SECA works
– for people's health, the environment, and pockets

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Air pollution is hard to avoid – the microscopic pollutants don't discriminate against anyone based on gender, age, income, or education. Once inhaled, they penetrate deep into the respiratory and circulatory system, damaging lungs, heart, and brain. Like smoking tobacco, the more one's exposed, the more negative consequences they're likely to face afterwards. However, smoking is a personal choice, while air pollution is a public matter.

Air pollution from cars and factories has been regulated in much of the world since the 1970s. High-sulphur residual fuel, known as bunker fuel, is commonly used globally in ships, despite containing 3,500 times more sulphur than car diesel. Burning bunker leads to significant emissions of smog-inducing nitrogen oxides (NO_X), health-damaging fine particles, and sulphur oxides (SO_X).

The International Maritime Organization (IMO) has recognised the issue of air pollution through the MARPOL Annex VI, first adopted in 1997, to limit the main air pollutants contained in ships exhaust gas, including SO_X and NO_X, and to prohibit deliberate emissions of ozone-depleting substances. MARPOL Annex VI also regulates shipboard incineration and the emissions of volatile organic compounds (VOC) from tankers.

With the aim to strengthen the emission limits in the light of technological improvements and implementation experience, MARPOL Annex VI was revised between 2005-2008 and entered into force in July 2010. The main changes to MARPOL Annex VI correlate with the progressive reduction globally in emissions of SO_X, NO_X, and particulate matter (PM), and the introduction of emission control areas (ECAs) to reduce emissions of these air pollutants further in designated sea areas.

Lowering the emissions: mission complete

The three-year-long project Environmental Impact of Low Emission Shipping: Measurements and Modelling Strategies (EnviSuM), co-financed by the Interreg Baltic Sea Region programme, analysed the impact the enforcement of the 0.1% Sulphur Emission Control Area (SECA) has had since it covered the Baltic Sea region (BSR) on 1 January 2015. The goal of this limit was to cut 90% of sulphur emissions from ship operations in the Baltic Sea, as the previous limit, enforced five years earlier, restricted the sulphur content in fuels to 1.0%.

The project revealed a significant decrease of SO_X from shipping emissions (-88%). Before SECA, the share of ship-caused sulphur emissions was higher than 10% in many coastal regions. Already in 2016, the share of shipping in sulphur emissions has gone down to insignificant levels. The stricter regulations resulted in marked reductions of the contribution to air pollution from shipping in the Baltic Sea. SECA has had an impact on the emission mixture composition; for instance, the fine particles associated with sulphur have also decreased (Fig. 1).

Less exposure to pollution

In terms of health, the most harmful part of the air pollution mixture is the concentration of fine particles (up to 30 times smaller than the width of a human hair; these particles, known as PM2.5, have a diameter of fewer than 2.5 micrometres, μg). Following SECA, there was a decrease of ship-related PM2.5 population exposure, on average, by about 35% in the countries bordering the Baltic Sea (Fig. 2).

However, the impact of air pollution differs across the BSR. The population exposure in a country depends both on the size of its population and air pollution levels. The mean exposure per person from Baltic shipping is highest in Denmark (about 0.5 μg/m^3 PM2.5), followed by Sweden, Estonia, Finland, Latvia, and Lithuania, while the total population exposure (in μg/m^3 x persons) is highest in Germany and Poland due to their large populations.

Many studies have examined the relation ("exposure-response functions") between air pollution levels and the risk of premature death, e.g., how much mortality increases due to a particular increase in PM2.5 levels. There is, however, still some uncertainty surrounding the relation between PM2.5 and premature death. EnviSuM, therefore, used two alternative exposure-response functions from literature. In both cases, the average reduction was 37%, comparing data from 2014 and 2016.

In addition to premature mortality, air pollution also increases the risk of certain diseases. The most established causal relations are for ischaemic heart disease (IHD; mainly myocardial infarction) and stroke. The decrease of PM2.5 from Baltic shipping prevented some 1,000 non-fatal disease cases (IHD and stroke) – a reduction by roughly one-third between 2014 and 2016.

