Chemical Drains:

New Zealand's new NPS-FW freshwater policy is not watertight.

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Introduction

Introduction

> Choices between promoting GDP and protecting the environment may be false choices, once environmental degradation is appropriately included in our measurement of economic performance.[1]

New Zealand policy concerning chemical contaminants, freshwater has delicately tripped around the subject of intensive chemical use in our environment.

Our regions may be required to protect and enhance New Zealand water, but without regulatory leadership chemical pollution will continue unchecked.

In June 2017, freshwater scientists, public health advocates, tourism industry representatives, environmental organisations, doctors & academics presented a Freshwater Rescue Plan[2], this released in response to the New Zealand National Policy Statement for Freshwater Management 2014. It was widely considered by the broader scientific community that the pollutant limits were weak, and, as such, unable to effectively protect water quality. The Freshwater Action Plan comprises seven important steps, and provides the critical framework for any freshwater strategy moving forward.

This paper seeks to explore the other massive gap in the recently updated New Zealand National Policy Statement for Freshwater Management 2014 (NPS-FW).[3] It may be argued that the NPS-FW leaks like a sieve. Increasing pressure from urban, industrial and agricultural chemical pollution, has resulted in a new risk - 'chemical intensification.' There are no nationally established parameters (recognised as 'attributes') for synthetic organic compounds.

In light of New Zealand's declining water quality, our restrictive stance on freshwater seems naïve at best, dangerous at worst.

Current economic and political policy appears to assume synthetic organic chemical compounds, particularly pesticides, are dispersed and degraded to a degree that they are harmless. This is incorrect. Environmental chemicals, including pesticides can be highly mobile, much more persistent, and more toxic than previously considered. The more chemicals are present the more harm occurs – either via acute lethal or chronic long-term effects.[4]

If we have not the science nor a public interest driven mandate to grasp the complexity of chemicals in our aquatic ecosystems, we will be blinkered and powerless act to future-proof our freshwater and marine systems.

New Zealand media and the public discuss the 'nutrients' that harm our waterways – they are chemicals, nitrogen and phosphorous, that act as nutrients. Let's call them chemicals.

There is no national trigger nor budget that provides scientists with a broad scope to investigate and understand chemical contaminants of emerging concern (what may be referred to as emerging

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[1] Report by the Commission on the Measurement of Economic Performance and Social Progress. 2008. Professor Joseph E. Stiglitz, ; Professor Amartya Sen; Professor Jean-Paul Fitoussi. http://graphics8.nytimes.com/packages/pdf/business/Stiglitzreport.pdf

[2] https://www.freshwaterrescueplan.org/

[3] New Zealand National Policy Statement for Freshwater Management 2014, which was u*pdated August 2017 to incorporate amendments from the National Policy Statement for Freshwater Amendment Order 2017*. http://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/nps-freshwater-ameneded-2017_0.pdf

[4] Malaj et al 2014. Organic chemicals jeopardize the health of freshwater ecosystems on the continental scale. Proc Natl Acad Sci U S A. 2014 Jul 1;111(26):9549-54. doi: 10.1073/pnas.1321082111

pollutants).[5] There is no national trigger nor budget to track heavily used pesticides in freshwater and sediment to understand contaminant chemical profiles that may be at risk of leaching into groundwater.

Complex systems have unexpected outcomes. New Zealand citizens deserve dedicated science in place to monitor, research and understand the toxicities synergies specific to the New Zealand 'exposome' in the twenty-first century. Our legislation demands that government employees protect and prevent harm to New Zealand people and the environment.

It's not just the regulations, resourcing for research in the public interest is inadequate to understand the chemical signatures in the New Zealand environment. Desperate scientists, fully aware of the challenge facing them, require funding and freedom to consider the chemical signatures in our environment. Restricted by already outdated regulations, and with no budget to engage permanent staff – for this problem will not go away, we are

In a nutshell, what could be done to address 21st century chemical challenges?

