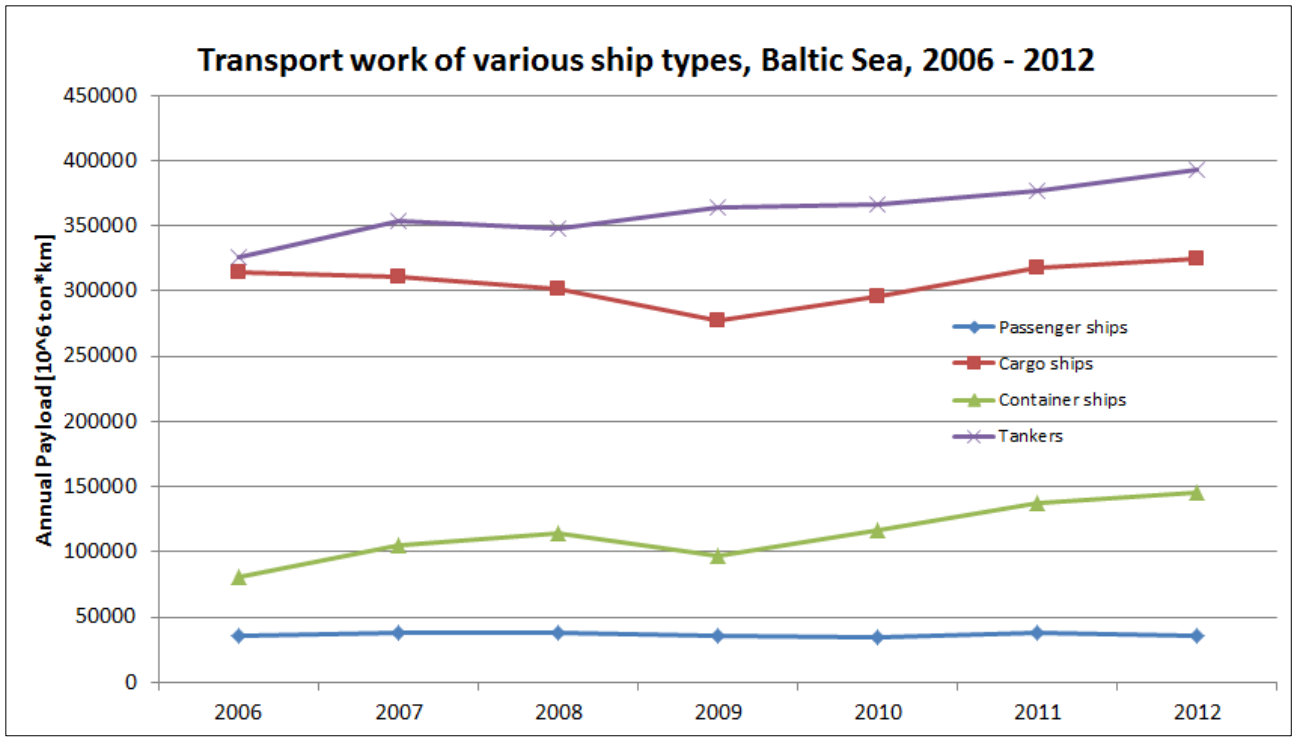

Figure 4. Transport work (ton km) of various types of vessels. The transport work methodology is described in detail in the second IMO GHG study (IMO, 2009). Contribution of small vessels is excluded from this figure.

A strong increase in the containership cargo transport work (+5.8%), to over 145 000 million ton km in 2012 was observed. The different cargo segments have surpassed the transport volumes they had before the recession. The decrease of cargo transport work seems to have been only temporary and is on increase again, but passenger traffic has not yet fully recovered from the recession.

Table 2. Modelled shipping statistics from 2012 AIS-data.