For estimates regarding morbidity, the relative risk was 1.026 (95% CI 1.00 – 1.06) per μg/m^3 of annual mean PM2.5 for IHD and 1.038 (95% CI 0.98 – 1.12) for stroke. To avoid double counting with mortality estimates, we subtracted the numbers of deaths due to IHD and stroke from the incidence, using data from the Institute for Health Metrics and Evaluation's Global Burden of Disease project and assuming that half the deaths were from new (incident) cases of IHD/stroke.

The number of extra cases of morbidity in IHD and stroke due to PM2.5 emissions from Baltic shipping is highest in Germany and Poland, mainly due to large exposed populations (Tab. 1). They are also relatively high in Denmark and Sweden due to higher exposures of PM2.5 from shipping, and in Russia, again due to population size.

Save lives, save money

In EnviSuM, we also analysed the monetary impact of the decrease in mortality resulted by SECA. It was estimated for the period 2014-2016, based on two approaches

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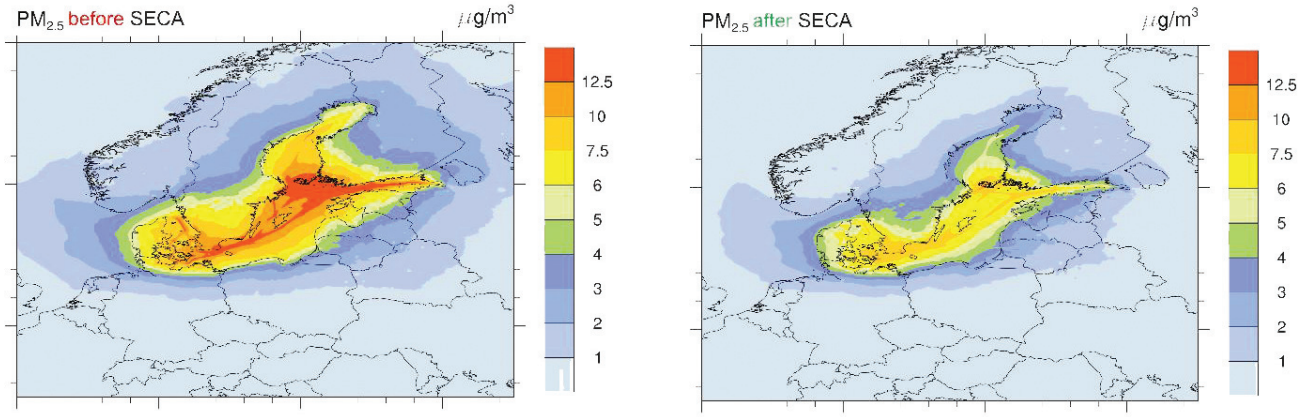
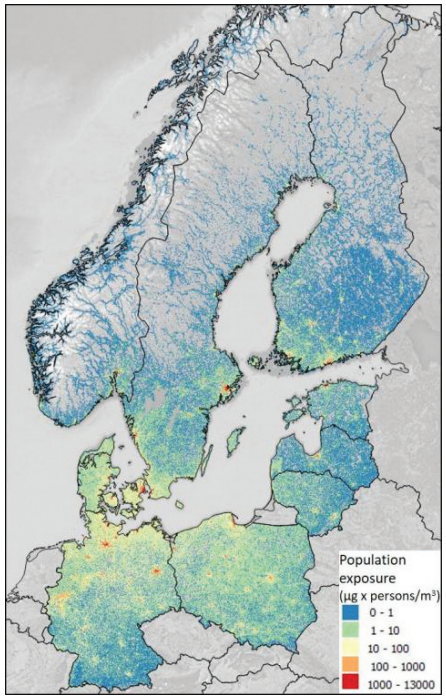
Fig. 1. Before SECA/after SECA concentrations of PM2.5 (in µg/m³) calculated with ships emissions



