TRAFICOM report on HELCOM BSAP Action S16

Estimate and evaluation of the volumes and impact of discharges of residues of MARPOL Convention Annex II noxious liquid substances contained in cargo tank washing waters into the Baltic Sea from Finnish ports in 2023

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Abstract Helsinki Commission (HELCOM) has a strategic programme, The Baltic Sea Action Plan (BSAP), to improve the environmental status and the healthiness of the Baltic Sea. This study is carried out as a part of the action S16 in the BSAP, to evaluate the volumes and impact of noxious liquid substances, as defined in MARPOL Annex II, released into the sea from tank washing. The study focuses on cargos imported to Finnish ports in 2023 and provides an example on how such an evaluation can be made with relatively low effort. Once carried out in other HELCOM Member States, too, the results can be used to assess whether and what actions are needed to reduce the noxious liquid substance discharges to the Baltic Sea from tank washing waters. The volumes of discharges of residues were evaluated using data obtained from the MARPOL inspections and from the ports. The volume of the discharged residue is highly dependent on the onshore tank washing requirements, as the washing significantly reduces the residues ending up into the sea. Harmfulness of eight selected focus chemicals was assessed using GESAMP/EHS hazard profiles. Focus chemicals were selected based on their large import volumes or high hazard ratings. Styrene monomer and pyrolysis gasoline containing benzene were assessed to be the most harmful of the focus chemicals. Most of the noxious liquid substances imported to Finnish ports do not present a major hazard to the marine environment or human health.
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Tiivistelmä Itämeren merellisen ympäristön suojelukomission (HELCOM) toimenpideohjelman (Baltic Sea Action Plan, BSAP) tavoitteena on parantaa Itämeren tilaa. Tämä selvitys on osa kyseisen ohjelman toimenpidettä S16, jossa arvioidaan MARPOL-yleissopimuksen liitteen II mukaisten haitallisten nestemäisten aineiden kuljetuksesta tankkien pesusta mereen päätyvien kemikaalien määriä ja vaikutuksia. Työssä toteutettiin selvitys Suomen satamiin vuonna 2023 tuotujen lastien mereen päätyvistä jäämistä. Selvitys toimii esimerkkinä siitä, kuinka tällainen arviointi voidaan toteuttaa suhteellisen vaivattomasti. Kun samankaltainen selvitys tehdään muissakin HELCOM-jäsenvaltioissa, voidaan tulosten perusteella arvioida, tarvitaanko lisätoimia haitallisten nestemäisten aineiden säiliöpesuvesien kautta mereen päätyvien päästöjen vähentämiseksi, sekä millaisia toimenpiteitä olisi tarpeen ottaa käyttöön. Mereen päätyvien kemikaalijäämien arvioimiseen käytettiin MARPOL-tarkastuslomakkeista sekä satamista saatuja tietoja. Mereen päätyvien jäämien määrä riippuu merkittävästi säiliöalustankkien pesuvaatimuksista, sillä tankkien pesu satamassa ja pesuvesien ohjaaminen käsittelyyn maissa vähentää huomattavasti mereen päätyvää jäämää. Kahdeksan valitun fokuskemikaalin haitallisuutta arvioitiin niiden GESAMP/EHS haitallisuusprofiilien avulla. Fokuskemikaalien valintaperusteina käytettiin suurta tuotua määrää tai korkeita haitallisuusluokituksia. Styreenimonomeeri ja bentseeniä sisältävä pyrolyysibensiini arvioitiin fokuskemikaaleista kaikkein haitallisimmiksi. Suurin osa Suomeen tuoduista säiliöaluskemikaaleista ei aiheuta merkittävää vaaraa meriympäristölle tai ihmisen terveydelle.
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Ämnesord kemikalie, tankfartyg, marina miljön, MARPOL, HELCOM, IMO, GESAMP/EHS
Sammandrag The Baltic Sea Action Plan (BSAP) är ett strategiskt program inom kommissionen för skydd av Östersjöns marina miljö (Helsingforskommissionen HELCOM) som syftar till att återställa en god ekologisk status i Östersjön. Denna studie är en del av BSAP:s åtgärd S16, och bedömer mängder och effekter av kemikalier som kommer ut i havet från tanktvätt på kemikalietankfartyg under transport av skadliga flytande ämnen enligt bilaga II till MARPOL-konventionen. Studien fokuserar på lastrester till havet från fartyg med last till finska hamnar under 2023 och fungerar som ett exempel på hur en sådan bedömning kan genomföras relativt enkelt. När en liknande studie genomförs i andra HELCOM-medlemsstater kan resultaten användas för att bedöma om ytterligare åtgärder behövs för att minska utsläppen av skadliga flytande ämnen till Östersjön från tanktvättvatten, samt vilka åtgärder som skulle vara nödvändiga att införa. För att bedöma volymen kemikalierester som hamnar i havet användes uppgifter från MARPOL-inspektionerna samt data från hamnar. Mängden rester som släpps ut i havet beror i hög grad på kraven för tankrengöring på land, eftersom rengöringen i hamn avsevärt minskar mängden rester som hamnar i havet. Den skadliga påverkan bedömdes utifrån GESAMP/EHS-riskprofiler för åtta utvalda fokuskemikalier. Urvalskriterierna för fokuskemikalierna var antingen stora importerade volymer eller höga riskklassificeringar. Styrenmonomer och pyrolysbensin innehållande bensen bedömdes vara de mest skadliga av fokuskemikalierna. De flesta kemikalier som importeras till till finska hamnar med tankfartyg utgör ingen betydande risk för havsmiljön eller människors hälsa.
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Foreword

The Baltic Sea is a particularly sensitive sea area, as it is shallow compared to other sea areas in the world. In addition, the salinity of the Baltic Sea is low (brackish), and the biodiversity of the biota is low. The Baltic Marine Environment Protection Commission, or the Helsinki Commission (HELCOM), can effectively impact the ecological state of the sea with its action programs and strive to improve it, for example by setting limits to nitrogen and phosphorus loading, causing eutrophication, from the coastal states of the Baltic Sea. Despite the recent changes in the geopolitical status of the Baltic Sea region, restricting the activities of HELCOM, the targeted work to improve the state of the Baltic Sea marine environment continues and progresses.

From the maritime point of view, Finland is an "island". Finnish import and export are based on maritime transport. Finnish industry uses several liquid substances. Chemical tanker transports from other ports in the Baltic Sea, Europe and other countries in the world are a cost-effective way to maintain the competitiveness of Finnish industry. When noxious (harmful to marine environment) and dangerous (harmful to human health) liquid chemicals needed by the industry are unloaded in Finnish ports, safety and a high level of protection of the marine environment must be ensured.

It is unequivocally justified to prohibit the entry into the marine environment of liquid substances from chemical tankers whose emptying into the sea due to tank cleaning or ballast reduction measures would cause a great harm to the marine environment or a great danger to human health. There is also entitlement to limit, both qualitatively and quantitatively, the entry into marine environment of liquid substances that would harm the marine environment or endanger human health or would compromise recreational or other legal uses of the sea. The international MARPOL convention imposes the required mandatory measures aimed at ensuring a high level of protection of the marine environment. In addition, the matter is nationally regulated by the Act on Environmental Protection in Maritime Transport (1672/2009).

From 2022, the joint Chemical Tanker project of the John Nurminen Foundation and Traficom has aimed to reduce the emissions of harmful substances into the Baltic Sea caused by tank cleaning of chemical tankers in Finland with practical measures. In cooperation with Finnish chemical industry companies, ports and shipping companies, feasible solutions to reduce emissions through voluntary actions have been sought and found. In spring 2023, the project extended to Sweden to cooperate with the environmental organization Coalition Clean Baltic and the competent authority, Transportstyrelsen.

The Chemical Tanker project has been successful. Consequently, the aim has been to spread the key results and goals of the project among the Baltic Sea states by organising workshops and especially by implementing the already agreed upon HELCOM action plan, Action S16. Finland and Sweden are, together, to lead the Action S16, and they aim to promote the environmental state of the Baltic Sea by first recording and monitoring chemical tanker discharges, and then by sharing established good practices and once agreed upon, concrete measures. Such measures are to be agreed upon by the states surrounding the Baltic Sea by 2028, first as HELCOM recommendations. The measures could then serve as a basis for targeted changes in international and national regulations, including the MARPOL convention and the Act on Environmental Protection in Maritime Transport.

The first steps of the Action plan consist of the first-of-its-kind survey published here. Finland is the first HELCOM country to produce such a report. It is intended to serve as an example and potential template for other HELCOM states. The implementation of Finland's HELCOM action plan, Action S16 was carried out by Wega Group Oy specialists Jenni Ikonen, Susanna Hietanen and Eija Kanto and Traficom monitoring team members Juuso Halin, Mirja Ikonen, Ville-Veikko Intovuori and Jyrki Vähätalo.

Traficom thanks all the maritime experts who participated in the study and its background work for their work to promote the protection of the Baltic Sea.

