Sulphur dioxide

Sulphur dioxide (SO_2) is a soluble gas generated from different natural and anthropogenic sources. Human activities generate most SO_2 emissions, via fossil fuel combustion, paper manufacturing, petroleum refining, metal smelting, superphosphate fertiliser production, crops fumigation, textile bleaching, food preservation, and wine making fermentation and brewing processes. In 2015, energy-related activities and industrial processes emitted most of the 49,900 tonnes of SO_2 released to air, and the *Our Air* report (2018) indicated concentrations of SO_2 above the national air quality standard at four of the nine monitored sites across New Zealand. Monitored concentrations above guideline limits were correlated to industrial and high traffic areas.[1]

Shipping activities also contribute significantly to SO_2 emissions in New Zealand. About 1500 ships navigate our coasts each year, including more than 120 cruise ships. Over 10,000 tonnes of sulphur dioxide are annually emitted by ships in New Zealand, and trends suggest an increase in SO_2 releases with tourism growth. In light of the potential risks associated with shipping activities, New Zealand has agreed to give effect to Annexes I, II, III and IV of the MARPOL Convention for the prevention of pollution from ships. However, it has not yet agreed to ratify Annex VI which deals with air pollution in ports and harbours.The implementation of this Annex is currently under public consultation.[2]

Sulphur dioxide is classified as a hazardous chemical due to its toxic and ecotoxic properties.[3]
High concentrations of sulphur dioxide in the air are associated with respiratory problems in humans. Concentrations of SO_2 can result in the formation of acid rain, acid deposits in soil, and can lead to the formation of sulphur oxides and other secondary compounds that contribute to high particulate matter concentrations (PM10). Excessive amounts of sulphur in soil and atmosphere also affect plants that take up SO_2, leading to growth and productivity impairments in crops and foliar injury in temperate forests and shrubs.[4]

National regulations

Under sections 13 and 21 of the Resource Management Act (RMA) 1991 and the National Environmental Standards for Air Quality 2004, regional councils are required to monitor air quality, assess applications for resource consents to discharge SO_2 into air, and assess the compliance of consent conditions against guidelines and standards.[5]

The EPA has approved the use of SO_2 for manufacturing processes. Controls are established under the Hazardous Substances Labelling, Safety Data Sheet, Disposal and Hazardous (Property Controls) Notice 2017. These controls include the use of specialized equipment to work with SO_2 in restricted workplaces (Clauses 13 and 47), and compliance with storage requirements (Hazardous Property Controls clauses 35-43).

WorkSafe regulates the use of SO_2 contained in cylinders and equipment in workplaces under HSWA (2015) and the HSW Hazardous Substances Regulations 2017 controls. PCBUs[6] are required to have an inventory of their hazardous substances, including amounts of SO_2 stored (Part 3 of HSW

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[1] https://www.stats.govt.nz/indicators/sulphur-dioxide-concentrations [Accessed 28 November 2018]
[2] https://www.transport.govt.nz/multi-modal/currentlyconsultingon/consultation-on-marpol-annex-vi-treaty-to-reduce-air-pollution-in-ports-and-harbours/ [Accessed 29 November 2018]
[3] SO_2 falls under the HSNO hazard classifications: 6.1C (All), 6.1C (I), 6.5A, 6.8B, 6.9A (All), 6.9A (D), 6.9A (I), 8.1A, 8.2B, 8.3A, 9.1A (All), 9.1A (F), 9.1A (A).
[4]https://books.google.co.nz/books?hl=en&lr=&id=k_AvKQKSmnsC&oi=fnd&pg=PA135&dq=sulphur+dioxide+%2B+crop+productivity&ots=0pSIR37Je8&sig=Z69PfpavX2jhLDA0Si9rPZj5Oh0#v=onepage&q=sulphur%20dioxide%20%2B%20crop%20productivity&f=false [Accessed 4 December 2018]
[5] National air quality standards for sulphur dioxide state that (1) SO_2 emissions must not exceed the threshold concentration of 350$\mu g/m^3$ in an air shed for an hour for more than 9 times (unless it is permitted under consent); and (2) the air quality standard for SO_2 is breached if it exceeds its threshold concentration (570 $\mu g/m^3$) in an air shed, and the exceedance is not permissible by the regional authority.
[6] PCBU: a Person Conducting a Business or Undertaking. The Act denotes all types of modern working arrangements commonly referred to as businesses.

Hazardous Substances Regulations). There are also requirements for labelling and signage of hazardous substances. Sulphur dioxide is not tracked throughout its life-cycle given that it is not considered to be sufficiently hazardous.

Clause 15 of the Resource Management (Marine Pollution) Regulation states that air discharges from ships are permitted providing their operations systems are listed under Schedule 4[7], including ship propulsion and the use of heat exchange. Ratification of Annex VI of the MARPOL convention would place restrictions on emissions of SO_2 from ships and contribute to the regulation of air pollutants harmful to public health.

Data availability

The Ministry for the Environment (MfE) produces a Greenhouse Gas Inventory on an annual basis, following the agreement signed by New Zealand under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. Information is compiled from different databases including those from the Ministry of Business, Innovation and Employment, the Ministry for Primary Industries, the Environmental Protection Authority and StatsNZ. However, the inventory for SO_2 has not been updated since 2008. Limited data availability is attributed to incomplete estimates and difficulty accessing to industrial emissions data. The confidentiality of some industrial activities affects the quality of reporting under New Zealand's Environmental Reporting framework. There is currently no mechanism in place to regularly collect and update industrial emissions data.

The last *Our Air* report (2018) showed SO_2 emissions at nine locations in New Zealand. Monitoring stations were strategically located in areas considered to have high levels of air pollution. Yet SO_2 emissions from other locations with significant industrial presence are not included in MfE's State of the Environment monitoring and reporting. Regional councils require consent holders to report on emissions to air in order to assess whether mass emission rates exceed target limits or not, but this information is not collated or available at the national level.

Data on sulphur dioxide imports is available on the StatsNZ website.[8] As of September 2018, 4493 kilograms of SO_2 were imported from Australia and 500 Kg from Belgium over the last year (October 2017-September 2018). However, the information cannot be narrowed down to SO_2 use or emissions by industry or location.

Overseas comparison

The Australian National Pollutant Inventory (NPI) records annual industrial emissions of sulphur dioxide, and serves as a good example on the use of pollution registers for the management of air quality. The latest published data estimated that 890 million kg of SO_2 were emitted between 2016 and 2017. The information from the NPI database is flexible and can be broken down by source. The list below illustrates the main sectors contributing to SO_2 emissions. The complete list can be found in the Australian National Pollutants Inventory.[9]

[7] Discharges made as part of normal operations of ship or offshore installation (Schedule 4) as fully described in: http://www.legislation.govt.nz/regulation/public/1998/0208/latest/DLM254510.html#DLM254510 [Accessed 31 January 2019]
[8] https://www.stats.govt.nz/tools/stats-infoshare [Accessed 30 October 2018].
[9] www.npi.gov.au. [Accessed 30 October 2018].

Source	Total Industry Air Emission (kg)/ year
Electricity Generation	483,474,878.05
Basic Non-Ferrous Metal Manufacturing	319,927,503.18
Fuel Combustion - sub reporting threshold facilities	40,719,979.06
Metal Ore Mining	29,006,868.57
Commercial Shipping/Boating	17,653,066.67
Fertiliser and Pesticide Manufacturing	16,911,461.57
Petroleum and Coal Product Manufacturing	16,857,057.94
Motor Vehicles	9,027,561.87
Basic Ferrous Metal Manufacturing	6,332,631.08
Sugar and Confectionery Manufacturing	2,651,125.62
Water Transport Support Services	2,045,250.56
Glass and Glass Product Manufacturing	1,701,858.60

Additionally, the table below shows sulphur oxide released and transferred by countries belonging to the European Union in 2015. NR= Not reported.