1. *Recognition that when science changes, if lower order rules and guidelines do not 'update' they may not be fit to fulfil the purpose of the Act of Parliament under which public servants operate. If public servants do not use the most relevant knowledge available (basing decisions on relevant considerations) their actions may be deemed, for example, invalid, illegal or unreasonable.*
2. *Recognition that the 'science is rarely settled'. Thus, while science will inform us, decision-making based on science must have an ethical base that serves the public interest and as a precaution, allows for future unknowns.*
3. *A pivot to public discourse that recognises pollution from environmental chemicals rather than focusing on a narrow range of 'nutrients.' Nitrogen & phosphorous are chemicals that act as nutrients*
4. *A nationally driven mandate to research and understand the complex chemical profiles that combine to pollute our freshwater and make it uninhabitable for aquatic life*
5. *Committed science to analyse the cumulative sub-lethal toxicity and risk of endocrine disruption at parts per billion*
6. *Clear analysis of chemical classes (and breakdown substances) that affect similar biological pathways (not just registered 'active ingredients')*
7. *A nationally funded program to assist Regional Councils to carry out legal obligations*
8. *Political will and action on triggers: The ethics and courage to restrict the hazardous chemicals that are profiling in our freshwater and groundwater systems – quickly*
9. *Reintroduction of publicly funded agricultural extension services to incorporate new science in soil management that reduces chemical inputs and improves soil quality.*
10. *Harmonisation with European pesticide authorisations & EOC restrictions to ensure foreign market access is not compromised by unauthorised contaminants*
11. *Acknowledgement of the worrying role of popularly used herbicides in antimicrobial resistance*

[5] 'EPs are categorized into more than 20 classes related to their origin (www.norman-network.net). The prominent classes are: pharmaceuticals (urban, stock farming), pesticides (agriculture), disinfection by-products (urban, industry), wood preservation and industrial chemicals (industry).' Geissen et al 2015 Emerging pollutants in the environment: A challenge for water resource management https://doi.org/10.1016/j.iswcr.2015.03.002

12. *Recognition that where science is 'undone' – instead of inaction we must act with precaution to protect future water sources. We cannot scrub our groundwater clean*

It's clear that freshwater and marine sediment can form a 'sink' helping chemicals to accumulate and persist. Darkened groundwater environments also ensure that toxic chemical breakdown products (metabolites), can last much longer.

Lack or response to new chemical challenges means that much science remains 'undone.' 'The 'data drought' facing hydrological pollution information is particularly concerning given the social benefits and vital importance of water resources.'[6]

If there is no science to detect a chemical – there can be no breach of standards, no budget to manage a clean-up, no public anxiety, and no restrictions on the industry or councils responsible for the contamination in the first place.

As such, New Zealand freshwater policies to monitor and address eutrophication (nutrient overload), pathogen contamination, and organic pollution[7] must face the very real fact that chemical pollutant contaminants represent a global threat to health. While this paper primarily addresses diffuse agrichemical pollution, it must be recognised that chemicals from industrial and waste are part of this toxic risk profile. Scientists in this sector are desperately in need of greater resourcing for science in the public interest to address emerging challenges and understand, track and treat the chemical threats that have the potential to adversely impact future water security.

Without a comprehensive, transparent profile of environmental toxicity we 'are like pilots trying to steer a course without a reliable compass'[8]

Former Parliamentary Commissioner for the Environment Dr Morgan Williams recently described New Zealand's current approach to water management as 'splintered', arguing that while delivery of water is a local government function, he considered that in 'a strategic sense, it should be a central government function with central government investment to match.'[9]

As of 2017, there is no strategic mandate in place to protect the New Zealand environment to safeguard soil and water quality from toxic chemical contaminants. There is no ministerial portfolio for water. As the east coast of the North Island and Canterbury become dryer, the need to protect the quality of existing (shrinking) water sources will become more urgent.

New Zealand is faced with a currently overwhelming onslaught from chemical technologies that end up as chemical pollution – yet bereft of budget and political will to engage and adopt the technology and science to meet this challenge head on.

This paper demonstrates that our current trajectory is untenable. New Zealand cannot afford to ignore the current challenges, nor make the current system more complicated, and it doesn't need to be.

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[6] Albert Cho, Alex Fischer, Martin Doyle, Marc Levy, Paola Kim-Blanco and Randolf Webb. "The Value of Water Information: Overcoming the Global Data Drought." Xylem Inc. White Paper, August 2017. http://xylem.com/waterdata.

[7] Organic pollution (eg. Domestic and industrial wastewater; nutrient runoff) is contamination of decomposable organic compounds in freshwater and reduces dissolved oxygen, essential for health of aquatic fauna.

[8] Stiglitz et al 2008. Report by the Commission on the Measurement of Economic Performance and Social Progress.

[9] A national strategy for water is needed, scientist says. C.Sivignon. *Stuff.* Dec 8 2017. http://www.stuff.co.nz/environment/98419845/climate-change-faster-than-expected-says-scientist-dr-morgan-williams

Success can come from leadership that acknowledges the future security of New Zealand is intricately tied to the long-term wellbeing of our farmers, and undoubtedly, the health of our soil and water.