Klaukkala, February 11th 2025

Jyrki Vähätalo

Special advisor

Finnish Transport and Communications Agency Traficom

Alkusanat

Itämeremme on erityisen herkkä merialue, sillä se on syvyydeltään matala verrattuna muihin maailman merialueisiin. Lisäksi Itämeren suolapitoisuus on vähäinen (murtovesialue) ja merialueen lajisto suhteellisen niukkaa. Itämeren merellisen ympäristön suojelukomissio eli Helsingin komissio (HELCOM) pystyy tehokkaasti toimintaohjelmillaan puuttumaan meren ekologisen tilaan ja pyrkiä sen parantamiseen; yhtenä esimerkkinä asettamalla enimmäismäärät Itämeren rantavaltioille rehevöitymistä aiheuttavan typpi- ja fosforikuormituksen vähentämiseksi. Vaikka alueen geopoliittinen status on merkittävästi muuttunut viime vuosina aiheuttaen rajoitteita myös HELCOM:in toimintaan, niin siitä huolimatta tavoitteellinen työ Itämeren meriympäristön tilan parantamiseksi jatkuu ja etenee.

Suomi on merenkulun näkökulmasta "saari". Maamme tuonti ja vienti perustuu meriliikenteeseen. Suomen teollisuus tarvitsee säännöllisesti erilaisia nestemäisiä aineita. Kemikaalisäiliöaluskuljetukset muista Itämeren, Euroopan ja maailman maiden satamista ovat osaltaan yksi kustannustehokas väylä maamme teollisuuden kilpailukyvyn ylläpitämiseksi. Kun maamme teollisuuden tarvitsemia haitallisia (meriympäristö) ja vaarallisia (terveys) nestemäisiä kemikaaleja puretaan Suomen satamissa, niin samalla tulee varmistaa turvallisuus ja meriympäristön suojelun korkea taso.

Sellaisten kemikaalisäilöalusten nestemäisten aineiden pääsy meriympäristöön, joiden tyhjentäminen mereen tankin puhdistus- tai painolastin vähentämistoimenpiteiden takia, aiheuttaisi suuren haitan meriympäristölle tai suuren vaaran ihmisen terveydelle, on yksiselitteisesti oikeutettu kiellettyksi. Edelleen sellaisten kemikaalisäilöalusten nestemäisten aineiden, joiden pääsy meriympäristöön aiheuttaisi haitan meriympäristölle tai vaaran ihmisen terveydelle tai aiheuttaisi haittaa viihtyisyydelle tai muille meren laillisille käyttömuodoille, on oikeutettu rajoitetuksi sekä laadullisesti että määrällisesti. Kansainvälinen MARPOL-yleissopimus määrää tarvittavat pakolliset toimenpiteet, jolla pyritään varmistamaan merellisen ympäristön suojelun korkea taso. Lisäksi kansallisesti asiasta määrätään erikseen Merenkulun ympäristösuojelulain (1672/2009) säädöksin.

Vuodesta 2022 John Nurmisen Säätiön ja Traficomin yhteisessä Kemikaalialushankkeessa on pyritty vähentämään Suomessa kemikaalisäilöalusten tankinpesusta aiheutuvia haitallisten aineiden päästöjä Itämereen käytännöllisin toimenpitein. Yhteistyöllä maamme kemianteollisuuden yritysten, satamien ja varustamoiden kanssa on etsitty ja löydetty käyttökelpoisia ratkaisuita päästöjen vähentämiseksi vapaaehtoisin toimin. Keväällä 2023 hanke eteni myös Ruotsiin yhteistyöhön Coalition Clean Baltic -ympäristöjärjestön ja naapurivaltion toimivaltaisen viranomaisen Transportstyrelsenin kanssa.

Kemikaalialushanke on onnistunut hyvin. Näin ollen hankkeen keskeisiä tuloksia ja tavoitteita Itämeren valtioiden kesken päätettiin pyrkiä laajentamaan työpajojen ja erityisesti jo sovitun HELCOM-toimenpideohjelma S16 avulla. Suomi yhdessä Ruotsin kanssa onkin vetovastuussa HELCOM-toimenpideohjelmalle S16. Suomi ja Ruotsi pyrkivät edistämään Itämeren ympäristön tilaa kemikaalisäiliöaluspäästöjen ensin tilastoinnin, seurannan ja sitten todettujen hyvien käytäntöjen jakamisen sekä myöhemmin sovittavien konkreettisten toimenpiteiden avulla; toimenpiteet on tarkoitus sopia eri Itämeren valtioiden kesken vuoteen 2028 mennessä ensin HELCOM-suosituksina. Toimenpiteet voisivat sitten jatkossa toimia pohjina kansainvälisten ja kansallisten säädösten kohdennetuille muutoksille mukaan lukien MARPOL-yleissopimus ja merenkulun ympäristösuojelulaki.

Toimenpideohjelman ensi askeleet koostuvat nyt käsillä olevista lajissaan ensimmäisestä selvityksestä. Suomi näin ensimmäisenä HELCOM-valtioina on tuottanut tällaisen selvityksen. Sen on tarkoitus toimia mahdollisena mallina muille HELCOM-valtioille. Suomen HELCOM-toimenpideohjelman S16 toteuttamiseen osallistuivat keskeisesti Wega Group Oy:n asiantuntijat Susanna Hietanen, Jenni Ikonen ja Eija Kanto sekä Traficomin seurantaryhmän jäsenet Juuso Halin, Mirja Ikonen, Ville-Veikko Intovuori ja Jyrki Vähätalo.

Traficom kiittää kaikkia suoraan selvitykseen ja sen taustatyöhön osallistuneita merenkulun osaajia työstään Itämeren suojelun edistämiseksi.

Klaukkalassa 11. helmikuuta 2025

Jyrki Vähätalo

erityisasiantuntija

Liikenne- ja viestintävirasto Traficom

Förord

Östersjön är ett särskilt känsligt havsområde, eftersom det är grunt jämfört med andra havsområden i världen. Dessutom Östersjön är ett brackvattenområde med låg salthalt, och den biologiska mångfalden är låg. Baltic Marine Environment Protection Commission, eller Helsingforskommissionen (HELCOM), kan effektivt påverka havets ekologiska tillstånd med sina åtgärdsprogram och sträva efter att förbättra det, till exempel genom att sätta gränser för kväve- och fosforbelastning, som orsakar övergödning, från kuststaterna i Östersjön. Trots att de geopolitiska förändringarna i Östersjöregionen under de senaste åren har skapat begräsningar för HELCOMs verksamhet, fortsätter och utvecklas det målmedvetna arbetet för att förbättra Östersjöns marina miljö.

Ur sjöfartsperspektiv är Finland en ”ö”, där Finlands import och export är beroende av sjötransporter. Den finländska industrin behöver regelbundet olika typer av flytande ämnen. Transporter med kemikalietankfartyg från andra länder runt Östersjön, Europa och världen utgör en kostnadseffektiv lösning för att upprätthålla konkurrenskraften inom landets industri. När skadliga (för havsmiljön) och farliga (för människors hälsa) flytande kemikalier som behövs inom industrin lossas i finska hamnar, måste samtidigt en hög nivå av säkerhet och skydd för havsmiljön säkerställas.

Det är otvetydigt motiverat att förbjuda utsläpp av flytande ämnen från kemikalietankfartyg i den marina miljön, där tömning i havet på grund av tankrengöring eller ballastreducerande åtgärder skulle medföra stor skada på havsmiljön eller utgöra en stor risk för människors hälsa. Det är också berättigat att begränsa, både kvalitativt och kvantitativt, utsläpp av flytande ämnen från kemikalietankfartyg, som skulle skada den marina miljön eller äventyra människors hälsa eller äventyra rekreation eller annan laglig användning av havet. Den internationella MARPOL-konventionen fastställer de obligatoriska åtgärder som krävs för att säkerställa en hög skyddsnivå för den marina miljön. Dessutom är frågan nationellt reglerad i Miljöskyddslagen för sjöfarten (1672/2009).

Sedan 2022 har John Nurminens Stiftelse och Traficom drivit det gemensamma kemikalietankerprojektet, som syftar till att minska utsläppen av skadliga ämnen i Östersjön från tankrengöring på kemikaliefartyg i Finland genom praktiska åtgärder. Genom samarbete med finländska företag inom kemiindustrin, hamnar och rederier har projektet identifierat fungerande lösningar för att minska utsläppen genom frivilliga åtgärder. Våren 2023 utvidgades projektet till Sverige i samarbete med miljöorganisationen Coalition Clean Baltic och den svenska transportmyndigheten Transportstyrelsen.

Kemikalietankerprojektet har varit framgångsrikt. Följaktligen har målet varit att sprida projektets centrala resultat och mål mellan Östersjöstaterna genom att anordna workshops och särskilt genom den redan överenskomna

HELCOM-åtgärden S16. Finland har, tillsammans med Sverige, huvudansvaret för genomförandet av HELCOM-åtgärden S16, och de strävar efter att förbättra miljötillståndet i Östersjön genom att först samla in statistik och övervaka utsläpp från kemikalietankfartyg, sedan genom att dela etablerad god praxis och slutligen genomföra konkreta åtgärder som ska fastställas senare. Dessa åtgärder ska överenskommas mellan de stater som omger Östersjön som HELCOM-rekommendationer senast 2028. På längre sikt kan de utgöra en grund för riktade förändringar i internationella och nationella regelverk, inklusive MARPOL-konventionen och Miljöskyddslagen för sjöfarten.