Source: Effects of Strengthening the Baltic Sea ECA Regulations. Atmospheric Chemistry and Physics (Jonson et al. 2019)

Fig. 2. Estimated contribution of shipping emissions in the Baltic Sea to population exposure of PM2.5 in 2016 in each square of 0.1o × 0.1o (about 10 × 10 km)[1]



[1] *µg/m³ PM2.5 × number of persons*
Source: Impact on Population Health of Baltic Shipping Emissions (Barregard et al. 2019)

Tab. 1. Estimated number of premature cases of ischaemic heart disease (IHD) and stroke due to PM2.5 emissions from Baltic shipping in 2014 and 2016

Country	Extra cases of IHD		Reduction [nominal]	Reduction [%]	Extra cases of stroke		Reduction [nominal]	Reduction [%]
	2014	2016			2014	2016		
Sweden	208	134	-74	-36%	180	116	-64	-36%
Norway	13	8	-5	-38%	18	11	-7	-39%
Denmark	210	158	-52	-25%	169	127	-42	-25%
Finland	93	50	-43	-46%	100	53	-47	-47%
Germany	521	379	-142	-27%	465	338	-127	-27%
Poland	231	155	-76	-33%	254	170	-84	-33%
Estonia	34	19	-15	-44%	36	20	-16	-44%
Latvia	28	17	-11	-39%	47	28	-19	-40%
Lithuania	44	29	-15	-34%	58	37	-21	-36%
Russia	166	91	-75	-45%	228	125	-103	-45%
Total	**1,548**	**1,040**	**-508**	**-33%**	**1,555**	**1,025**	**-530**	**-34%**

Source: Barregard et al. 2019

to value such a decrease in terms of years of life lost. Although valuing human life is controversial, the total value of health benefits due to SECA amount to at least €670m/year, according to our calculations (more information on the methodology we used can be found in the EnviSuM final report).

The changes in mortality levels observed were significant even in the cities that already had good air quality and that already had regulations in place to limit sulphur emissions; the 0.1% sulphur limit has already been in place in port areas before our health analysis started. The stricter regulation has lessened sulphur deposition, reducing shipping's contribution to environmental degradation such as acidification and eutrophication of the Baltic Sea. A clean environment is essential to human health; thus, environmental benefits are, to some extent, connected to health benefits. In addition, SECA induced innovation across the BSR and improved the reputation of the regional shipping sector, now globally recognized as the front-runner of clean shipping. The innovation inducement will probably be higher when the markets grow because of the 0.5% global cap, due to enter into force on 1 January 2020, or other regional regulation.

To be continued

The EnviSuM project successfully assessed the costs and benefits of making the Baltic a SECA (as well as the ship owners' and operators' compliance with the new rules). The results were compiled in the final report *Clean Shipping: Exploring the impact of emission regulation*, which is freely available online. Although the project came to its conclusion, the works will continue under the Clean Shipping Platform (CSHIPP), also co-financed by Interreg Baltic Sea Region. By focusing on collaboration, CSHIPP strives to connect the dots between the various clean shipping-related initiatives – and do it from different angles. In total, seven projects (nviSuM, Sheba, Baltic Lines, GoLNG, BSR Electric, Smartup Accelerator, and Ecoprodigi) have partnered to enhance and promote clean shipping in the BSR and, hopefully, also beyond. ■

Interreg Baltic Sea Region EnviSuM — EUROPEAN REGIONAL DEVELOPMENT FUND — EUROPEAN UNION

The EnviSuM project was launched in 2016 to assess the present and future costs as well as the health and environmental effects of introducing stricter ship emission regulations, specifically the 0.1% Sulphur Emission Control Area the Baltic Sea region became in 2015. For more info about the initiative, its findings (incl. the final report), and partners, please visit https://blogit.utu.fi/envisum