Country	Releases				
	Air emissions	Surface water discharges	Land emissions	Landfills	Total Releases
Austria	977,000.00	NR	NR	NR	977,000.00
Belgium	83,510,000.00	NR	NR	NR	83,510,000.00
Bulgaria	109,694,000.00	NR	NR	NR	109,694,000.00
Cyprus	11,964,000.00	NR	NR	NR	11,964,000.00
Czech Republic	179,644,000.00	NR	NR	NR	179,644,000.00
Denmark	3,262,000.00	NR	NR	NR	3,262,000.00
Estonia	37,585,000.00	NR	NR	NR	37,585,000.00
Finland	28,356,000.00	NR	NR	NR	28,356,000.00
France	78,952,000.00	NR	NR	NR	78,952,000.00
Germany	616,429,000.00	NR	NR	NR	616,429,000.00
Greece	91,950,000.00	NR	NR	NR	91,950,000.00
Croatia	11,102,000.00	NR	NR	NR	11,102,000.00
Hungary	12,359,000.00	NR	NR	NR	12,359,000.00
Ireland	7,101,000.00	NR	NR	NR	7,101,000.00
Iceland	11,360,000.00	NR	NR	NR	11,360,000.00
Italy	104,120,000.00	NR	NR	NR	104,120,000.00
Luxembourg	533,000.00	NR	NR	NR	533,000.00
Latvia	191,000.00	NR	NR	NR	191,000.00
Malta	1,996,000.00	NR	NR	NR	1,996,000.00
Netherlands	44,491,000.00	NR	NR	NR	44,491,000.00
Norway	10,242,000.00	1,441,500.00	NR	NR	11,683,500.00
Poland	589,768,000.00	NR	NR	NR	589,768,000.00

Portugal	36,644,000.00	NR	NR	NR	36,644,000.00
Romania	197,485,000.00	NR	NR	NR	197,485,000.00
Spain	233,673,000.00	NR	NR	NR	233,673,000.00
Slovenia	6,310,000.00	NR	NR	NR	6,310,000.00
Sweden	8,915,000.00	NR	NR	NR	8,915,000.00
Switzerland	1,927,000.00	NR	NR	NR	1,927,000.00
United Kingdom	407,585,000.00	NR	NR	NR	407,585,000.00

Sulphur dioxide summary

What we know: Sulphur dioxide (SO_2) is a soluble gas that originates from natural and anthropogenic sources. It is emitted from the combustion of fuel in vehicles and ships but is also a compound used in the processing of food and metal smelting. SO_2 has been classified as a hazardous gas with toxic and ecotoxic properties capable of triggering respiratory problems in humans and acidifying soils and water ways, resulting in the reduction of plant growth. The EPA regulates the use of SO_2 for manufacturing activities, and StatsNZ manages the import data, which is available to the public through the Infoshare tool. There is no obligation on facilities to report the use and storage of SO_2. However, WorkSafe inspectors have access to inventories upon request, in order to check hazardous substances present in the work place and the controls required to reduce risks. This information is confidential and is not designed to be collated by the regulatory agency nor made public. Regulation of SO_2 emissions from ships hinges on whether New Zealand ratifies Annex VI of the MARPOL Convention.

What we don't know: The Ministry for the Environment produces annual greenhouse gas inventories, but SO_2 emissions have not been updated since 2008. Limitations in data availability are attributed to incomplete estimates and difficult access to industrial emissions data. The confidentiality of some industrial activities affects reporting quality, and there are no mechanisms in place to regularly collect and update industrial data.

Arsenic

Arsenic is a naturally occurring metalloid found in the crust of the Earth as a pure element, or combined with sulphur and metals. [1] When arsenic binds with oxygen, chlorine and sulphur, inorganic arsenic compounds, such as arsenite (As^{III}) and arsenate (As^{V}), are formed. These inorganic arsenic compounds are easily soluble in water, meaning they become available and can be toxic to organisms.[2]

Inorganic arsenic compounds have been widely used in a variety of industrial sectors in New Zealand. Arsenic-containing insecticides and herbicides used in sheep dips and orchards, and in food additives for poultry and swine were commonly used between 1950 and the mid-80s, although these uses were completely banned in New Zealand in the 2000s.[3] Nowadays, the largest volumes of arsenic are used in chromated copper arsenate (CCA) solutions used for timber treatment.[4] New Zealand has more than 165 timber treatment facilities, all of which use nationally manufactured CCA formulations approved by the Environmental Protection Authority (EPA). Arsenic is also found in fertiliser formulations[5], and is used as alloying agents for heavy metals, and as semiconductors in electronic devices.

Emissions of arsenic have been associated with the burning of CCA-treated timber offcuts[6], and with the burning of coal and lignite in power and food processing plants, and battery recycling plants (which are now closed) in New Zealand. Ash from burned wood, and arsenic-contaminated stormwater originating from energy and processing plants, can further contribute to arsenic contamination in soils and water. A number of studies have also shown arsenic leachate emerging from treated timber poles in use or stockpiled in agricultural settings.[7] Arsenic can also be naturally released to the environment from geothermal sources, and as a by-product from industrial processes including mining, smelting of copper and lead ores, the generation of geothermal power, and the manufacturing of glass and ceramics.

Arsenic compounds are harmful to human and ecosystems health. They can accumulate in the environment and build up along the food chain, affecting higher organisms, including human beings. In 2018, The Ministry of Health published a report on the Biological Monitoring of Selected Chemicals of Concern in New Zealand, in which arsenic was assessed. Results showed that higher levels of arsenic in urine were correlated with recent consumptions of fish.[8] The World Health Organisation notes that long-term exposure to inorganic arsenic from water consumption can cause skin lesions and increase the risks of cardiovascular disease and diabetes in humans. Further, exposures to airborne arsenic can cause lung cancer and can induce kidney and nerve damage.[9]

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[1] A metalloid is an element that shares properties from metals and non-metal elements. It can behave as an electric insulator or as an electric conductor depending on the room temperature and its contact with specific elements.

[2] However, the toxicity of inorganic arsenic can change depending on the oxidation state of the compound (As^{III} or As^{V}, monomethylarsonic acid and dimethylarsinic acid), and the type of soil in which it occurs.

[3] Pesticides containing MSMA arsenic, lead arsenate, zinc arsenate and calcium arsenate are banned in New Zealand. James T and Gaw S. 2015. Review of potential soil contamination issues form pesticide use in productive land and sports fields. Report for Tasman District Council.

[4] New Zealand is the world's second largest exporter of industrial round wood, and processes over 13 million logs per year for domestic use. Building standards require the treatment of timber to avoid deterioration, and CCA is the most commonly used chemical for timber preservation. OECD (2017), *OECD Environmental Performance Reviews: New Zealand 2017*, OECD Environmental Performance Reviews, OECD Publishing, Paris,

[5] https://ballance.co.nz/medias/Fertiliser-Association-Metals-Dec-Version-1-6-Oct-2014-2-.pdf?context=bWFzdGVyfERvY3VtZW50c3w1NDQyODV8YXBwbGljYXRpb24vcGRmfGgwYS9oMGIvODgwMzAzMDY2MzE5OC5wZGZ8MDFmMDdiNmM1ZjA0NGFiOTJiODY2Mjk4ZmQyOTdiZDc1YzBiN2ZjNzY3YzVkNTYwNjQ1NmM4YzY2M2I1MDA4Yw [Accessed 15 March 2019]

[6] *Our Air* 2018 report showed exceedances of arsenic emissions in Henderson (Auckland), Nelson, Richmond and Wanuiomata between 2007 and 2016. http://www.mfe.govt.nz/sites/default/files/media/Air/our-air-2018.pdf

[7] https://www.waikatoregion.govt.nz/assets/WRC/Services/publications/technical-reports/2018/TR201811.pdf [Accessed 21 November 2018]).
https://www.marlborough.govt.nz/repository/libraries/id:1w1mps0ir17q9sgxanf9/hierarchy/Documents/Your%20Council/Meetings/2017/Environment%202017%20List/Environment_16_March_2017_Item7_Vineyard_Post_Pile_Investigation_Ver10.pdf [Accessed 5 February 2019].