De första stegen i handlingsplanen består av den nu genomförda första utredningen i sitt slag. Finland är det första HELCOM-landet som producerar en sådan utredning, och den är avsedd att fungera som ett exempel och en möjlig modell för andra HELCOM-stater. Genomförandet av Finlands HELCOM-handlingsplan, åtgärd S16, genomfördes av experterna Jenni Ikonen, Susanna Hietanen och Eija Kanto från Wega Group Oy samt medlemmarna i Traficoms uppföljningsgrupp: Juuso Halin, Mirja Ikonen, Ville-Veikko Intovuori och Jyrki Vähätalo.

Traficom tackar alla maritima experter som direkt bidragit till studien och dess bakgrundsarbete för deras insatser för att främja skyddet av Östersjön.

Klövskog, den 11 Februari 2024

Jyrki Vähätalo

Specialsakkunnig

Transport- och kommunikationsverket Traficom

Contents

1 Introduction

1.1 Baltic Sea Action Plan encourages actions to reduce discharges of noxious liquid substances

The Baltic Sea is a brackish water body with an average depth of only about 55 meters. Due to limited water exchange with the North Sea and heavy industrial and agricultural activities in the catchment area of the sea, it suffers from significant chemical contamination, including high levels of nutrients and pollutants. Helsinki Commission (HELCOM), also known as The Baltic Marine Environment Protection Commission, has a strategic programme to improve the environmental status and the health of the Baltic Sea. This programme, The Baltic Sea Action Plan (BSAP), is divided into four segments: biodiversity, eutrophication, hazardous substances and litter and sea-based activities. Each of these segments has their own specific goals and actions plans. (HELCOM, 2021)

The action concerning this study, S16, is part of the sea-based activities segment, pollution from ships topic of the BSAP. It urges to carry out a study and impact assessment by 2026 to estimate and evaluate the volumes and impact of discharges of residues of **noxious liquid substances** (from here on, term **chemicals** will be used in this study) contained in cargo tank washing waters under the International Convention for the Prevention of Pollution from Ships (MARPOL) Convention Annex II into the Baltic Sea, and based on the results, to take relevant action by 2028 on whether and how to further limit discharges of residues of noxious liquid substances contained in cargo tank washing waters under MARPOL Annex II into the Baltic Sea (Figure 1). This study implements the first part of the action, the study of the volumes and impact of discharges of residues regarding ships unloading chemicals in Finnish ports in 2023.

Figure 1. BSAP action S16 approach to discharges of noxious liquid substant discharges to the Baltic Sea from tank washing waters.

1.2 Regulation of transportation of chemicals

International Maritime Organization (IMO) regulates transportation of chemicals in bulk by SOLAS Chapter VII, Part B (Carriage of dangerous goods) and MARPOL Annex II (Regulations for the Control of Pollution by Noxious Liquid Substance in Bulk). The SOLAS Convention determines standards for ships to ensure their safety, while MARPOL is an international convention to prevent pollution of the marine environment. Both SOLAS and MARPOL Annex II require chemical tankers constructed after 1.7.1986 to follow the standards defined in the International Bulk Chemical Code (IBC Code). The IBC Code sets international standards for the safe transportation of dangerous chemicals and noxious liquids by the sea, including the regulations regarding tank washing. Under regulations of MARPOL Annex II, chemical tankers constructed before 1 July 1986 must comply with the requirements of the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (BCH Code), the predecessor of the IBC Code. The BCH Code remains as a recommendation under the 1974 SOLAS Convention.

Chemical tankers need to wash their tanks between cargos of different types, or for example to enable maintenance works in the tanks. For most chemicals, the regulations allow discharging the cargo residues mixed with the washing water to the sea en route, provided it takes place at least 12 nautical miles from shore, the discharge outlet is below the waterline, the water depth is more than 25 metres, and the speed of the ship is at least 7 knots to ensure proper mixing of the discharge.

However, tankers carrying harmful[1] chemicals are required to wash their tanks and discharge washing waters to a reception facility at the port of unloading, instead of releasing the washing residues in the sea. Onshore tank washing significantly lowers the concentration of chemical in the strip (the residual volume of transported cargo left in tank after unloading) and hence also reduces the amount of chemicals discharged to the sea. For tankers containing chemicals which do not require onshore tank washing, the strip is 25–350 litres of the transported chemical, depending on the age of the ship. While the volume of the strip remains the same, onshore tank washing significantly dilutes the concentration of the chemical in the strip, usually to less than 1 % of the original.

Based on their impact on environment (noxious chemicals) or human health (dangerous chemicals), liquid chemicals are divided in MARPOL Annex II into different categories: X (major hazard), Y (hazard), Z (minor hazard) or OS (no harm). Annex II contains regulations for the allowed strip volumes and discharges of chemical residues, and for tank washing when carrying chemicals with X or Y MARPOL classification.

[1] The term "harmful chemicals" covers both "noxious chemicals" (having impact on environment) and "dangerous chemicals" (having impact on human health) and is used to refer to them together.

- Ships carrying chemicals of category X must always wash the tanks at the port after unloading, unless an exemption has been granted. The washing must be extensive enough to ensure that the concentration in strip after washing is at or less than 0.1 %.
- Onshore washing requirement applies to category Y chemicals only if they have high viscosity or are solidifying substances or persistent floaters. There are no requirements regarding the concentration after washing.
- Other chemicals in Y category, as well as in categories Z and OS, do not require tank washing and their residues are allowed to be discharged into the sea.

In certain cases, no washing is required despite the harmful properties of the chemical. An exemption from washing regulations can be granted, for example, as "load on top", i.e. when the tank will be reloaded with the same or compatible substance after unloading and will not be washed in between unloading and reloading, or if the residues are removed by ventilation due to the high vapour pressure of the chemical. If a tank is ventilated instead of washed, it must be done in accordance with appendix 7 of MARPOL Annex II. If the unloaded tank is not washed or ballasted at sea, it can also be washed in another port, if the availability and adequacy of the reception facility at that port has been confirmed in writing.

2 Data and calculations

This study was conducted to estimate the volume and impact of residues that potentially end up in the Baltic Sea, of noxious liquid substance cargos imported to Finnish ports in 2023. The evaluation of discharged **volume** was done by assessing the number of cargos of chemicals and the age of the transporting ships and applying strip volume and tank washing regulations of MARPOL Annex II. The **impact** of discharged chemicals was assessed for a selection of chemicals by combining the volume of discharge with the hazard profile of the chemical, determined by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection/Environmental Hazards of Harmful Substances (GESAMP/EHS).

2.1 Data from the MARPOL inspections

MARPOL regulation requires official inspections for ships unloading chemicals classified in category X. In Finland, **inspections are carried out also for ships unloading category Y chemicals,** as regulated in the national Act on Environmental Protection in Maritime Transport (1672/2009). Appointed and authorised MARPOL surveyors, meeting the legal requirements of the Government Degree on Qualification Requirements of Nominated Inspectors and Surveyors and of Nominated Admeasurers (1796/2009), record the information, including the onshore tank washing, from the operations. This study is based on the MARPOL inspection records of the unloading operations of chemicals classified in X and Y categories in MARPOL Annex II in Finnish ports in 2023.

The following information was recorded for each cargo unloaded:

- Port of unloading
- Ship name
- Unloading date and time
- MARPOL surveyor, inspection number and measurement ID
- Chemical
- MARPOL category of the chemical
- Amount of unloaded chemical, t (metric tons)
- Volume of water used for washing, m^3
- Justification for exemption from onshore tank washing requirements, if applicable

2.2 Data from the Finnish ports

The MARPOL inspections are carried out for the chemicals classified in categories X and Y, only. To complement the data, a questionnaire regarding the chemicals in categories Z and OS was sent to the eleven largest chemical ports in Finland (based on statistics from years 2021–2023, Statistics Finland). The following information regarding bulk liquid chemicals imported in 2023 were requested from the ports in the questionnaire:

- Ship name
- Chemical
- Amount of unloaded chemical, t (metric tons)

Replies were received from all ports. In addition to chemicals classified in categories X and Y, a total of 12 cargos of category Z (one chemical) or OS (three chemicals) were recorded. These categories do not require onshore tank washing.

2.3 Calculations

The residual volumes (volume of the chemical in the strip) were calculated based on the discharge regulations. For cargos that do not require onshore washing this equals original strip volume. For cargos that require onshore washing, this equals the remaining chemical volume in the diluted strip.

The strip volume was estimated based on the construction year of the ship (Table 1). The maximum strip volumes are the same for all cargos regardless of the transported chemical and whether onshore tank washing is required or not. In this study, the ships constructed after 2007 are referred as "new ships" and older as "old ships". For the old ships, the allowed strip volumes of the old ships are 0,3 m^3 and 0,1 m^3, but they are assigned a maximum tolerance of 50 l, i.e., the strip may exceed the nominal value by maximum 50 l. For the new ships, the allowed strip volume is 75 l and no tolerance has been assigned.

Table 1. Allowed strip volumes based on ship age.

Ship construction time	Before 08/1986	08/1986–12/2006	After 01/2007
Allowed strip volume (l)	300 +tolerance 50	100 +tolerance 50	75

For category X chemicals, the strip after washing must be at or less than 0.1 %. There is no such regulation concerning the category Y chemicals requiring tank washing, and the calculation of the remaining residues of these cargos was based on the volume of the water used in the washing procedure and the accepted strip volume. For the category Y chemicals not requiring onshore tank washing and the chemicals classified to categories Z and OS, the chemical residues from the tanks are equal to the strip volumes.