The science must not be shaped by political convenience, and it must reflect the urgency of the global challenge we face.

1. Chemical Pollution & Planetary Boundaries

International responsibility to *prevent* pollution and *protect* water

> "Pollution prevention", or "source control of pollutants", is the banning, avoidance, reduction, or elimination of a contamination at the source.

As water becomes more polluted, clean water becomes more precious. It is accepted that human activities are shaping our planet to such a degree that we have moved from the Holocene into a new geological epoch, the Anthropocene.

In 2017 The Lancet Commission on pollution and health reported:

> More than 140·000 new chemicals and pesticides have been synthesised since 1950. Of these materials, the 5000 that are produced in greatest volume have become widely dispersed in the environment and are responsible for nearly universal human exposure. Fewer than half of these high-production volume chemicals have undergone any testing for safety or toxicity, and rigorous pre-market evaluation of new chemicals has become mandatory in only the past decade and in only a few high-income countries.[10]

New knowledge that human activities can negatively impact planetary activities, carries with it appreciation of a global responsibility to take steps to prevent the degradation of our environment.

The 1972 Stockholm Declaration on the Human Environment, principle one advised that man:

> 'bears a solemn responsibility to protect and improve the environment for present and future generations…. While Principle 2 states that 'natural ecosystems, must be safeguarded for the benefit of present and future generations '[11]

The 2015 United Nations Sustainable Development Goals (SDGs) comprise 17 voluntary goals, agreed on by UN countries including New Zealand. The SDGs include a specific goal (SDG 6) to ensure the 'availability and sustainable management of water and sanitation for all.'

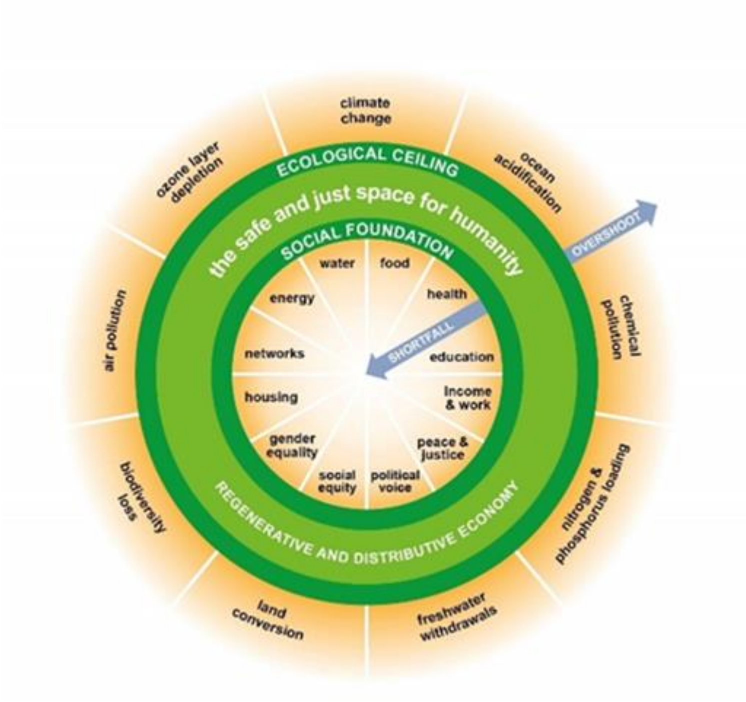
Protection of freshwater ecosystems (and therefore adequate information of water health) are recognised as essential to human health, environmental sustainability and economic prosperity.

[10] Landrigan et al 2017. The *Lancet* Commission on pollution and health. http://dx.doi.org/10.1016/S0140-6736(17)32345-0
[11] Stockholm Declaration on the Human Environment of the United Nations Conference on the Human Environment. Jun. 16, 1972 http://webarchive.loc.gov/all/20150314024203/http%3A//www.unep.org/Documents.Multilingual/Default.asp?documentid%3D97%26articleid%3D1503

Freshwater health impacts entire system health. Logically, SDG 6 is integral to attaining nearly all 17 of the Sustainable Development Goals (UN Water 2016)[12]

Chemical Pollution: Ensuring a 'safe operating space'

The 2009 Planetary Boundaries[13] approach aims to find a 'safe operating space' for human societies to develop and thrive. Scientist Will Steffen and colleagues have defined planetary level thresholds where, if ecological systems degrade beyond these points, the result would likely be 'devastating for human societies.' New Zealand is monitoring many of these thresholds, including carbon, phosphorous and nitrogen.