[8] http://publichealth.massey.ac.nz/assets/Uploads/SOCs-Report-FINAL-06032018.pdf

[9] https://www.who.int/news-room/fact-sheets/detail/arsenic [Accessed 18 March 2019].

The absorption of arsenic by terrestrial plants is low. However, the accumulation and effects of arsenic in freshwater plants and fish has been shown to be significantly higher than terrestrial plants.[10,11] Recent samples of watercress collected from the Wharemauku Stream in Paraparaumu, a common food gathering area, showed concentrations of arsenic nine times higher than those permitted in food safety standards (1mg/kg). In this case, the source of arsenic was attributed to the soil from an old market garden, which was disturbed and entered the stream as a result of road works.[12]

High levels of inorganic arsenic in soils can also alter microbial communities by triggering the decline of arsenic-sensitive microbiota, and increasing the presence of arsenic-resistant organisms. For example, As(III)-oxidizing bacteria become relatively abundant in the presence of arsenite, while more sensitive As(III) oxidizers get eliminated under these conditions.[13] These types of bacteria play a crucial role in arsenic transformation in soils, influencing the fate and behaviour of arsenic in terrestrial environments.

National regulations

The use of arsenic compounds is regulated by the EPA under the Hazardous Substances and New Organisms Act 1996 (HSNO), and by WorkSafe under the Health and Safety at Work Act 2015 (HSWA) Hazardous Substances Regulations. The most extensive controls exist around the use of arsenic in timber treatment facilities.

The HSW (Hazardous Substances) Regulation 3.1 requires the PCBU[14] of a workplace to keep an inventory of arsenic-containing solutions and wastes. The inventory should include information on the amount of arsenic-containing solution stored, the hazard classification of the chemical, and the storage location. Further requirements for using, handling and storing hazardous substances (e.g. specifications for containers, separation distances and maximum quantities) will apply to hazardous waste from 1 June 2019.[15]

Arsenic substances classified as acutely toxic and fatal (classes 6.1A and 6.1B) require tracking for each phase of their life cycle. This includes 6.1A substances, such as arsine oxide, and 6.1B substances, such as pure arsenic, arsenic trioxide and pentoxide, and arsenic acid solutions at concentrations greater than 26%. Substance tracking requirements include the recording, location and movement of the chemicals, from where they were imported or manufactured through to their final use or disposal.[16]

On the other hand, products manufactured with arsenic (such as acid lead batteries, or electronic devices), or treated with arsenic-containing solutions (such as timber), are considered to be manufactured articles, not hazardous substances; hence they don't fall under HSNO legislation.

The management of the arsenic-containing solution in the treated timber is not regulated under HSW Hazardous Substances Regulations 2017, given that the focus of the Act is on the management of the activities that create risks at a workplace where treated timber is handled, not on the control of treated timber per se. Instead, the management of arsenic-treated timber is controlled by other legislation

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[10] Robinson, B., Kim, N., Marchetti, M., Moni, C., Schroeter, L., van den Dijssel, C., & Clothier, B. 2006. Arsenic hyperaccumulation by aquatic macrophytes in the Taupo Volcanic Zone, New Zealand. *Environmental and Experimental Botany*, *58*: 206-215.

[11] Tuulaikhuu, B. A., Bonet, B., & Guasch, H. 2016. Effects of low arsenic concentration exposure on freshwater fish in the presence of fluvial biofilms. *Science of the Total Environment*, *544*: 467-475.

[12] http://www.scoop.co.nz/stories/AK1812/S00366/detection-of-arsenic-and-lead-contamination-in-stream.htm

[13] Dong, D. T., Yamamura, S., & Amachi, S. 2016. Impact of Arsenite on the Bacterial Community Structure and Diversity in Soil. *Microbes and environments*, *31*(1), 41-8.

Ghosh, D., Bhadury, P., & Routh, J. 2014. Diversity of arsenite oxidizing bacterial communities in arsenic-rich deltaic aquifers in West Bengal, India. *Frontiers in Microbiology*, *5*: 602.

[14] PCBU: a Person Conducting a Business or Undertaking. The Act denotes all types of modern working arrangements commonly referred to as businesses.

[15] https://worksafe.govt.nz/dmsdocument/2647-new-rules-for-hazardous-substances-changes-to-the-regulations-for-hazardous-substances-in-the-workplace

[16] http://www.legislation.govt.nz/regulation/public/2017/0131/latest/DLM7311086.html?search=ts_act%40bill%40regulation%40deemedreg_hazardous+substances*_resel_25_a&p=2

including the Resource Management Act (RMA) 1991, the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health, MfE's Ambient Air Quality Guidelines, the Building Act 1991 and Best Practice Guidelines for timber treatment activities (e.g., New Zealand Chemical Preservation of Round and Sawn Timber Standard NZS 3640:2003).

New Zealand processing plants where arsenic is either used or produced are generally required to comply with specific controls on water, soil and air emissions under resource consent conditions. Plants granted resource consent with arsenic monitoring conditions include timber treatment facilities, milk powder plants, and energy generation plants that burn coal. Until 2015 battery recycling plants required resource consents to discharge arsenic to the air, but these activities ceased in 2015, and batteries are now collected locally and processed overseas.

Data availability

Data on arsenic imports is available on the StatsNZ website. In 2018, 4,147,494 kilograms of acids of arsenic were imported from Malaysia, and 100,000 kilograms of arsenic trioxide were imported from China.[17] Further imports from the USA, Germany, Israel and Norway are registered, without quantities recorded. The data collected for arsenic imports to New Zealand is generic, and cannot be narrowed down to industry or location where the substance is stored or used.[18] The best source of information available was provided by the New Zealand Timber Preservation Council (NZTPC) in the 1990s, where 5000 tonnes of CCA salts were estimated to be used in the treatment of 650,000 m^3 of timber per year.[19] However, formal statistics have not been tracked or audited since then, and it is difficult to get information on CCA treated timber from production plants, especially from plants not registered with the NZTPC.

All arsenic-containing substances approved for use in New Zealand are acutely toxic (classes 6.1B or 6.1C). This means that under regulation 13.38 of the HSW (Hazardous Substances) Regulations 2017, users require a location compliance certificate (LCC) when quantity thresholds of the substance are reached.[20] The threshold for a LCC depends on the type of substance: for industrial sites this is 250 kg or litres for class 6.1B substances which include arsenic, arsenic pentoxide and arsenic trioxide; 1,000 kg or litres for class 6.1C chemicals, which include as arsenic acid or sodium arsenate. LCCs are entered into the register of compliance certificates that is managed by WorkSafe. Only authorised parties specified in the regulations have access to this information (generally other regulators). Facilities managing quantities below the threshold are not required to obtain a LCC and, therefore, there is no data available on volumes of substance stored at the workplace.

There is no data publicly available on the volumes of arsenic-containing waste transferred from timber treatment facilities, energy producing plants, mining activities, laboratories and construction sites to disposal facilities. However, each one of these waste streams is required to be chemically treated for local landfill burial.[21] Estimates of treated timber disposed to landfills add up to 420,000 tonnes each year.[22] Inventories kept by PCBUs are reviewed by WorkSafe inspectors (upon request) to ensure hazardous substances in the workplace are managed accordingly with the HSW (Hazardous Substances) Regulations 2017. However, the data presented in the inventory is confidential and is not collated in local or national databases.