The volume of water used in onshore tank washing was obtained from the MARPOL inspection forms. The chemical concentration in the diluted strip was calculated from strip volume and washing water volume (Equation 1.)

$$Chemical\ concentration\ in\ the\ diluted\ strip = \frac{Strip\ volume\ (l)}{Strip\ volume(l) + Washing\ amount\ (l)}$$

Equation 1. Concentration of the chemical in the diluted strip.

The volume of chemical in the strip after washing was obtained by multiplying the chemical concentration in the diluted strip with the strip volume.

Chemical tankers usually have multiple tanks which vary in size. A given chemical cargo can be transported using one or several of tanks. The number of tanks used cannot be concluded from the volume of the unloaded chemical. The MARPOL inspection forms do not record the number of tanks used, and therefore the calculations in this study were carried out for three scenarios: assuming that each cargo was transported using only one tank, and assuming that each cargo was transported using 10 or 20 tanks. The more tanks are used in transportation of the cargo, the larger the discharged chemical residue will be.

2.4 GESAMP hazard profiling

The properties of chemicals that may enter the marine environment have been analysed by the GESAMP/EHS, an independent advisory body that advises the United Nations system on the scientific aspects of marine environmental protection. The analyses have been carried out according to the GESAMP Hazard Evaluation Procedure (2019), resulting in GESAMP hazard profiles for the chemicals (Table 2). A profile summarises the different harmful properties (see Chapters 2.4.1–2.4.5) of a chemical, allowing for a comprehensive assessment of its harmfulness rather than focusing on the hazard associated with a single characteristic, only. The impacts of chemicals in aquatic organisms have mainly been tested in either marine or freshwater conditions. The impacts may be stronger in a brackish environment where most organisms already suffer from salinity stress.

Table 2. Properties assessed in the GESAMP/EHS evaluation procedure and the scale of rating for the properties. Abbreviation NI, no information, is used in the hazard profiles if there is no sufficient data for the rating.

Group		Description	Rating
Bioaccumu-lation & Biodegrada-tion	**A1**	**Bioaccumulation**	0-5
	A1a	**The log n-octanol/water partition coefficient**	0-5
	A1b	**The measured BCF in fish, crustaceans or molluscs as test organisms**	0-5
	A2	**Biodegradation**	
	R	*Readily biodegradable (rating for A2)*	*Yes/No*
	NR	*Not readily biodegradable (rating for A2)*	*Yes/No*
Aquatic toxicity	**B1**	**Acute aquatic toxicity**	0-6
	B2	**Chronic aquatic toxicity**	0-4
Acute toxicity	**C1**	**Oral toxicity**	0-4
	C2	**Dermal toxicity (skin contact)**	0-4
	C3	**Inhalation toxicity**	0-4
Irritation, corrosion & long-term health effect	**D1**	**Skin irritation/corrosion**	0-3
	3A-C	*Corrosive categories A-C (rating for D1)*	*3A-3C*
	D2	**Eye irritation**	0-3
	D3	**Long-term health effects**	
	C	*Carcinogenicity (rating for D3)*	*Yes/No*
	M	*Mutagenicity (rating for D3)*	*Yes/No*
	R	*Reproductive toxicity (rating for D3)*	*Yes/No*
	Ss	*Skin sensitization (rating for D3)*	*Yes/No*
	Sr	*Respiratory sensitization (rating for D3)*	*Yes/No*
	A	*Aspiration hazard (rating for D3)*	*Yes/No*
	T	*Specific organ toxicity (rating for D3)*	*Yes/No*
	N	*Neurotoxicity (rating for D3)*	*Yes/No*
	I	*Immunotoxicity (rating for D3)*	*Yes/No*
Interfer-ence with other uses of the sea	**E1**	**Flammability**	0-4
	E2	**Behaviour of chemicals in the marine environment**	
	Fp	*Persistent floater (rating for E2)*	*Yes/No*
	F	*Floater (rating for E2)*	*Yes/No*
	S	*Sinker (rating for E2)*	*Yes/No*
	G	*Gas (rating for E2)*	*Yes/No*
	E	*Evaporator (rating for E2)*	*Yes/No*
	D	*Dissolver (rating for E2)*	*Yes/No*
	E3	**Interference with coastal amenities**	0-3

2.4.1 Bioaccumulation and biodegradation

Bioaccumulation (A1) is divided into two subcategories, bioaccumulation of organic substances in fish and their toxicity to other aquatic organisms (A1a) and bioconcentration factor (BCF) in fish, crustaceans or molluscs as test organisms (A1b). Bioaccumulation is rated from no potential to bioaccumulate (0) to very high potential to bioaccumulate (5).

Biodegradation (A2) has only two categories, readily biodegradable or not readily biodegradable.

For inorganic substances, A1a or A2 cannot be measured and those are indicated in the profile as “inorg.”

2.4.2 Aquatic toxicity

Aquatic toxicity is divided into two subcategories, acute (B1) and chronic (B2) toxicity to aquatic organisms. Acute toxicity is rated from non-toxic (0) to extremely toxic (6) and chronic toxicity from negligible (0) to very high (4).

2.4.3 Acute toxicity

Acute toxicity is a property of a substance which causes adverse effects to humans from oral (C1), dermal (C2) or inhalation (C3) exposure. The level of acute toxicity of each exposure method is defined separately. All categories in acute toxicity are rated from negligible (0) to high (4).

2.4.4 Irritation, corrosion and long-term health effects

Irritant and corrosive substances cause adverse effects on skin, eyes or mucous membranes. Skin irritation and corrosion (D1) is rated from not irritating (0) to corrosive (3). Rating 3 can be used if exposure time is not reported, otherwise exposure time-based ratings (3A-3C) are used. Eye irritation (D2) is rated from not irritating (0) to severely irritating, with irreversible corneal injury (3).

For long-terms effects (D3), the chemicals are categorised as either having or not having such effects. The effects assessed are carcinogenicity (C), mutagenicity (M), reprotoxicity (reproductive toxicity) (R), skin sensitization (Ss), respiratory sensitization (Sr), aspiration (A), specific organ toxicity (T), neurotoxicity (N) and immunotoxicity (I).

2.4.5 Interference with other uses of the sea

The flammability (E1) of a substance is rated from not flammable (does not burn) (0) to highly flammable (4).

The behaviour of the chemicals in the marine environment (E2) is determined by their properties. The behaviours of substances covered in this category are floater, sinker, gas, evaporator and dissolver. These can also be given as combinations of properties, for example as persistent floater.

The chemical substances have also a potential to interfere with coastal amenities (E3), for example on use of beaches, on fishing, and on human populations on the coastal areas. Interference with coastal amenities is rated from none (0) to highly objectionable (3) and the ratings are based on the data from the other categories, such as human health effects and physical properties.

3 Discharges of noxious liquid chemical residues

3.1 Noxious liquid chemical cargos unloaded in Finnish ports in 2023

In 2023, almost 1.8 million tonnes of bulk liquid chemicals were imported to Finnish ports in 384 separate cargos[2](Table 3). Of the 33 chemicals, 29 were classified in MARPOL Annex II categories X and Y and formed the majority, 372 cargos, transported using 90 different ships, of all cargos. Only 12 category Z and OS cargos were imported. More than half of the ships carrying bulk liquid chemicals were constructed in or later than 2007 and comply with the stricter strip regulations.

In total tanks of 82 cargos were washed onshore and 64 cargos were exempted from tank washing. Most of the chemicals requiring onshore tank washing were transported on newer ships (Figure 2). Most of the chemicals did not require onshore tank washing (Table 3) and approximately half of those cargos were transported on older ships.

Table 3. MARPOL Annex II categories, tank washing status and exemptions from tank washing requirements for bulk liquid chemical cargos imported to Finnish ports in 2023.

Category and requirements	Tons	Cargos
X and Y, tanks washed onshore	390 623	82
Y, tanks not washed onshore	974 383	226
X and Y, exemption granted	377 908	64
Z and OS (no onshore tank washing required)	36 210	12
TOTAL	**1 779 124**	**384**

[2] please note: chemicals in categories X and Y are all accounted for, chemicals in category Z have been collected from 10 largest chemical ports.