Graphic from 'Doughnut Economics – Seven Ways to Think Like a 21st Century Economist. K. Raworth.

The 2015 update included 'novel entities.' New forms of existing substances and modified life-forms that have the potential for unwanted geophysical and/or biological effects that are of concern because they persist in the environment, are highly mobile, and they can potentially harm vital life Earth System processes of sub-systems. This primarily acknowledges risk to people and the environment from recent 'chemical intensification' driving chemical pollution. (It also addresses unanticipated effects and ecological disruption resulting from unwanted (volunteer) genetically engineered organisms that have escaped into the environment.)

A 2017 FAO report stated: 'agricultural pollution has already overtaken contamination from settlements and industries as the major factor in the degradation of inland and coastal waters.' It calls the increasing levels of pollution in water a 'crisis', noting that irrigation has played a strategic role in transferring agricultural pollution to water bodies. Significantly it did not confine discussion of pollution to nutrient runoff, stating:

> 'Major agricultural contributors to water pollution (and the main targets for water pollution control) are nutrients, pesticides, salts, sediments, organic carbon, pathogens, metals and drug residues.'

[12] United Nations Sustainable Development. https://sustainabledevelopment.un.org/sdgs Note: Goal 6 will be reviewed in depth at the high level political forum in 2018.

[13] Steffen, W.; Richardson, K.; Rockström, J.; Cornell, S.E.; Fetzer, I.; Bennett, E.M.; Biggs, R.; Carpenter, S.R.; de Vries, W.; de Wit, C.A.; Folke, C.; Gerten, D.; Heinke, J.; Mace, G.M.; Persson, L.M.; Ramanathan, V.; Reyers, B.; Sörlin, S. Planetary boundaries: Guiding human development on a changing planet. Science (2015) 347 (6223) 1259855-1259855. [DOI: 10.1126/science.1259855]

Pesticides, include insecticides, fumigants, miticides, herbicides and fungicides. A Worldbank project: *Toxic Pollution from Agriculture: Costs and Remedies* noted:

> Chemically polluted runoff from fields has also contaminated surface and ground waters, damaged fisheries, destroyed freshwater ecosystems and created growing "dead zones" in ocean areas proximate to the mouths of rivers that drain agricultural regions. Local agricultural pollution has now become a global problem, as toxic compounds from pesticides accumulate in oceanic food chains.[14]

Human Health and Human Rights

In October 2017, The *Lancet* Commission on pollution and health estimated that globally, pollution-related death, sickness and welfare equates to $4.6 trillion in annual losses.[15] [16] The paper advised:

> Pollution is now understood to be an important causative agent of many non-communicable diseases including asthma, cancer, neurodevelopmental disorders, and birth defects in children; and heart disease, stroke, chronic obstructive pulmonary disease, and cancer in adults.

In August 2016 the United Nations Special Rapporteur on human rights and hazardous substances and wastes, Baskut Tuncak, urged governments and businesses across the world to act to prevent the widespread childhood exposure to toxics and pollution which has triggered a 'silent pandemic' of childhood disease and disability.[17]

> *'States have a human rights obligation and businesses a corresponding responsibility to prevent childhood exposure to toxic chemicals and pollution'*
>
> *UN General Assembly, Human Rights Council.*

The UN Special Rapporteur noted a month later [18] that REACH, considered the strongest law for industrial chemicals in the world, is dependent on industry supplied data that may not be adequately scrutinised, and notes that it is not clear if there is sufficient information for the most common

[14] http://web.worldbank.org/archive/website01004/WEB/0__CO-35.HTM
[15] Landrigan et al 2017. The *Lancet* Commission on pollution and health. http://dx.doi.org/10.1016/S0140-6736(17)32345-0
[16] Pollution causing more deaths worldwide than war or smoking: Lancet. Associated Press October 20, 2017. http://www.cbc.ca/news/health/pollution-worldwide-deaths-1.4363613
[17] Human Rights Council Thirty-third session. Agenda item 3 Promotion and protection of all human rights, civil, political, economic, social and cultural rights, including the right to development. Report of the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes. http://www.srtoxics.org/wp-content/uploads/2016/09/Rights-of-Child-and-Toxics.pdf
[18] Human Rights Council Thirty-third session Agenda item 3 Promotion and protection of all human rights, civil, political, economic, social and cultural rights, including the right to development. Report of the Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes on his mission to Germany*

industrial chemicals regarding prenatal developmental toxicity, and toxicity for reproduction, nor data on long term (chronic) exposure.