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[17] http://archive.stats.govt.nz/infoshare/ViewTable.aspx?pxID=57c34410-1d02-44dc-9fa0-1537a91bc9c9

[18] The StatsNZ Infoshare tool report 14,790.407 tons of copper and copper articles imported. http://archive.stats.govt.nz/infoshare/ViewTable.aspx?pxID=d2f843a6-9030-45cb-be8c-3c5db353b015 [Accessed 16 November 2018]

[19] ERMA New Zealand. 2003. Report on Copper, Chromium and Arsenic (CCA) Treated Timber: http://www.ecotect.co.nz/_downloads/cca-report.pdf. [Accessed 25 January 2019]

[20] Regulation comes into force on 1 December 2019

[21] Waste containing arsenic must pass a Toxicity Characteristic Leaching Procedure (TCLP); a chemical analysis used to simulate leaching through a landfill that can identify if the waste is dangerous to the environment or not. Waste for disposal must contain less than 5 mg arsenic/L. Waste Management. pers, comm. 28 March 2019.)

[22] Estimate from which 11,500 (YTD2018) are accepted by the Redvale landfill. Waste Management, pers, comm. 19 November 2018.

Under the Basel Convention, arsenic-containing waste requires a permit from the EPA when it is to be exported. There are currently no permits for the export of arsenic itseld. However, the StatsNZ Infoshare tool presents general information on arsenic-containing waste exports. Slag, ash and residues containing metals, arsenic or their compounds were purchased by Australia and China in 2018 for NZD $182,232. Additionally, exports of waste and scraps of lead acid batteries were sold to the Republic of Korea for $21,547,273.[23;24] However, no information is available on the weight or amount of arsenic the exported waste might contain.

Overseas comparison

Releases and transfers of arsenic and their compounds are recorded in Europe's E-PRTR, Australia's National Pollutant Inventory (NPI), the USA's Toxics Release Inventory (TRI), Canada's National Pollutant Release Inventory (NPRI) and Japan's Pollutant Release and Transfer Register (PRTR). The table below shows the industrial sectors using or producing arsenic in Australia during 2016/ 2017. The information from each industrial sector and region can be further disaggregated, but not to the level of individual companies or sources.

Industry	Releases (kg)			Transfers (Kg)
	Air Emission	Land emission	Water emission	
Basic Non-Ferrous Metal Manufacturing	6,7176	394.3912301	1679.470883	8,400,000
Metal Ore Mining	5,7008	753.5644025	2701.787744	80,000
Paved/ Unpaved Roads	9,369	-	-	-
Coal Mining	5,480	719.8376512	248.2352541	240,000
Aeroplanes	2,256	-	-	-
Electricity Generation	1,423	0.873277444	141.133808	29,000
Windblown Dust	1,435	-	-	-
Basic Ferrous Metal Manufacturing	886	-	58.47	710
Water Supply, Sewerage and Drainage Services	9.7	0.09305	900.7432	-
Burning (fuel)/ Wildfires	634	-	-	-
Other Transport Equipment Manufacturing	575	0.006324	-	4.3
Glass and Glass Product Manufacturing	454	-	-	-
Water Transport Support Services	256	0.53737216	131.1101615	110
Oil and Gas Extraction	133	17.62742343	140.2303047	5.5
Other Non-Metallic Mineral Mining and Quarrying	234	4.4	51.32	27,000
Commercial Shipping/Boating	198	-	-	-
Fuel Combustion - sub reporting threshold facilities	195	-	-	-
Basic Chemical Manufacturing	155	0.0614116	13.371895	450
Cement, Lime, Plaster and Concrete Product Manufacturing	153	-	-	390
Ceramic Product Manufacturing	137	-	-	-
Fertiliser and Pesticide Manufacturing	14	19	72.9773	

[23] http://archive.stats.govt.nz/infoshare/ViewDataOptions.aspx?pxID=fcca54e6-f799-4a8c-b783-c000aaff6c99

[24] Arsenic is a significant component of lead based batteries. Recycling facilities accepting and exporting batteries for overseas processing include: EcoCentre in Wellington, Ecotech Services, Macaulay Metals and IT Recycla.

Construction Material Mining	100	-	-	-
Petroleum and Coal Product Manufacturing	20	0.41	73.6327	100
Waste Treatment, Disposal and Remediation Services	25	53.26562372	-	1,100,000
Pulp, Paper and Paperboard Manufacturing	6.4	70.007425	-	-
Solid fuel burning (domestic)	57	-	-	-
Log Sawmilling and Timber Dressing	40	-	-	7,800
Motor Vehicles	22	-	-	-
Other Wood Product Manufacturing	15	-	7.235	330
Meat and Meat Product Manufacturing	20	-	-	-
Sugar and Confectionery Manufacturing	16	-	-	-
Gaseous fuel burning (domestic)	9.3	-	-	-
Other Food Product Manufacturing	9.3	-	-	-
Recreational Boating	4.5	-	-	-
Liquid fuel burning (domestic)	4.4	-	-	-
Basic Ferrous Metal Product Manufacturing	3.8	-	-	650
Other Non-Metallic Mineral Product Manufacturing	3.8	-	-	-
Grain Mill and Cereal Product Manufacturing	2.7	-	-	-
Oil and Fat Manufacturing	2	-	-	-
Dairy Product Manufacturing	1.8	-	-	-
Fruit and Vegetable Processing	1.7	-	-	-

Arsenic summary

What we do know: Arsenic is a natural element used in different industrial sectors including timber treatment, agrochemical compounds, electronics, mining and smelting of metals. Human risks associated with arsenic are bladder, lung and skin cancer, and it can affect the central and peripheral nervous system. Arsenate (As^{V}) is part of chromated copper arsenate (CCA), the most commonly used chemical in timber preservation in New Zealand. Human risks associated with the use of CCA-treated timber are low when regulations are in place and followed, but the leachability of aged timber could lead to the contamination and accumulation of arsenic in soil. The EPA regulates the use of arsenic through conditions set under the HSNO Act 1996. Regional councils approve discharges of arsenic to air, soil and water through resource consent conditions. Regulations for arsenic-containing articles are however different given that they are not considered a hazardous substance, and therefore they don't fall under HSNO legislation.

What we don't know: Data on arsenic releases or transfers to disposal facilities are not collated nationally. Requirements to keep an inventory and label hazardous substances in workplaces were enforced in December 2017, and provisions to record waste information will be enforced on the 1st of June 2019. However, the information collected in these inventories is confidential and only accessible to workers and inspectors from WorkSafe and emergency services upon request.

Chlorinated solvents

Chlorinated solvents are non-flammable hydrocarbons, fundamental in a wide range of industrial applications such as cleaning and degreasing, and as solvents for other organic compounds. Some well recognised chlorinated solvents include trichloroethylene and perchloroethylene, both used in dry cleaning and metal cleaning, and methylene chloride which is used in paint stripper and in pharmaceuticals and chemical processes.

Chlorinated solvents evaporate easily and as a result, significant amounts of these compounds can be released to air during their transfer to tips, sewers, and landfill facilities. Big plumes of chlorinated solvents have been found in soil and groundwater reservoirs around the world. Around half of the efforts being made globally to remediate groundwater are focused on cleaning up sites contaminated with these chlorinated compounds.[1]In New Zealand however, soil and groundwater are not monitored for the presence of chlorinated solvents.

Chlorinated solvents are harmful to humans and to ecosystem health.[2] They can cause, or are suspected of causing, respiratory depression, hepatic and renal toxicity, and a range of cancers in humans. Chlorinated solvents are also toxic to aquatic organisms, inhibiting central nervous system functions and causing respiratory irritation. Specific solvents such as perchloroethylene have also shown to be mutagenic to humans. Assessments conducted on workers exposed to high levels of this solvent in dry-cleaning environments showed positive associations with bladder cancer.[3] Furthermore, all chlorine-containing materials can lead to the formation of dioxins following incomplete combustion.[4] Dioxins are persistent environmental pollutants known to accumulate in the food chain.