Baltic - 2012		NO_x [t]	SO_x [t]	$PM_{2.5}$ [t]	CO [t]	CO_2 [t]	Transport work [10^6 ton*km]	Ships
All		369 623	83 703	23 159	33 867	19 012 801	899 997	16 797
	IMO registered	301 931	75 429	19 824	24 443	14 921 517	899 997	8 231
	vessels without IMO	67 692	8 273	3 335	9 423	4 091 285	0	8 566
Top flags	**Sweden**	56 433	13 221	3 837	6 129	3 407 834	38 113	2 956
	Finland	35 580	9 109	2 470	3 571	1 979 540	48 042	778
	Denmark	32 575	6 100	1 914	4 039	1 850 202	32 201	1 381
	Germany	23 229	5 094	1 438	2 414	1 231 987	26 424	2 219
	Netherlands	18 701	4 636	1 241	1 682	976 872	51 029	1 032
	Malta	17 798	4 030	1 067	1 338	814 943	66 369	521
	Liberia	19 378	4 176	1 096	1 357	798 789	102 645	621
	Antigua_and_Barbuda	15 530	3 829	1 019	1 349	784 857	45 314	601
	Cyprus	16 295	3 880	1 025	1 321	782 613	53 753	327
	Bahamas	14 637	3 472	890	949	644 945	31 007	336
	Russia	9 774	1 414	506	1 016	541 670	9 979	752
	United_Kingdom	10 693	2 525	664	865	500 148	38 785	436
	Norway	9 962	2 371	622	762	469 070	29 646	518
	Gibraltar	8 830	1 950	525	708	406 228	25 967	189
	Greece	8 543	1 879	471	587	310 310	70 253	143
	Marshall_Islands	7 035	1 515	400	504	291 786	44 739	328
	Italy	4 832	1 326	330	319	231 346	12 800	103
	Hong_Kong	4 330	952	251	309	182 333	25 477	246
	Saint_Vincent	2 171	372	116	163	115 253	3 601	107
	Samoa	1 952	409	107	115	79 900	8 257	74
Ship types	**Passenger ships**	81 370	26 018	6 468	6 957	4 562 292	36 002	462
	Cargo ships	86 565	21 178	5 591	6 794	4 267 080	325 079	3 862
	Container ships	51 556	11 552	3 106	4 205	2 355 978	145 666	957
	Tankers	64 394	14 564	3 771	4 748	2 697 836	393 249	1 779
	Other	18 047	2 118	889	1 738	1 038 330	0	1 171