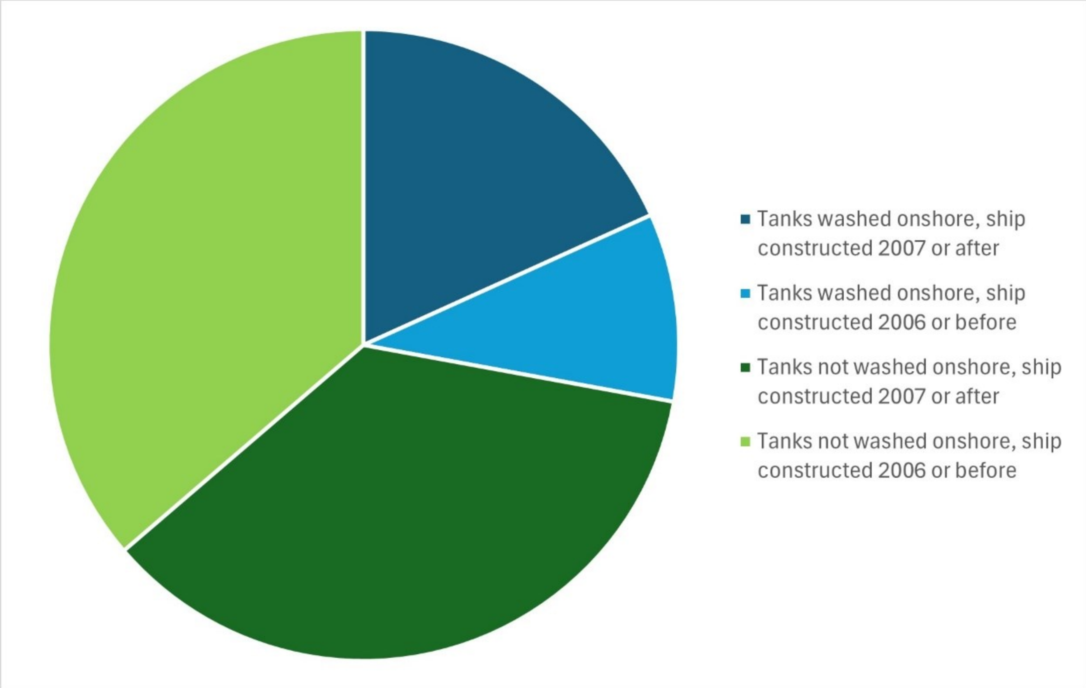

Figure 2. Share of cargos for which tanks were washed/not washed onshore after unloading and construction year of the ships carrying these cargos in 2023.

3.2 Noxious liquid residues potentially entering the sea

As the chemicals can be transported using one or several tanks and the number of tanks used for the transportations was not available, the residues were calculated for three scenarios: using one, 10 or 20 tanks for the cargo, giving a range from theoretical minimum to potential maximum (Table 4).

Modern tankers may have significantly lower strip volume than allowed by the regulations. Assuming that all the ships built after 2007 would have a strip of 25 litres instead of the allowed 75 litres would lower the estimated discharge volumes of 19 chemicals that were partly transported using such ships. The reduction is usually less than two thirds for these chemicals as well, as few chemicals was transported solely on new ships and the older ships were estimated to have a strip volume of 100 or 300 litres (plus potential tolerance of 50 litres), depending on the age of the ship. For example, for styrene monomer, that was largely transported using new ships, the reduction would have been from 7.9 litres to 2.8 litres (assuming one tank per cargo).

Table 4. Chemicals imported to Finnish ports in 2023, number of cargos and volume of chemical residues potentially ending up into the sea when using one, 10 or 20 tanks per cargo.

CHEMICAL	Imported (t)	Number of cargos	Residue, 1 tank (l)	Residue, 10 tanks (l)	Residue, 20 tanks (l)
Benzene and mixtures having 10% benzene or more (i)[2]	15 725	5	425	4 250	8 500
Bio-fuel blends of gasoline and ethyl alcohol (>25 % but <99% by volume)[3]	10 665	14	-	-	-
Butyl acrylate (all isomers)[2]	7 230	9	875	8 750	17 500
Butylamine (all isomers)[2]	898	1	75	750	1 500
Cashew nut shell oil (untreated)[1]	1 120	1	0.3	3.3	6.6
Ethylenediaminetetraacetic acid, tetrasodium salt solution[2]	2 538	6	575	5 750	11 500
Hydrogen peroxide solutions (over 8% but not over 60% by mass)[2]	2 197	1	75	750	1 500
Lard[1]	186 970	26	1.5	14.5	29.1
Lard[3]	274 959	27	-	-	-
Methyl alcohol[2]	66 990	10	775	7 750	15 500
Nitric acid (less than 70%)[2]	4 500	1	100	1 000	2 000
Palm fatty acid distillate[1]	26 909	6	0.4	4.0	7.9
Palm fatty acid distillate[3]	54 270	11	-	-	-
Palm oil mill effluent oil[1]	5 100	1	0.1	0.9	1.9
Potassium hydroxide solution[2]	3 407	4	400	4 000	8 000
Pyrolysis gasoline (containing benzene)[2]	1 899	1	100	1 000	2 000
Rapeseed oil[1]	4 518	3	30	302	604
Rapeseed oil[3]	7 609	2	-	-	-
Sodium hydroxide solution[2]	695 982	129	11 450	114 500	229 000
Styrene monomer[1]	64 986	20	7.9	79	157
Styrene monomer[2]	41 735	29	2 425	24 250	48 500
Sulphuric acid[2]	92 852	12	1 075	10 750	21 500
Sunflower seed oil[3]	1 002	1	-	-	-

CHEMICAL	Imported (t)	Number of cargos	Residue, 1 tank (l)	Residue, 10 tanks (l)	Residue, 20 tanks (l)
Tall oil fatty acid (resin acids less than 20%)[2]	8 985	3	225	2 250	4 500
Tall oil pitch[1]	13 148	3	1.1	11	21
Tall oil pitch[2]	6 617	6	600	6 000	12 000
Tall oil, crude[1]	73 791	16	6	60	120
Tall oil, crude[2]	17 895	6	550	5 500	11 000
Tall oil, crude[3]	7 086	2	-	-	-
Tall oil, distilled[1]	2 092	1	0.1	1.2	2.5
Tall oil, distilled[2]	4 311	1	100	1 000	2 000
Tallow[3]	9 924	3	-	-	-
Used cooking oil (m)[1]	3 015	1	0.1	0.8	1.5
Used cooking oil (m)[3]	10 894	3	-	-	-
Used cooking oil (Triglycerides, C16- C18 and C18 unsatu-rated) (m)[1]	4 035	1	<0.1	0.3	0.7
Vegetable acid oils (m)[1]	4 938	3	1.1	11	23
Vegetable acid oils (m)[3]	1 500	1	-	-	-
Vinyl acetate[2]	524	1	100	1 000	2 000

1: Tank washed onshore, 2: Tank not washed onshore, 3: Exemption granted

4 Impacts of discharges of selected chemicals

This study focuses on the impacts of the most significant noxious liquid chemical residues discharged in the Baltic Sea from cargoes unloaded in the Finnish ports in 2023. Focus chemicals were chosen based on their current and continuing large import volumes and the hazard they present to marine environment, human health or economy. The GESAMP hazard profiles published in July 2024 (IMO 2024) were used in describing the impacts of the selected focus chemicals: styrene monomer, sodium hydroxide solution, benzene, pyrolysis gasoline and various tall oil fractions.

4.1 Styrene monomer

Styrene monomer has a low to moderate potential to bioaccumulate, but it is readily biodegradable (Figure 3). The substance has moderate acute aquatic toxicity and inhalation toxicity. Oral toxicity and dermal toxicity are rated as slight and negligible, respectively. Skin and eye irritation are rated as irritating and long-term health effects include carcinogenicity and mutagenicity. Styrene monomer is a floater that evaporates. It is also flammable. As a result of being carcinogenic, mutagenic, and a floater, styrene monomer is rated as highly objectionable for interference with coastal amenities.

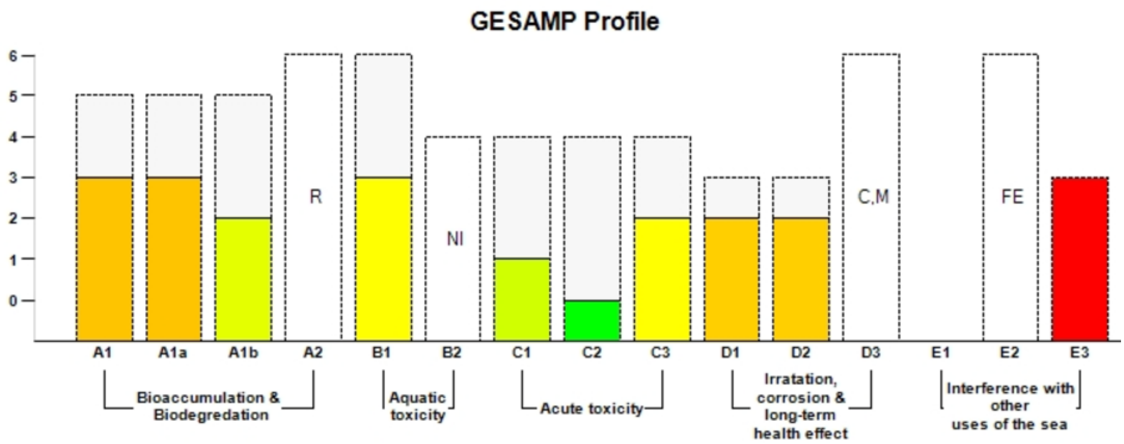

Figure 3. GESAMP profile of styrene monomer. R = readily biodegradable, NI = no information, C = carcinogenic M = mutagenic, FE = floater that evaporates. Please notice that according to the latest hazard evaluation, category E1 rating for styrene monomer is 3 out of 4, flammable. (Figure source: Milbros system, https://sync.milbros.com/)

Onshore tank washing is not mandatory for styrene monomer that is classified in MARPOL category Y. In 2023, for approximately half of the cargos, tanks were voluntarily washed onshore. Therefore, from these ships the chemical residue discharged into the sea was less than 8 litres, assuming one tank per cargo. For the remaining cargos, tanks were washed at sea which resulted in 2 425 litres of chemical discharged into the sea, assuming one tank per cargo.