National regulations

The EPA and WorkSafe are involved in setting regulatory requirements for chlorinated solvents. The EPA sets controls for non-working places and for the protection of the environment under the HSNO Act 1996 and the Hazardous Substances Notice 2017. WorkSafe enforces regulations for the use of chlorinated solvents at workplaces under section 212 of the HSW Act 2015 and the HSW (Hazardous Substances) Regulations 2017. Controls from HSW legislation require a PCBU[5] to keep records of the application of chlorinated solvents classified as being acutely toxic (classes 6.1A, 6.1B, 6.1C), known or presumed to be human mutagens (6.6A), suspected to be human mutagens (6.7A), and corrosive to skin (substances from classes 8.2A and 8.2B). Requirements to be included in the inventory include volumes of chlorinated solvents stored, and volumes of chlorinated solvents waste stored at the workplace. WorkSafe inspectors use the information from the inventories (upon request) to ensure hazardous substances in the workplace are managed accordingly with the HSW Hazardous Substances Regulations.

Under part 19 of the HSW (Hazardous Substance) Regulations 2017, chlorinated solvents with hazardous classification 6.1A and 6.1B (such as Phenyl chloroformate, Carbon tetrachloride and Methyl chloroformate) require tracking for each phase of their life cycle. This includes recording the

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[1] https://www.wasteminz.org.nz/wp-content/uploads/Ben-Keet1.pdf [Accessed 23 November 2018]
[2] Hazard classification: 2.1.1A, 6.1D (All), 6.1D (O), 6.1E (I), 6.5B, 6.6A, 6.7A, 6.9A (All), 6.9A (I), 9.3B
[3] https://worksafe.govt.nz/dmsdocument/3489-workplace-exposure-standard-wes-review-perchloroethylene
[4] Zhang, M, Buekens, A., Jiang, X., Li, X. 2015. Dioxins and polyvinylchloride in combustion and fires. *Waste Management Research*. 33, 630–643.
[5] PCBU: a Person Conducting a Business or Undertaking. The Act denotes all types of modern working arrangements commonly referred to as businesses.

location and movement of the chemical, from when they are imported or manufactured locally until their final use or disposal.[6]

Risks associates with perchloroethylene have been widely reviewed by the International Agency for Research on Cancer (IARC, 2014), the United States Department of Health and Human Services National Toxicology Program (NTP, 2016), and the European Scientific Committee on Occupational Exposure Limits (SCOEL, 2009). By the end of last year, WorkSafe lowered the Worksafe Exposure Standard- Time Weighted Average (WES-TWA) value to 20 ppm (136mg/m^3) and the Short Term Exposure Limit (WES-STEL) to 40ppm (271mg/m^3), to minimise potential neurotoxic effects, upper respiratory track irritation and liver and kidney damage associated with high exposure to the chemical.[7] Workplace Exposure Standards (WES) are intended to be used as reference guidelines at workplaces, and are not a prescribed exposure standard.

Data availability

Imports data (collected by Customs NZ) can be obtained on the StatsNZ website, which includes a range of unspecific chlorinated solvents. In the case of perchloroethylene and tetraethylene, the only information available is the import costs of unsaturated chlorinated derivatives for each compound, which added up to $245,974 and $117,338 respectively over the 2018 year. However, no data is publicly available for volumes of these chlorinated compounds used per year. In 2015, StatsNZ indicated that 4,140 New Zealand workers were employed in the laundry and dry cleaning services industry, where perchloroethylene and tetrachloroethylene and used. However the number of workers potentially exposed to these substances cannot be inferred from these figures.

No reports exist for the export of perchloroethylene, tetraethylene or vinyl chloride.[8]

Overseas comparison

The wide use of chlorinated solvents around the world has resulted in legislation initiatives such as the European Solvents Emission Directive to limit emissions of volatile organic compounds from the use of organic solvents. The USA, the European Union, Japan and Canada report on chlorinated solvents releases and transfers to their pollution registers. The table below shows the releases and transfers of vinyl chloride, one of the multiple chlorinated compounds reported in international PRTRs.

[6] http://www.legislation.govt.nz/regulation/public/2017/0131/latest/DLM7311086.html?search=ts_act%40bill%40regulation%40deemedreg_hazardous+substances*_resel_25_a&p=2

[7] https://worksafe.govt.nz/dmsdocument/3489-workplace-exposure-standard-wes-review-perchloroethylene

[8] https://www.stats.govt.nz/tools/stats-infoshare

Country		Releases				
	Year	Air emission	Surface water discharge	Land Emissions	Landfills	Total releases
Belgium	2013	175,260.0	148.5	NR	NR	175,408.5
	2015	88,780.0	855	NR	NR	89,635.0
Czech Republic	2013	NR	NR	NR	NR	NR
	2015	48,500.0	NR	NR	NR	48,500.0
France	2013	235,300.0	666.3	NR	NR	235,966.3
	2015	146,990.0	56.6	NR	NR	147,046.6
Japan	2013	79,435.0	3,570.9	NR	NR	83,005.9
	2014	82,051.00	4,060.10	NR	0.1	86,111.2
	2015	66,292.0	4,894.0	NR	NR	71,186.0
USA	2013	14,970.3	21.8	NR	4.55	14,996.7
	2014	14,975.3	26.3	NR	6.82	15,008.5
	2015	9,695.0	12.2	NR	6,625.4	16,332.7

Country		Transfers				
	Year	Off-site transfers in waste	Off-site transfers to treatment	Off-site transfers for recycling	Off-site transfers for energy recovery	Transfers to sewage
Belgium	2013	NR	NR	NR	NR	NR
	2015	NR	NR	NR	NR	NR
Czech	2013	NR	NR	NR	NR	NR
Republic	2015	NR	NR	NR	NR	NR
France	2013	NR	NR	NR	NR	148
	2015	NR	NR	NR	NR	79.8
Japan	2013	203,101.2	NR	NR	NR	6.1
	2014	275,039.0	NR	NR	NR	NR
	2015	244,039.0	NR	NR	NR	NR
USA	2013	32,781.1	33.2	NR	2,755.0	2.2
	2014	19,871.0	101.5	NR	2,667.7	2.0
	2015	22,807.6	73.3	NR	3,918.1	2.0

Chlorinated solvents summary

What we do know: Chlorinated solvents are non-flammable hydrocarbons used in a wide range of industrial applications. They are suspected of causing cancer, and are toxic to aquatic organisms. Specific solvents such as trichloroethylene, perchloroethylene and methyl chloride have also been shown to be clastogenic and mutagenic to humans. While highly volatile, chlorinated solvents have been traced worldwide at significant levels in soil and groundwater systems. New Zealand collects data on unspecific chlorinated solvents imported to the country, and this information can be accessed from StatsNZ.

What we don't know: There is no information collated by a single authority for volumes of solvents used or emitted to the environment each year.

Atrazine (synthetic herbicide)

Atrazine is a wide spectrum herbicide commonly used in the control of broadleaf weeds and grass in horticultural crops. It belongs to the triazine class group, designed to inhibit plant photosynthesis by obstructing the transfer of electrons in the photosystem II. Atrazine is a persistent and stable compound with polar properties. These characteristics allow atrazine to be easily soluble in water, and leach into groundwater systems more easily than other herbicides. [1] As a consequence, it has been detected worldwide in ground, surface and drinking water, and can be transported to areas as far as 1000 km from the application site.[2]

The Institute of Environmental Science and Research (ESR) conducted a national groundwater pesticide survey in 2014 (published in 2016) and identified the presence of atrazine active compounds in 6 wells from 13 regions. While the concentrations were below toxicity limits for human consumption, research shows that drinking water guidelines are not always sufficient to protect groundwater and surface water ecosystems.[3] Atrazine is classified as an ecotoxic compound under the HSNO Act 1996 (Classes 9.1A (All), 9.1B (F), 9.2A and 9.3C), capable of triggering endocrine disruptive and genotoxic responses, which affect larval development, growth, and the immune systems of freshwater and marine organisms.[4]

Between December 2017 and January 2018 University of Otago researched atrazine concentrations in 36 agricultural streams across Southland, Canterbury and Waikato. They found the presence of the chemical in 72% of the samples, with concentrations ranging between 0.039 and 6.8 ng/l.[5]

National regulations

The management of atrazine is regulated under the Agricultural Compounds and Veterinary Medicines Act (ACVM) 1997, the HSNO Act 1996 in non-working environments, and the HSW Act 2015 in work places. The use of atrazine is a permitted activity for agricultural uses under regional plans, provided it complies with statutory rules (for examplemaximum application rate, frequency and interval).[6] Under circumstances where the use of atrazine doesn't comply with the conditions stated in regional plans (i.e. commercial use of the pesticide at public spaces), the applicant must provide information to regional councils on the application of the herbicide including date, location, volume and concentration applied, weather, method of discharge, and any adverse effect on the environment resulting from the herbicide application.