Paragraph 33 draws on an important advance in pesticides regulation that New Zealand policy - makers should consider – the adoption of hazard based legislation to protect European citizens.:

> 'One of the most innovative features of recent changes to European Union pesticides laws is the prohibition on the use of certain pesticides linked with cancer, reproductive effects, hormone (endocrine) disruption and other adverse health effects, and certain physical properties.
>
> The so-called "hazard-based" approach of European Union pesticides legislation is based on evidence that protection of human health and the environment cannot be adequately assured for certain pesticides with such properties. The "hazard-based" approach to pesticides is grounded in the principle of precaution, provided in the Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community.'

In addition to adopting best practice in chemicals management, the European market is possibly the wealthiest market in the world. Transparently piggybacking, or synchronizing with European regulations would perhaps reduce confusion for farmers and producers and ensure New Zealand export products niche effortlessly, and that our unique brand is protected, for years to come.

Emerging Organic Contaminants

While this paper focuses on pesticides pollution, and our NPS-FW focusses on the nine attributes[19] these are not the sole challenges relating to environmental pollution.

Emerging organic contaminants (EOC), which may be naturally present or synthetic, present a low level, long term threat to environmental systems.

Some good studies have been undertaken to assess EOCs in the New Zealand environment, but this is limited.[20] [21]

EOCs include pharmaceuticals and personal care products (PPCPs), illicit drugs and drug of abuse, hormones and steroids, benzothiazoles, benzotriazoles, polychlorinated naphthalenes (PCNs), perfluorochemicals (PFCs), polychlorinated alkanes (PCAs), polydimethylsiloxanes (PDMSs), synthetic musks, quaternary ammonium compounds (QACs), bisphenol A (BPA), triclosan (TCS), triclocarban (TCC), as well as polar pesticides, veterinary products, industrial compounds/by-products, food additives and engineered nano-materials.[22] [23]

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[19] phytoplankton, cyanobacteria; Escherichia coli; dissolved oxygen; ammonia; nitrate; periphyton; total phosphorus; and total nitrogen
[20] Stewart, M.; Olsen, G.; Hickey, C.W.; Ferreira, B.; Jelić, A.; Petrović, M.; Barcelo, D. (2014). A survey of emerging contaminants in the estuarine receiving environment around Auckland, New Zealand. Science of The Total Environment 468–469(0): 202-210.
[21] Tremblay, L.A.; Stewart, M.; Peake, B.M.; Gadd, J.B.; Northcott, G.L. (2011). Review of the Risks of Emerging Organic Contaminants and Potential Impacts to Hawke's Bay. Prepared for Hawke's Bay Regional Council. Cawthron Report No. 1973. 39 p.
[22] Thomaidis et al 2012. Emerging contaminants: A tutorial mini-review Global NEST Journal, Vol 14, No 1, pp 72-79, 2012 https://www.researchgate.net/publication/234168573_Emerging_contaminants_A_tutorial_mini-review [accessed Nov 20 2017].
[23] Lapworth D.J., Baran N., Stuart M.E., Ward R.S., (2012), Emerging organic contaminants in groundwater: A review of sources, fate and occurrence, Environ. Pollut., 163, 287-303.

EOCs as part of the pollution mix deserve a much greater public profile, and scientific budget than currently granted.

Perhaps the most hopeful initiative in New Zealand is recent success by the Cawthron Institute. The MBIE's 2017 Endeavour Round[24] has granted $5,607,675 to research EOCs – managing risk for a safer NZ environment and economy.'

> 'An interdisciplinary team of local and international scientists will identify those EOCs predominating in NZ aquatic ecosystems, characterise their risk to our unique taonga, their potential to induce antimicrobial resistance, and investigate their presence in food.'