4.2 Sodium hydroxide solution

Sodium hydroxide, commonly known as Caustic soda, has no potential to bioaccumulate. As it is an inorganic substance, bioconcentration factor (A1a) and biodegradation (A2) cannot be measured (Figure 4). Sodium hydroxide is rated as slightly toxic in acute aquatic toxicity and oral and dermal toxicity. Although an unlikely route of exposure, the inhalation toxicity of sodium hydroxide solution is evaluated as moderately high. The corrosiveness is at highest level, 3C, which indicates full-thickness skin necrosis from exposure up to 3 minutes. Eye irritation is rated highest, severely irritating, with irreversible corneal injury. Sodium hydroxide is a dissolver and rated as highly objectionable for interference with coastal amenities due to being severely irritating or corrosive to skin or eyes. Corrosiveness and irritability are the most harmful properties of sodium hydroxide. However, sodium hydroxide is also beneficial in the marine environment, as it increases salinity and mitigates ocean acidification due to its alkalinity.

Sodium hydroxide is classified in MARPOL category Y and does not require onshore tank washing. All tanks used to carry sodium hydroxide solution were washed at sea and the estimated residue discharged to sea was 11 450 litres, assuming one tank per cargo.

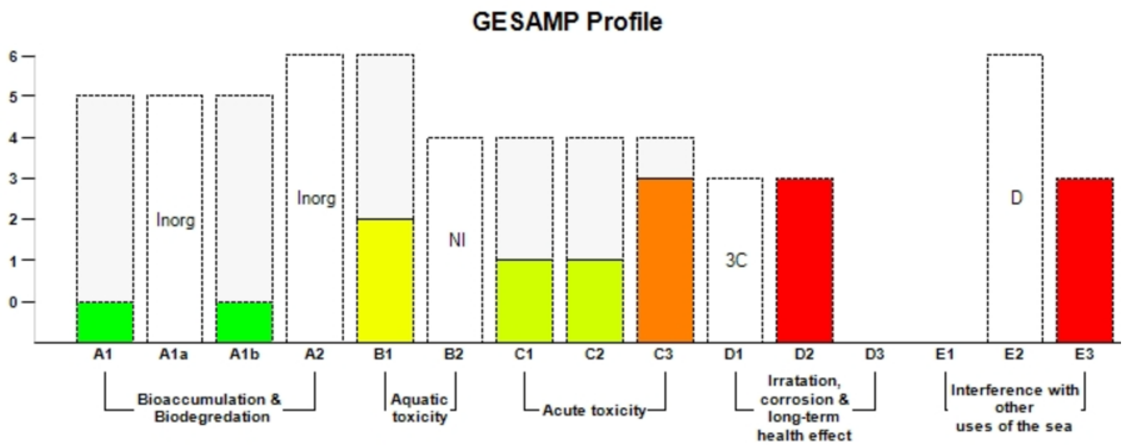

Figure 4. GESAMP profile of sodium hydroxide solution. Inorg = inorganic, NI = no information, 3C = corrosive (full-thickness skin necrosis from exposure up to 3 min), D = dissolver. Please notice that according to the latest hazard evaluation, category E1 rating for sodium hydroxide solution is 0 out of 4, not flammable (does not burn). (Figure source: Milbros system, https://sync.milbros.com/)

4.3 Benzene and pyrolysis gasoline

Benzene and mixtures having 10 % or more benzene have a low or very low potential to bioaccumulate, and they are readily biodegradable (Figure 5). These chemicals are rated slightly toxic for acute and aquatic toxicity and oral toxicity. Dermal and inhalation toxicity is negligible. The most harmful properties of benzene and benzene mixtures are irritation to skin and eyes, and long-term health effects, which include carcinogenicity (found to be clearly carcinogenic to humans), mutagenicity and specific organ toxicity. These chemicals are also highly flammable and evaporating and rated as highly objectionable for interference with coastal amenities due to being carcinogenic and mutagenic.

Benzene and benzene mixtures are classified in MARPOL category Y and do not require onshore tank washing. Washing residues discharged to sea were 425 litres in 2023, assuming one tank per cargo.

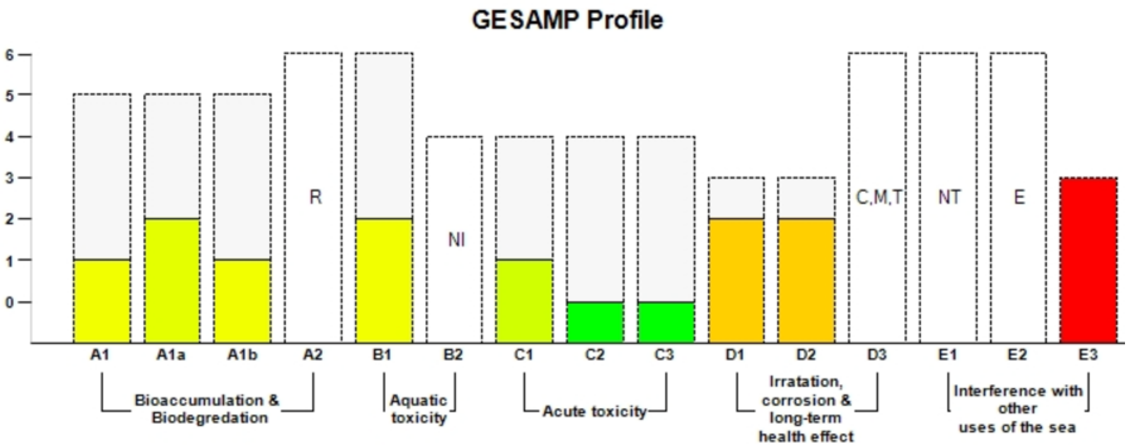

Figure 5. GESAMP profile of benzene and mixtures having 10 % benzene or more (i). R = readily biodegradable, NI = no information, C = carcinogenicity, M = mutagenicity, T = specific organ toxicity, E = evaporator. Please notice that according to the latest hazard evaluation, category E1 rating for benzene and benzene mixtures is 4 out of 4, highly flammable. (Figure source: Milbros system, https://sync.milbros.com/)

Pyrolysis gasoline containing benzene has moderate to high potential to bioaccumulate, but it is readily biodegradable (Figure 6). Pyrolysis gasoline has moderate acute and low chronic aquatic toxicity. It has slight oral, negligible dermal and moderate inhalation toxicity. Similarly, to benzene and benzene mixtures, pyrolysis gasoline is irritating to skin and eyes and cause long-term health effects through carcinogenicity, mutagenicity and specific organ toxicity. It is also highly flammable. The substance is floater that evaporates and rated as highly objectionable for interference with coastal amenities due to its carcinogenicity, mutagenicity and floating characteristics.

Pyrolysis gasoline containing benzene is classified in MARPOL category Y and does not require onshore tank washing. Washing tanks at sea is estimated to have resulted in 100 litres of residue discharged into the sea, assuming one tank per cargo.

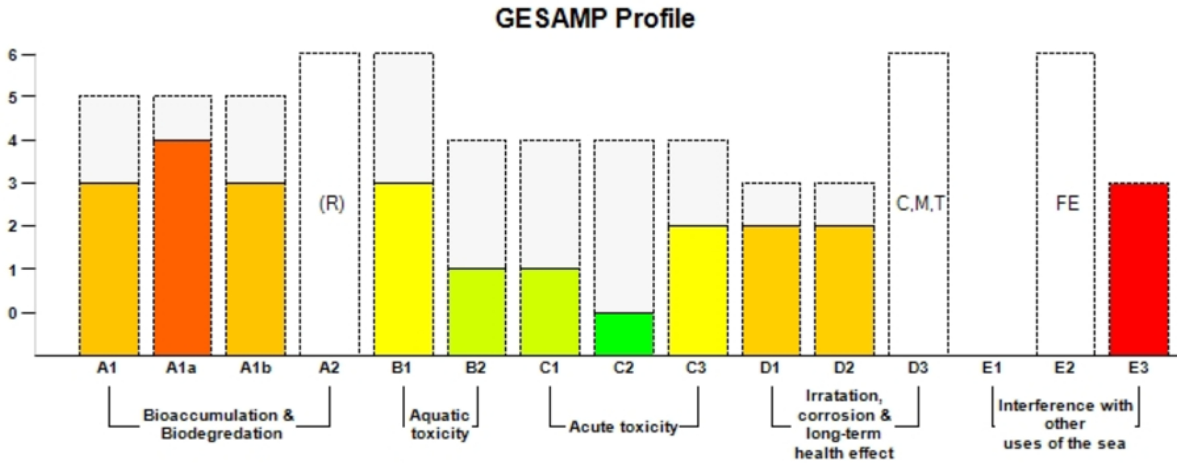

Figure 6. GESAMP profile of pyrolysis gasoline (containing benzene). R = readily biodegradable, C = carcinogenicity, M = mutagenicity, T = specific organ toxicity, FE = floater that evaporates. Please notice that according to the latest hazard evaluation, category E1 rating for pyrolysis gasoline is 4 out of 4, highly flammable. (source: Milbros system, https://sync.milbros.com/)

4.4 Tall oil fractions

Tall oil is transported both as crude tall oil and in refined fractions. Of these, the crude oil is most harmful. Refining stepwise removes harmful properties, although it also impacts e.g. biodegradability. All tall oil fractions are classified in MARPOL category Y. The requirement for onshore tank washing depends mainly on the unloading temperature (e.g. heating of the cargo), as it directly impacts the viscosity of the chemical.