The EPA's Hazardous (Property Controls) Notice 2017 imposes controls on the application of atrazine in all places including workplaces.[7] The whole of Part 4 of this Notice is applicable to atrazine. The notice requires the recording of atrazine application in spray diaries, but this is limited to

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[1] The leachability of a compound is measured with Groundwater Ubiquity Scores (GUS). Scores above 2.8 indicate high leaching properties. Atrazine has a GUS score of 4.10.

[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2842049 [Accessed November 2018]

[3] Sub lethal effects of atrazine to freshwater organisms can occur at concentrations as low as 0.1mg/l, well below the Maximum Acceptable Values (MAV) set for drinking water.

[4] Zhu, L., Dong, X., Xie, H., Wang, J., Wang, J., Su, J. and Yu, C. 2011. DNA damage and effects on glutathione *S* transferase activity induced by atrazine exposure in zebrafish (*Danio rerio). Environmental Toxicology*. 26: 480-488.
Glen J. Van Der Kraak, Alan J. Hosmer, Mark L Hanson, Werner Kloas, Keith R Solomon. 2014. Effects of Atrazine in Fish, Amphibians, and Reptiles: An Analysis Based on Quantitative Weight of Evidence. Critical Reviews in Toxicology. 44: 1-66.

[5] Christoph Matthaei, New Zealand Freshwater Conference 2018. "Pesticides in New Zealand's running waters: a survey of agricultural streams". Nelson, New Zealand.

[6] A spray diary is required under regional rules of permitted agrochemicals only when the agrochemical used are applied by any means other than by hand operations (and manually pumped), and the area must not be located within 50 meters of properties or public areas.

[7] Atrazine is a class 9 hazardous compound under HSNO. EPA regulates class 9 substances in workplaces as these cannot be regulated under the HSW Act.

circumstances where pesticide application exceeds 3kg within 24 hours (section 48 of Hazardous Property Controls Notice 2017). Under the same Notice, there are also controls on maximum application rates, frequency, and intervals (clause 50), setting of buffer zones (clause 51), and Environmental Exposure Limits (EELs) (clause 49), with specific requirements for personnel qualification (Subpart C). [8] However, there is no requirement to provide recorded information to a regulatory authority on a regular basis.

HSNO requirements for the disposal of atrazine are set out in the Hazardous Substances (Disposal) Notice 2017. Atrazine cannot be fully destroyed by treatment facilities in New Zealand although some basic treatment can alkalise the substance. Full disposal requires export to a certified treatment facility.

The management of atrazine in work places is controlled by WorkSafe under the Health and Safety at Work Act 2015 (HSWA) regulation. Controls enforced by WorkSafe are those set in the HSW (Hazardous Substances) Regulations 2017. Under these regulations, a PCBU[9] is required to maintain an inventory of atrazine used, manufactured and stored. WorkSafe inspectors use the information from the inventories (upon request) to ensure hazardous substances in the workplace are managed accordingly with the HSW (Hazardous Substances) Regulations.

Under part 19 of the same regulations, atrazine products are not required to be tracked by a workplace PCBU throughout the life cycle of the pesticide.

Data availability

New Zealand Customs and StatsNZ collect information on herbicide products containing atrazine, and simazine, another triazine compound. While the information cannot be narrowed down to volumes of atrazine imported, 93,060 litres of triazine (the general group to which atrazine belongs) were reported in the last year.

There is no information available on volumes of atrazine used, disposed or transferred to treatment facilities. Waste facilities collect information on the amounts of atrazine transferred to disposal sites for internal reporting, but reporting to regulatory authorities is not mandatory.

Overseas comparison

Atrazine discharges and transfers are reported in all countries with a PRTR system where the herbicide is handled, including chemical manufacturers, crop producers, merchant wholesalers, waste management facilities and remediation services. In 2015, the OECD released a "*Resource compendium of PRTR release estimation techniques specific for diffuse sources*", with an emphasis on pesticide emissions (Section 4.5.1.5). Information on volumes of pesticide sold and used, and the concentration of chemical used, are reported annually so that releases can be estimated in all OECD countries. Japan provides an example of how diffuse releases from pesticides use can be estimated. Because household and farm use of pesticides generally falls below the reporting threshold, the Japanese Ministry of the Environment estimates pesticides releases based on area coverage, volumes of product purchased, and the properties of the chemical.

[8] https://www.epa.govt.nz/assets/Uploads/Documents/Hazardous-Substances/EPA-Notices/Hazardous-Substances-Hazardous-Property-Controls-Notice-2017.pdf [Accessed 9 January 2019]

[9] PCBU: a Person Conducting a Business or Undertaking. The Act denotes all types of modern working arrangements commonly referred to as businesses

The table below shows the measured and estimated releases of atrazine in Japan over a 3 year period. Measurements are reported in kilograms.

	Releases					Transfers				
Year	Air emission	Surface water discharge	Land Emissions	Landfills	Total releases	Off-site transfers in waste	Off-site transfers to treatment	Off-site transfers for recycling	Off-site transfers for energy recovery	Transfers to sewage
2013	0.7	NR	NR	NR	60,298.9	170	NR	NR	NR	NR
2014	0.7	NR	NR	NR	63,036.1	104	NR	NR	NR	NR
2015	1	NR	NR	NR	55,121.0	76	NR	NR	NR	NR

NR= Data not reported

Atrazine summary

What we do know: Atrazine is a wide spectrum herbicide commonly used in the control of broadleaf weeds and grass in horticulture crops. It is classified as an ecotoxic compound capable of triggering endocrine disruptive and genotoxic responses, affecting larval development and the immune system of freshwater and marine organisms. New Zealand Customs collects data on imported herbicides, but information cannot be narrowed down to volumes of atrazine, or to the locations where the products are sold or used. All HSNO controls specified in Part 4 of the Control Notice 2017 apply to atrazine. In addition, the use of atrazine is a permitted activity under regional plans, provided it complies with statutory rules. Under circumstances where the rules can't be fulfilled, a resource consent issued by the regional council is needed. At the national level, inventories for pesticides in groundwater systems are nationally conducted every 4 years. The latest report is currently underway. While national surveys have not been conducted to monitor pesticides in surface waters in agricultural areas, a recent study conducted in 36 streams around New Zealand identified the presence of atrazine in >70% of the tested samples.

What we don't know: There is a lack of information on volumes of atrazine used and released to the environment. The permitted use of herbicides with no reporting requirements (when usage complies with statutory rules) limits our knowledge of the environmental risk posed by non-point source chemicals, such as atrazine, entering the environment.

Glyphosate

Glyphosate is the most commonly used herbicide in New Zealand. It is a broad-spectrum organophosphonate compound designed to kill plants such as broadleaf weeds and grasses. It inhibits the enzyme 5-enolpyruvylshikimate-3-phosphate synthase, a protein essential for plant growth. Glyphosate is also widely used as a crop desiccant prior to harvest but no records are available on the extent of such use in New Zealand. Glyphosate has low mobility in soil due to its high affinity for soil particles, which allows it to persist in soils for up to 6 months (soil type and bacteria dependent). However, the strong bonds with soil reduce glyphosate exposure and risk to groundwater bodies.