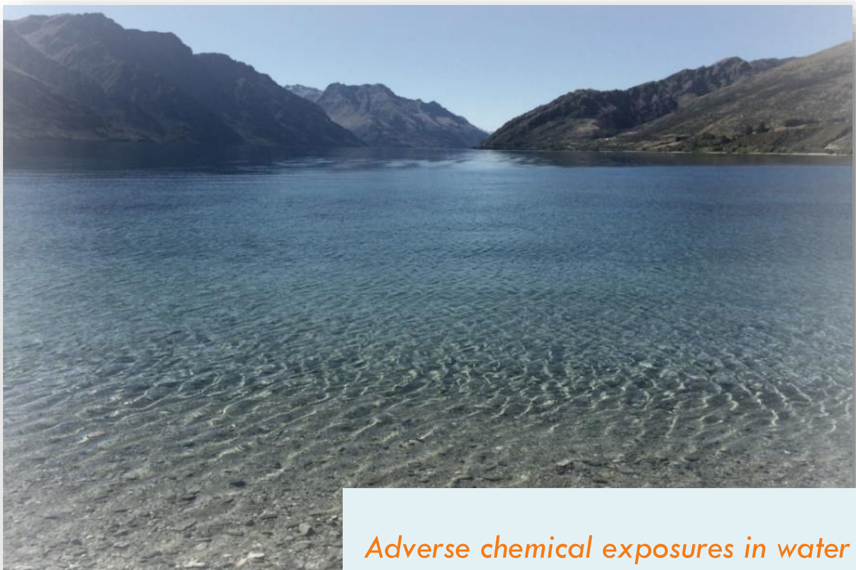
Common sources of EOC pollution might include point-source pollution, originating from an identified location. This can:

> 'include industrial effluents, municipal sewage treatment plants and combined sewage-storm-water overflows, resource extraction, waste disposal sites and buried septic tanks. Diffuse pollution, in contrast, originates from poorly defined, diffuse sources that typically occur over broad geographical scales.' [25]

While older agrichemicals, thrown away as waste can also leach from landfills or from private dumping sites, the agrichemical pollution discussed in this paper, frequently appears as diffuse pollution.

Agrichemicals are directly applied to our soil and water in greater quantities, which alters the risk profile. Agrichemicals are directly authorised for widespread application through the Ministry for Primary Industries and the Environmental Protection Agency.

This is different, for example, to chemicals widely included in imported medicines or beauty products that are considered EOCs but are more difficult to pin down and regulate.



Significant and accumulating environmental exposures that contaminate soil and water, impact other government agencies, including the Ministry of Health and Ministry of Business, Innovation and Employment -whose portfolio includes tourism and who also promote New Zealand as 100% Pure.

Adverse chemical exposures in water systems are not easily reversed, and increasing contamination levels are well documented in scientific literature.

[24] http://www.mbie.govt.nz/info-services/science-innovation/investment-funding/current-funding/2017-endeavour-round/document-image-library/successful-proposals-detailed-summary-2017-fund.pdf
[25] Thomaidis et al 2012. Emerging contaminants: A tutorial mini-review Global NEST Journal, Vol 14, No 1, pp 72-79, 2012 https://www.researchgate.net/publication/234168573_Emerging_contaminants_A_tutorial_mini-review [accessed Nov 20 2017].

Borderless Pollution

Pollutant inputs extend far beyond bacterial and nutrient (nitrate and phosphate) threats. Pollution arises from domestic, agricultural and industrial chemical sources, either through deliberate discharge of effluents; via the air as volatile compounds or through leaching from domestic, industrial or waste disposal sites.

Water pollution is borderless. Many of the commonly applied chemicals are highly mobile and persistent. Breakdown products, metabolites, can take years to breakdown. Even longer once the reach dark groundwater environments.

Yearly applications of synthetic organic compounds, particularly the legacy pesticides,[26] cumulate and result in higher levels of compound residues. Aquifers are not watertight, interconnected networks under the ground can result in chemical mixtures travelling in underground streams.

It appears unscientific and illogical to authorise chemicals that will be used in great amounts, but to not monitor their use, to enable their use and risk profile to be tracked and assessed, for human and environmental protection. It may also provide a degree of economic protection, as New Zealand councils have contracts to supply clean bottled water.

Pollution or contamination of environmental ecosystems is one of the most important drivers of quality of life for the inhabitants. As such, this deserves a commitment to understanding so that the ecosystem may not be just managed, but *protected.*

2. Chemical dominance: Intensification of chemical use

The agrichemical industry in New Zealand is high volume and thriving. From 2010 to 2014 (when data was last supplied) the value of pesticide sales in New Zealand increased from USD161,427,300 to USD204,812,900, a jump of 27%.[27]

The most recent entry in the Food and Agriculture Organization FAOSTAT pesticides database advised that in 2008, of the 5,857 tonnes of active ingredients of pesticides sold New Zealand, well over half, 3,761 of these tonnes, were sold as herbicides.[28] There is no data after 2008.