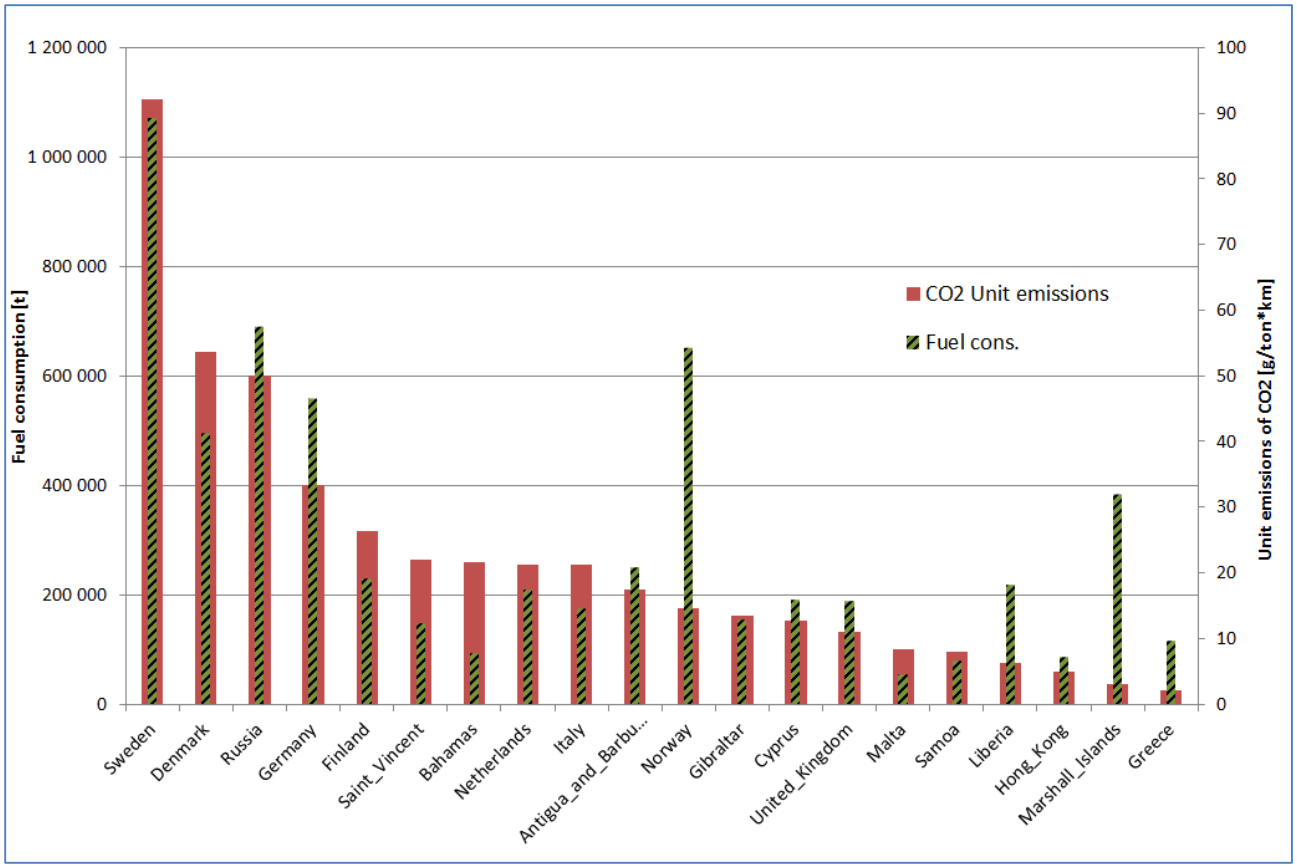

Figure 5. Unit emissions of CO_2 (in g/(ton km) and total fuel consumption according to flag state in 2012. The transport work has been calculated as described in the second IMO GHG study (IMO, 2009).

Unit emissions and total fuel consumption were calculated for each flag state. Cargo oriented fleets have low unit emissions, contrary to the passenger vessels. It should be noted, that passenger carrying capacity has no effect on the unit emission calculation, because only DWT of vessels is considered. The net weight of the cargo transport onboard was evaluated with a method described in the second IMO GHG study (IMO, 2009).

References

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Data

The emission estimates for the year 2012 are based on over 320 million AIS-messages sent by 16 798 different ships, of which 8863 had an IMO registry number indicating commercial marine traffic. The AIS position reports were received by terrestrial base stations in the Baltic Sea states and collected to regional HELCOM AIS data server. The HELCOM server contains position updates for each vessel every 5-6 minutes. Emissions are generated using the Ship Traffic Emission Assessment Model (STEAM) of Jalkanen et al. (2009, 2012). Temporal coverage of the data was better than previously in 2010 and 2011; AIS signals were received 99.4 % of the time, without any significant data gaps. In the limited number of cases with missing data, routes of each vessel were interpolated between two known locations.

Metadata

Fuel and vessel operational procedures can have a large impact on exhaust emissions. Emission factors for ships are in accordance with the latest literature and are believed to represent a reasonable estimate of the resulting emissions. Marine currents and sea ice can have a significant impact on emissions, but both of these effects have been neglected. Some uncertainty in predicted emissions arises from the large number of small vessels for which technical details are unavailable.

Definitions of fuel types for different types and ages of engines were updated and use of shaft generators have been included. The transport work calculation has been made compatible with the second IMO GHG study, which has changed also the unit emission calculations. For these reasons, this indicator fact sheet contains the complete data series from 2006-2012, which facilitate identification of long-term trends of ship emissions. The changes of emissions and transport work between different years thus reflect the variations of policy and shipping activity and are not impacted by the changes made to the emission model software itself. Relatively large data gaps in 2010 AIS data (92 % of total number of hours had data) have an impact on the 2010 emissions and affect also 2011-2010 emission changes. In cases of incomplete temporal coverage of AIS data, the values given in this Indicator Fact Sheet have been scaled to reach 100% coverage.

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