New Zealand has used glyphosate since 1976, and currently has twenty-five manufacturing companies producing more than 90 glyphosate products registered as agricultural compounds and veterinary medicines (ACVM) and approved by the Environmental Protection Agency (EPA). The high demand for glyphosate has led to its inclusion in the Food Residues Survey Programme managed by the Ministry for Primary Industries (MPI), which compares tested samples with guideline Maximum Residue Levels (MRL). The 2015-2016 survey (published in 2017) found glyphosate traces above MRL in 20 out of 60 wheat samples. However, none of the samples were assessed as posing a risk to human safety. A follow up investigation identified that the majority of farmers followed the controls stated on the label, suggesting that the problem is the default MRL of 0.1mg/kg. MPI will initiate a reassessment of the pre-harvest label claims which may clarify label directions and set specific MRLs for glyphosate.[1] However, recent studies focusing on the different modes of toxicity of glyphosate have shown effects on a range of non-target organisms. [2,3]

In 2016 the International Agency for Research on Cancer (IARC) re-classified glyphosate as a probable human carcinogen (class 2A). However, the conclusions reached by the IARC conflict with those from reports released by the US EPA, the European Food Safety Authority and the European Chemicals Agency. The Joint meeting on Pesticides Residues (JMPR) and Australia's APVMA also suggest that glyphosate does not pose risks when used as intended.

Concerns about the risks of glyphosate have led to calls to reassess its approval in New Zealand but no formal application has been lodged to the EPA. In 2018 the EPA revisited their reassessment programme and expanded its scope to look at 700 chemicals from all sectors. The EPA's screening process did not prioritise glyphosate in the reassessment programme due to its low-risk profile when compared to other hazardous compounds[4]. The EPA maintains a 'watching brief' on all approved hazardous substances, and as new information comes to hand it can reprioritise its focus on chemicals with higher risk profiles'.[5]

National regulations

The EPA and WorkSafe are involved in the approval and setting of regulatory requirements for glyphosate. The EPA sets controls for non-work places and for the protection of the environment under the Hazardous Substances New Organisms (HSNO) Act 1996 and the Hazardous Substances Notice (2017). WorkSafe regulates the use of glyphosate in workplaces by enforcing section 212 of

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[1] MPI assessed the samples with values above MRL and concluded that there was no food safety concern. The rationale behind this was that a person would have to consume 14 kg of wheat-based products containing glyphosate traces of 5.9mg/kg (which is well above the 0.1mg/kg MRL value for glyphosate) on a daily basis to reach the acceptable daily intake for glyphosate. The acceptable daily intake of glyphosate is set at 0.5mg/kg body weight per day.

[2] Zebral, Y.D., Lansini L.R., Costa P.G., Roza M., Bianchini A., Robaldo R.B. 2018. A glyphosate-based herbicide reduces fertility, embryonic upper thermal tolerance and alters embryonic diapause of the threatened annual fish *Austrolebias nigrofasciatus*. *Chemosphere*, 196: 260-269.

Lopes, F.M., Varela Junior A.S., Corcini C.D., da Silva A.C., Guazzelli, V.G., Tavares G., da Rosa C.E. 2014. Effect of glyphosate on the sperm quality of zebrafish *Danio rerio*. *Aquatic toxicology*, 155: 322-326.

[3] http://theconversation.com/new-research-suggests-common-herbicides-are-linked-to-antibiotic-resistance-87678 [Accessed 12 December 2018]

[4] https://www.epa.govt.nz/industry-areas/hazardous-substances/chemical-reassessment-programme/priority-chemicals-list/ [Accessed 4 December 2018]

[5] https://www.epa.govt.nz/industry-areas/hazardous-substances/chemical-reassessment-programme/priority-chemicals-list/ [Accessed 4 December 2018]

the Health and Safety at Work HSW Act 2015 (HSWA), and the controls set in the Health and Safety at Work (Hazardous Substances) Regulations 2017. Under these controls, a PCBU[6] is required to maintain an inventory of hazardous substances used, manufactured and stored. WorkSafe inspectors use the information from the inventories (upon request) to ensure hazardous substances in the workplace are managed accordingly with the Hazardous Substances Regulations.
Glyphosate products are not required to be tracked by a workplace PCBU throughout their life cycle under part 19 of the HSW (Hazardous Substance) Regulations 2017. In addition, the EPA sets the requirements for labelling, packaging, and for safety data sheets, in all places under EPA Notices.

MPI regulates the use of glyphosate through the registration of the product under the ACVM Act 1997. MPI has also set maximum residue levels for pesticides in crops and raw milk under the Food Notice 2018[7], and conducts routine tests on products.

Data availability

No information on glyphosate is available in New Zealand Customs or StatsNZ inventories. Likewise, no sales information is collated across the country.[8] A minimal amount of glyphosate is received by waste treatment companies (<10kg/year)[9] as purchased chemical is usually fully used.

In 2015 MPI published a list of crops allowed to be treated with glyphosate-containing products. However, there is no information available on where or what amounts of glyphosate are used per region or nationwide. Information on pesticides used and handled by facilities is confidential and is not collected in regional or national databases[10].

Groundwater pesticide trace surveys are conducted every four years across the country. Surveys prior to 2018 excluded glyphosate due to the lack of methods to analyse the compound's concentrations. This year's survey will be the first attempt to identify traces of glyphosate in groundwater systems, using a separate suite of analysis in laboratory.

Overseas comparison

Glyphosate has not yet been included in any pollution release register in the world. The selection of chemicals for Pollution Release and Transfer Register (PRTR) reporting relies on hazard and exposure characteristics. Information available on glyphosate hazard suggests that any risks fall below the relevant thresholds.

The new evidence on hazards associated with glyphosate exposure may influence its inclusion in PRTRs from Japan, Canada and the USA.

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[6] PCBU: a Person Conducting a Business or Undertaking. The Act denotes all types of modern working arrangements commonly referred to as businesses.
[7] https://www.mpi.govt.nz/dmsdocument/19550/loggedIn
[8] MPI does not collect information on sales or use of pesticides imported or manufactured domestically. The label provides information on how much pesticide should be used to control the pest/disease on a crop or use situation (i.e. good agricultural practice). MPI does not generally make it a legal requirement to comply with the label directions (MPI, pers. comm. 10 October 2018).
[9] Pers. comm. Waste Management (November 2018)
[10] The regulations were not written with the intention that WorkSafe would capture the information in a database.

Glyphosate summary

What we do know: Glyphosate is the most widely herbicide in New Zealand, with more than 90 glyphosate-based products approved. MPI monitors glyphosate traces in food under the Food Residues Survey Programme. The risks of glyphosate to human health are not unanimously agreed on, and conflicting conclusion have been reached by different international agencies. Studies on environmental risks associated with the use of glyphosate at doses considered safe have shown shifts in community composition in soil microbiota, and in the gut microbiome from terrestrial mammals.

What we don't know: Records of glyphosate imports, sales, usage and disposed volumes are limited. New Zealand Customs collects data on herbicide imports but it cannot be narrowed down to specific amounts of glyphosate or to the locations where the products are sold or used. Some businesses record glyphosate use for internal reporting, but there is no mandatory requirement to provide this information to regional authorities. There is no publically available data on the presence of glyphosate in waterbodies; the 2018 groundwater survey will be the first one to measure glyphosate traces in water wells.

Synthetic insecticides (neonicotinoids)

Neonicotinoids are systemic insecticides that have been used in New Zealand and Australia for over 20 years. They are designed to be applied to plants directly or as seed coating, where they are absorbed and transported throughout the plant's tissues, including pollen and nectar. When insects come in contact with treated plants, their central nervous system becomes inhibited, leading to paralysis and eventual death.