The stress placed on New Zealand water bodies by government and dairy industry expansion policies has resulted in a backlash to farmers, who are demonstrably working conform to freshwater standards.

Yet the agricultural profile of New Zealand regions perhaps documenting the greatest degradation of water-bodies, hosts heavy cropping industries, which involve intensive agrichemical spraying of pesticides, including herbicides, fungicides and insecticides.

A 2004 New Zealand paper advised that the:

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[26] 'Dominant legacy compounds included organochlorine pesticides, such as DDT and lindane, the organophosphate chlorpyrifos and triazine herbicides such as terbutylazine and simazine which have long been banned in the EU.' Rassmussen et al 2015a. The legacy of pesticide pollution: An overlooked factor in current risk assessments of freshwater systems. https://doi.org/10.1016/j.watres.2015.07.021
[27] Food and Agriculture Organization FAOSTAT pesticides database. Pesticides trade value. http://www.fao.org/faostat/en/#data
[28] Food and Agriculture Organization FAOSTAT. Pesticides Use database. http://www.fao.org/faostat/en/#data

> 'horticultural sectors is still the most intensive users of pesticides on an land area basis (13.2kg a.i./ha), followed by the arable (2.4kg a.i./ha), forestry (0.3kg a.i./ha), and pastoral sectors (0.2kg a.i./ha).' [29]

While data on New Zealand agrichemical use is scarce due to lack of resourcing, farmers in New Zealand will be similar crop management practices to Europe and the United States. Pesticide use arable crops alone as increased profoundly. The UK Food and Environment Research Agency (Fera)[30] considered data from 1988 to 2014. Average number pesticide applications on all arable crops are staggering:

The FERA report documented that the staple cereal wheat, received on average 4 fungicides, 3 herbicides, 2 growth regulators, 1 insecticide application and 1 molluscicide treatment.

- 6 spray rounds
- 17 active substances (excluding seed treatments).
- How many formulation/adjuvant ingredients – 60+?
- 12 individual formulations

Data such as the FERA report are difficult to locate in New Zealand. The FERA report advises that herbicides comprise 44% of pesticides by volume sold. The extensively-used herbicide formulations were glyphosate, diflufenican/flufenacet and iodosulfuron-methylsodium/mesosulfuron-methyl.

The FERA report particularly outlined the huge quantities of fungicides used in the environment. Yet there is little science to understand the environmental effects of fungicides. For example, how do common fungicide triazoles used in the environment, impact our use of medical triazoles critical to treating aspergillus disease that impact related multiple underlying conditions including leukaemia, transplantation, chronic obstructive pulmonary disease (COPD)?[31] New Zealand does not know.

Intensive chemical application use has accelerated in the last twenty years, with little public interest science to understand the health based ramifications of the technology.

The use of herbicides on cereal crops, particularly wheat and barley, in New Zealand are widespread and prophylactic. In 2016 the MPI tested glyphosate residues in wheat. Glyphosate was detected in 26 out of 60 samples. Twenty of these samples contained

[29] Trends in Pesticide Use in New Zealand: 2004. Report to the Ministry for the Environment, Project SMF4193 Manktelow et al 2005.
[30] PESTICIDE USAGE SURVEY REPORT 263. ARABLE CROPS IN THE UNITED KINGDOM 2014. Garthwaite et al. https://secure.fera.defra.gov.uk/pusstats/surveys/documents/arable2014v2.pdf
[31] European Centre for Disease Prevention and Control. Risk assessment on the impact of environmental usage of triazoles on the development and spread of resistance to medical triazoles in Aspergillus species. Stockholm: ECDC; 2013.

glyphosate above the maximum residue level (MRL) of 0.1mg/kg – the highest at 5.9mg/kg, significantly higher than the permitted highest MRL.

No data is available to understand glyphosate residues on staple food crops, and the consequent impact to the human gut microbiome, and consequent immune health. The science has not been done.

The speed of this shift to chemical agriculture may in part result from the removal of publicly funded agricultural extension services, which may have considered broader environmental impacts (for example, long term soil quality). Domestic and export markets demand the cheapest possible product. Lacking publicly funded, independent information, farmers in a complex environment have increasingly relied on input recommendations by commercial industry to enable them to achieve these demands. It may not be a complete coincidence, that over this same thirty-year period, our soil quality and water quality have declined dramatically.