Crude tall oil has a high potential to bioaccumulate, but it is readily biodegradable (Figure 7). It has slight acute aquatic toxicity but negligible chronic aquatic toxicity. Its oral, dermal and inhalation toxicity is negligible, and it is not irritating to skin or eyes. Crude tall oil causes skin sensitization as a long-term health effect. It has low flammability. It is rated as persistent floater and therefore highly objectionable for interference with coastal amenities.

In 2023, tanks of 16 out of 24 crude tall oil cargos were washed onshore due to high viscosity of the cargo, and only 6 litres of chemical were discharged into the sea from these cargos, assuming one tank per cargo. Two cargos were exempted from washing. For six cargos with low viscosity, tanks were washed at sea, which resulted in 550 litres of chemical discharge into the sea, assuming one tank per cargo.

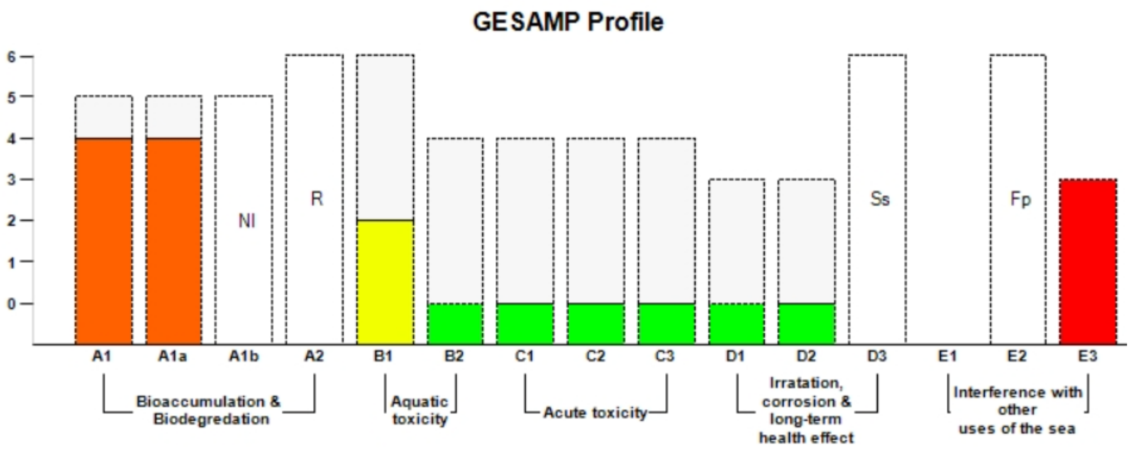

Figure 7. GESAMP profile for crude tall oil. NI = no information, R = readily biodegradable, Ss = skin sensitization, Fp = persistent floater. Please notice that according to the latest hazard evaluation, category E1 rating for crude tall oil is 1 out of 4, low flammability potential. (Figure source: Milbros system, https://sync.milbros.com/)

Tall oil pitch has a moderate potential to bioaccumulate, lower than that of the crude tall oil. However, unlike crude tall oil, it is not readily biodegradable (Figure 8). It has negligible acute and chronic aquatic toxicity and oral, dermal and inhalation toxicity. Tall oil pitch is not irritating to skin or eyes and has low flammability. It is a persistent floater and therefore rated as moderately objectionable for interference with coastal amenities.

In 2023, tanks of 6 out of nine tall oil pitch cargos were washed at sea, resulting in 600 litres of chemical discharge into the sea. For three cargos, tanks were washed onshore due to high viscosity, which resulted in only 1 litre of chemical discharge into the sea, assuming one tank per cargo.

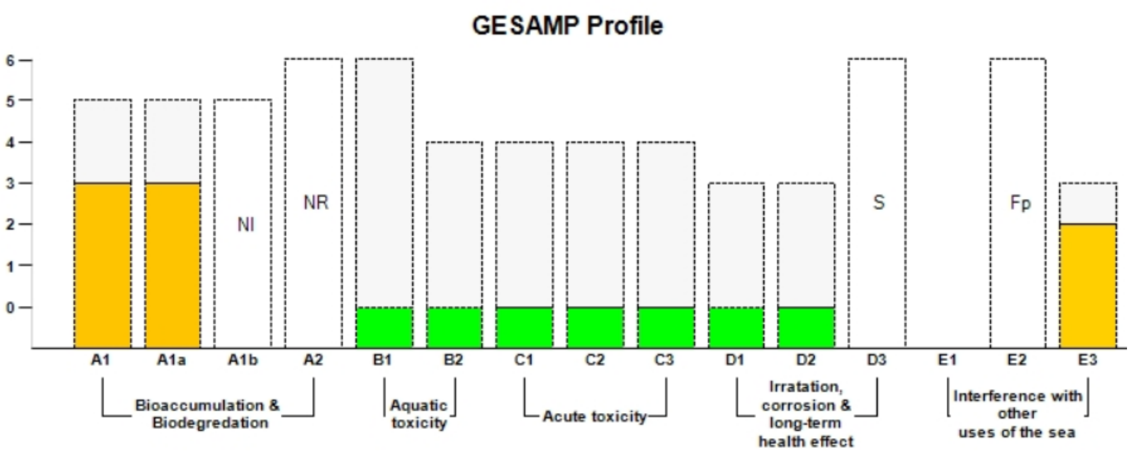

Figure 8. GESAMP profile for tall oil pitch. NI = no information, NR = not readily biodegradable, S = sensitizing, Fp = persistent floater. Please notice that according to the latest hazard evaluation, tall oil pitch is not considered sensitizing (D3 is zero) and category E1 rating for tall oil pitch is 1 out of 4, low flammability potential. (Figure source: Milbros system, https://sync.milbros.com/)

Tall oil fatty acid has no potential to bioaccumulate, and it is readily biodegradable (Figure 9). It has negligible aquatic, oral and dermal toxicity, but slight inhalation toxicity. Tall oil fatty acid is mildly irritating to skin but not irritating to eyes. It does not have long-term health effects and has low flammability. It is a persistent floater and therefore rated as moderately objectionable for interference with coastal amenities.

In 2023, all three tall oil fatty acid cargos were washed at sea, resulting in 225 litres of chemical discharge into the sea, assuming one tank per cargo.

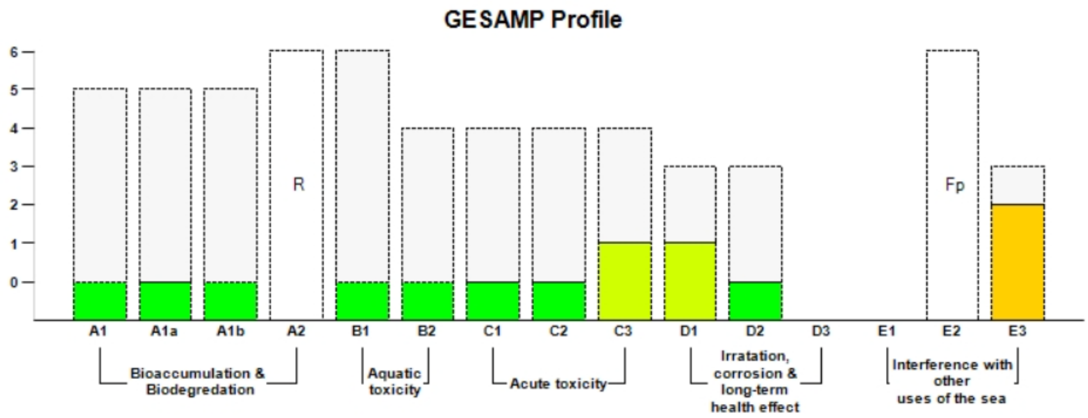

Figure 9. GESAMP Profile for tall oil fatty acid. R = readily biodegradable, Fp = persistent floater. Please notice that according to the latest hazard evaluation, category E1 rating for tall oil fatty acid is 1 out of 4, low flammability potential. (Figure source: Milbros system, https://sync.milbros.com/)

Distilled tall oil has no potential to bioaccumulate, and it is readily biodegradable (Figure 10). It has negligible acute aquatic, oral, dermal and inhalation toxicity. Distilled tall oil is not irritating to skin and eyes and does not have long-term health effects. It has low flammability. It is persistent floater and therefore rated as moderately objectionable for interference with coastal amenities.

In 2023, tanks were washed onshore for half of the cargos, which resulted in 0.1 litres of chemical discharge into the sea. Washing tanks at sea resulted in 100 litres of residue discharge into the sea, assuming one tank per cargo.