The neonicotinoid class can be divided into five compounds: clothianidin, imidacloprid, thiamethoxam, acetamiprid and thiacloprid. All these compounds are available in New Zealand in different forms, such as seed coating (used in maize, cereals and grass), soil granules and foliar spray (used in orchards and other crops). In April 2018, the European Union banned the use of clothianidin, imidacloprid and thiamethoxam following risk assessments presented by the European Food Safety Authority (EFSA). On the basis of the same EFSA report, the use of acetamiprid was approved under strict greenhouse conditions until 2033, and thiacloprid was added to the list of candidate pesticides for substitution for a more favourable alternative, and its approval expires on April 2019.

The occurrence of neonicotinoid compounds in the environment, and the level of contamination in the soil and in water bodies, remains unreported nationally in New Zealand. While coated seeds were believed to have a low leaching potential, overseas studies have found that only between 1.6 and 4.9% of imidacloprid is absorbed by the plant, and the remaining is leached into the soil[1]. The first survey on pesticides in 36 streams across agricultural areas in New Zealand was conducted this year by a research group from Otago University, and showed the presence of imidacloprid, clothianidin and thiamethoxam in 22, 8 and 3% of the samples[2]. The highest concentrations measured were below environmental exposure limits (EELs) (38ng/l for imidacloprid and 350ng/l for thiamethoxam). A follow up study further demonstrated the effects of neonicotinoids in the swimming impairment and mortality of a New Zealand native mayfly when using concentrations of imidacloprid found in international surveyed streams (geometric mean concentration in surveys: 0.73µg/l). However, not much is known about the chronic effects of these compounds on other non-target organisms and to the environment.

National regulations

The EPA and WorkSafe are involved in setting regulatory requirements for neonicotinoids. The EPA sets controls for non-working places and for the protection of the environment under the HSNO Act 1996 and the Hazardous Substances Notice 2017. Under HSNO Act sections 5, 6 and 7, the EPA must prevent adverse effects of hazardous substances to the environment and human wellbeing, and should only approve substances that comply with conditions set in section 29 of the act.

There are a number of controls on the use of neonicotinoids in New Zealand. Regulatory controls set by the EPA are strict for the use of foliar spray in areas close to hives, crops frequently visited by bees, and during flowering and budding seasons. Additionally, records of application of pesticides and plant growth regulators are to be kept by a PCBU[3] if 3kg or more of the substance is applied within 24 hours in places where the substance is likely to leave the application area as spray drift (HPC Notice Part 4 Clause 48)[4]. Since 2008 the EPA has been adding controls to the use of seeds coated with neonicotinoids in New Zealand. However, regulatory conditions aren't set under HSNO for imported

[1] Sur, R. and Stork, A. 2003. Uptake, translocation and metabolism of imidacloprid in plants. *Bulletin of Insectology*, *56*, pp.35-40.
[2] Christoph Matthaei, New Zealand Freshwater Conference 2018, Nelson New Zealand. "Pesticides in New Zealand's running waters: a survey of agricultural streams". Samples in the study were collected during a drought season. Given that imidacloprid tends to be persistent under aerobic soil, it may be transported through runoff periods.
[3] PCBU: a Person Conducting a Business or Undertaking. The Act denotes all types of modern working arrangements commonly referred to as businesses.
[4] https://www.epa.govt.nz/assets/Uploads/Documents/Hazardous-Substances/EPA-Notices/Hazardous-Substances-Hazardous-Property-Controls-Notice-2017.pdf [Accessed 10 October 2018].

neonicotinoid-coated seeds[5], which are intensively used in crop farms and in dairy farms as the main source of maize, brassicas and grass for cattle feeding[6].

Clause 13 of the Hazardous Property Control Notice, enforced by the EPA, restricts the supply of certain substances for the use of neonicotinoids in workplaces only, and requires the recording of who they sell the product to. However, this provision only applies to class 6.1C substances.

WorkSafe regulates the use of neonicotinoids in workplaces by enforcing section 212 of the HSW Act 2015, and the controls set in the Hazardous Substances Regulations.[7] Some of the controls applied to active compounds are different to those applied to formulated products containing the active compound. Most of the neonicotinoid formulated products approved under HSNO are classes 6.1D or 6.1E, or are not class 6 products. This means they are not required to be tracked under HSW Hazardous Substances Regulations. The tracking of pure active ingredients (class 6.1C) was compulsory under HSNO before December 2017, but this requirement is no longer required under part 19 of the HSW (Hazardous Substances) Regulations 2017.

MPI also regulates neonicotinoids in the food safety context. It manages monitoring programmes that seek to ensure neonicotinoid residues in animal and plant food products comply with national standards.[8] These programmes align with the Animal Products Act 1999 and the ACVM Act 1997 regulations. While samples from monitoring in 2015/16 show no detectable levels of neonicotinoids in honey, a worldwide survey showed that New Zealand samples contained traces of neonicotinoids above the detection limit, although all of them were still below the maximum level for consumption, posing no risk to human health.[9]

Data availability

There is no systematic reporting for neonicotinoids released in New Zealand at a regional or national level. Likewise, no specific information is available on imports or manufacturing of neonicotinoids in the country or of the volumes applied.[10] In August 2018 the EPA opened a call for neonicotinoids' manufacturers, suppliers, users and researchers to provide information on annual sales and amounts of clothianidin, imidacloprid and thiamethoxam manufactured and imported to New Zealand, and the concentrations of the active ingredients, quantities of neonicotinoids-coated seeds used across different agricultural practices, plus mitigation measures implemented to reduce neonicotinoid exposure to the environment. The call also requested ecotoxicological information for neonicotinoid-containing products, and environmental monitoring conducted in areas exposed to these products.

Overseas comparison

Neonicotinoids are not included in other PRTRs due to the lack of information available on the effects to organisms or the environment. The banning of these compounds in the EU will restrict the release of these compounds to the environment.

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[5] Under the HSNO Act, hazardous substances are regulated by the EPA, which has set controls to the neonicotinoid products applied to the seeds treated in New Zealand. However, imported treated seeds are not regulated under HSNO at present.

[6] Pers. comm. NZFF conference, Nelson 2018. Dairy farmers grown grass, brassicas and maize from neonicotinoids coated seeds as nutritional complement to cattle.

[7] Provisions 13.3 and 13.4 of the Health and Safety at Work (Hazardous Substances) apply to neonicotinoids class 6.1A, 6.1B, 6.1C, 6.6A, 6.7A, 8.2A, or 8.2B. Not all formulated compounds of neonicotinoids fall in this criteria, http://www.legislation.govt.nz/regulation/public/2017/0131/latest/DLM7366700.html

[8] https://www.foodsafety.govt.nz/elibrary/industry/consolidated-list-of-tests-for-animal-products.pdf [Accessed 19 November 2018]

[9] http://science.sciencemag.org/content/358/6359/109 [Accessed 21 November 2018]

[10] StatsNZ Infoshare tool. http://archive.stats.govt.nz/infoshare [Accessed 30 November 2018] and New Zealand Customs, pers. comm, 5 December 2018.

Neonicotinoids summary

What we do know: Neonicotinoids are systemic insecticides designed to be absorbed and transported through plants tissues, nectar and pollen. Recent research has raised concerns over the risk of neonicotinoids to pollinators and to invertebrates in freshwater ecosystems. New Zealand has strict controls on the use of neonicotinoids as foliar sprays, but only has controls on seeds treated with neonicotinoids when the coating is applied within the country. On the food safety front, MPI manages monitoring programmes to ensure neonicotinoid residues in animal and plant food products comply with national standards, and conducts further investigations when pesticide threshold values are exceeded.

What we don't know: No specific information is available on the import or manufacturing of neonicotinoids in New Zealand, or the volumes of product applied to crop plantations. There is no systematic reporting on the exposure of pollinators to neonicotinoids, or the level of contamination in soil and in water bodies. Studies overseas have shown that the most commonly used neonicotinoids in seed coatings present high leaching potential. However, the leachability of neonicotinoids used in New Zealand is neither monitored nor reported.