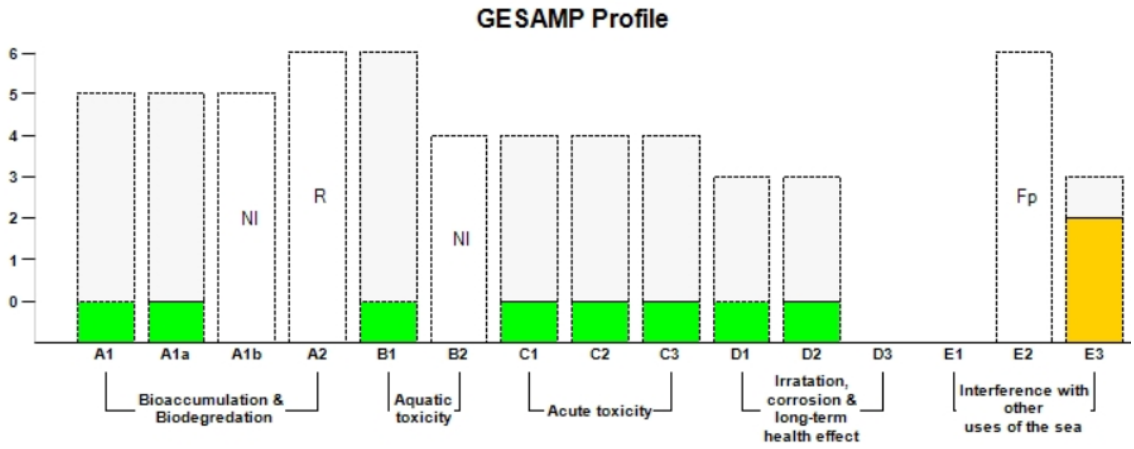

Figure 10. GESAMP profile for distilled tall oil. NI = no information, R = readily biodegradable, Fp = persistent floater. Please notice that according to the latest hazard evaluation, category E1 rating for distilled tall oil is 1 out of 4, low flammability potential. (Figure source: Milbros system, https://sync.milbros.com/)

5 Discussion

The purpose of this study was to evaluate the volume of residue discharges of noxious liquid chemical cargos unloaded in Finnish ports in 2023 and to evaluate impacts of these discharges in the marine environment.

Impact of onshore tank washing on chemical residue discharge

Onshore tank washing significantly reduces the chemical residues ending up into the sea. For category X chemicals the regulation requires washing until the chemical concentration has been diluted to 0.1 % of the original. For category Y chemicals, the data collected in this study indicates that washing usually theoretically results in less than 1 % chemical concentration in the strip (range 0.02–4.1 %, median 0.2 %). The real value depends on properties of the chemical and cannot be evaluated using the data available. For example, high viscosity chemicals are more resistant to washing and may require physical sweeping of the tank floor to ensure adequate removal of residues.

For most of the chemicals imported in Finland, the residues may currently be discharged into the sea. Of the 384 cargos imported in 2023, the tanks of only 82 cargos were washed onshore. Of these 390 600 tonnes of chemicals, the calculated combined volume of chemical discharge would have been 48.8 litres (of 100 % chemical), assuming that only one tank was used per cargo. Of the 974 400 tonnes of chemicals for which the tanks were not washed onshore, combined chemical residue discharges were 21 100 litres. As the tank number in reality is higher, also the residue volume is multiple times higher. The large difference in discharges reflects the properties of the chemicals – the regulation is tighter for more harmful chemicals.

Impact of ship age on chemical residue discharge

A total of 94 chemical tankers, of which 33 were built before 2007, were used to import the cargos analysed in this study. Six out of the ten most frequently visiting ships were constructed prior to 2007. The share of old and new ships used for transportations affect the total volume of chemical discharges, as the regulation concerning allowed strip volume is tighter for new ships: the maximum allowed strip for ships built after 2007 is 75 l, for older ships the maximum is 100 l (plus the potential tolerance of 50 l). Assuming that the new ships, in practise, have a much lower strip, down to 25 l, the difference in discharges between the old and new ships increases significantly. Over time, the discharges will decrease automatically, as new ships replace the current old ships. However, the fleet is renewing slowly, while the marine environment needs protection and actions as soon as possible.

GESAMP rating and tank washing requirements

The GESAMP profiles enable a comprehensive assessment of harmfulness of a chemical and is used to classify the chemicals on MARPOL Annex II categories. The most important criteria for chemical classification are the levels of bioaccumulation and acute aquatic toxicity. A chemical will be classified to X category if

- acute aquatic toxicity rating is five
- acute aquatic toxicity rating is four and the chemical is not readily biodegradable
- acute aquatic toxicity rating is four and bioaccumulation is four or higher
- bioaccumulation rating is four or higher, the chemical is not readily biodegradable, and it has long-term health effects.

The category X chemicals are assessed to present a major hazard to the marine environment and/or human health and therefore onshore tank washing is always required to minimise the chemical discharges into the sea.

The focus chemicals in this study are all classified in MARPOL category Y. Both styrene monomer and pyrolysis gasoline containing benzene have bioaccumulation and acute aquatic toxicity at level three, which is close to the category boundary. As the hazard assessments are based on data from marine and freshwater conditions, the impacts may, in reality, be graver for the organisms inhabiting the brackish Baltic Sea. Both chemicals are, however, readily biodegradable.

While categorised as presenting hazard, but not a major hazard, to the marine environment and/or human health, styrene monomer is also carcinogenic, mutagenic, flammable and a floater, and therefore highly objectionable for interference with coastal amenities. Similarly, pyrolysis gasoline is irritating to skin and eyes, carcinogenic, mutagenic and has specific organ toxicity. It is also highly flammable and a floater that evaporates and therefore highly objectionable for interference with coastal amenities.

As the hazard ratings of styrene monomer and pyrolysis gasoline containing benzene remain slightly below values placing them to X category, the washing requirement is based on their physical properties. As they are not high-viscosity or solidifying substances, nor persistent floaters, no onshore tank washing is required for these chemicals despite their clearly harmful properties.

The other focus chemicals have lower rating for bioaccumulation and acute aquatic toxicity. Sodium hydroxide solution is corrosive, but as a dissolver it is quickly diluted to harmless concentrations. As sodium hydroxide increases salinity and mitigates ocean acidification, discharges of sodium hydroxide are also beneficial to the marine environment.

Crude tall oil potential to bioaccumulate is rated at four, but it is readily biodegradable. Currently, tall oil fractions do not always require onshore tank washing, if the viscosity of the chemical remains low enough during unloading, for example due to heating of the cargo. However, during 2025, a regional regulation concerning onshore tank washing for all tall oil cargos in western Europe is discussed in IMO based on an amendment proposal of the Sub-committee on pollution prevention and response (PPR 12/4 on 21 November 2024).

Voluntary actions

In addition to tightening the regulation, discharges of chemicals into the sea can also decrease through voluntary actions in onshore tank washing. These require that actions are economically viable, for example due to the high value of the cargo and cost-efficient technological solutions. For example, a polystyrene packaging producer BEWI has required onshore tank washing for the styrene monomer cargos in their Porvoo facility since 1985[3]. BEWI collects the washing water and separates the styrene from the water using a simple density-based system. As a result, they gain annually approximately 25 tons of styrene monomer to be used as raw material,

[3] see BEWI presentation in HELCOM Informal workshop on discharges of harmful substances from tank washing on chemical tankers in Riga on May 16, 2024 (pages 90-98)

instead of discharging it to the sea. At the same time, they keep their annual styrene emissions at approximately 10 % of the permitted.

Next steps

Obtaining a comprehensive understanding on the chemical residues discharged into the Baltic Sea requires performing studies similar to this in all the Baltic Sea States. This study describes one way for evaluating the volumes and impacts of discharges of residues of chemicals. Similar study can be carried out in other countries by using for example national data bases or port surveys (Appendix 1). The impacts can be assessed using the public GESAMP data. Solid data on the total discharge of noxious liquid chemicals is crucial when conducting the second phase of the BSAP Action S16, which covers deciding whether and what action needs to be taken to further limit the discharges.

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Appendix 1

Steps to carry out a study to estimate volumes of discharges of residues of noxious liquid substances

In this report, Finland presents a study in which volumes of discharges of residues of noxious liquid substances from chemical tanker tank washing was estimated. The methods of the study can be used as an example and potential template in other HELCOM states. Carrying out similar studies in other HELCOM Member States would contribute to Baltic Sea Action Plan, Action S16. Therefore, following steps should be taken in other HELCOM Member States:

1. Collect the information on the imported liquid bulk chemical cargos which require onshore tank washing from the MARPOL surveyors (MARPOL X category).
2. Collect the information on the imported liquid bulk chemical cargos from European or national data banks or directly from largest chemical ports (MARPOL Y, Z and OS categories). If information on tank washing is recorded, use that. Otherwise assume that washing was done according to regulations (required/ not required).
3. If data on water volume used in washing is available, calculate chemical residue volumes in the strip after onshore tank washing using accepted strip volumes and water volumes used for washing. If no data is available, assume e.g. 1 % chemical concentration after washing (0.1 % for category X chemicals). Multiply with allowed strip volume.
4. Calculate the chemical residue volumes from cargos not requiring onshore tank washing using the allowed strip volumes.
5. In addition to this theoretical estimate, calculate the upper range of discharges by assuming than twenty (instead of theoretical one) tanks were used for transporting the single cargo.
6. Summarize the results into a report of residues discharged into the sea.

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