The shift to heavy dependence on chemical based agriculture has been swift and the true cost of chemical based agriculture, to date, has not been absorbed in the product costs. Farmers hands have been tied by an economic and knowledge system that has expedited short term production but hasn't reflected the environmental externalities. Farmers using chemicals, and their children, also bear the brunt of exposures. Both carry a higher burden of chemical related illness.

Soil fertility is declining and degraded water in agricultural areas is now a common occurrence. Farmers perhaps, should not be held solely responsible as consumers and export markets have directly benefitted from cheap accessible food. Transitioning to less chemical-intensive agriculture that places less stress on the environment will have a cost.

Perhaps it is time to reframe 'subsidies' and restructure farming to help farmers address these harmful externalities.

In place of the much-maligned agricultural subsidy, farmers and New Zealanders may welcome the strategic opportunity to harness dedicated, systems based twenty-first century science to shift into a more sophisticated gear. New science is equipping many farmers and helping them adopt best practice integrated, biological or organic soil-based farming. But not all farmers have the time or inclination to transition. Science based public extension services, dropped thirty years ago, deserve re-analysis for a role that is more likely to consider the long-term impact to farm and soil health.

This may perhaps, underpin a strategic shift to a 'food as commons' approach that strategically incorporates long term food and soil security, shifting policy out of narrow election cycle confines.

This may also act to protect the export industry from foreign rejections of food products containing unsuspected contaminants.

System weaknesses in chemical evaluations

Linked inextricably with a narrow suite of national freshwater parameters are other system weaknesses. Our current chemical approvals process is arguably opaque and outdated. Studies supplied by industry for toxicity assessment are hidden from the public because of claimed confidentiality purposes, and the patented formulation is never assessed.

It is also vital that we recognise that our chemical authorisation process today, does not represent best practice; that it is overwhelmed by the 150,000 substances (minimum) that are in use; the 28,000 chemicals on the registry. The New Zealand assessment process does not have the capacity to review scientific literature, instead depending on industry to supply relevant data, and so misses vital new science that can demonstrate harm to users and exposed individuals at lower levels than the registrant, or chemical industry tests at.

Current freshwater pesticide controls allow a surprisingly high level of contamination in the environment.[32] The Environmental Protection Authority (EPA) does not recognise that toxicity can develop via complex chemical synergies (including in the formulation that is expressly patented for synergies) at environmentally relevant levels.

EPA and the Ministry for Primary Industries ignore new knowledge that ingredients in formulations are increasingly found to exert their own toxicity, and, as with the active ingredients in common herbicides, to play a role in antimicrobial resistance.

Our regulators ignore the extremely low levels at which endocrine systems can be affected, ignoring toxicity of the full formulation (which is patented for synergy); ignoring the toxicity of the tank mixes our farmers use and never assessing risk via environmental accumulation.

The cost of human exposure to preventable environmental chemicals is now understood to result in health costs of 10% of global GDP. Functional deficits, especially regarding cognition greatly add to the global burden of disease.[33]

The current regulatory process for chemical risk assessment appears unable or unwilling to grasp these new complexities and challenges evident in emerging science.

Regional councils, are left with the cleanup.

The overwhelming burden of monitoring and managing freshwater is held by regional councils. Yet without a nationally directed mandate that takes a whole of system approach and scientific funding to understand the complete burden of toxicity, underfunded regions will never have the toolkit to be able to grasp their own toxicity profile, or 'chemical signature.'

Without this knowledge regional councils cannot possibly 'protect and enhance their ecosystems', nor can they protect drinking water, as they are obliged by the Resource Management Act, to do.

[32] S.38 Maximum environmental exposure limits Hazardous Substances (Classes 6, 8, and 9 Controls) Regulations 2001 http://www.legislation.govt.nz/regulation/public/2001/0117/latest/whole.html?search=qs_act%40bill%40regulation%40deemedreg_sediment_resel_25_h&p=1#DLM39619

[33] P Grandjean & M Bellanger 2017. Calculation of the disease burden associated with environmental chemical exposures: Application of toxicological information in health economic estimation. *Environmental Health.* https://doi.org/10.1186/s12940-017-0340-3

Regional councils, like farmers, have their hands tied. If there is no science, there can be no tracing back to contaminant sources and resultant action to prevent the pollution.

Budgetary challenges have resulted in councils reducing permanent science staff, and moving to engage corporate consultants where needed. Due consideration should be made for wider public and environmental benefits of full time staff that have the time to engage and understand complex political and environmental challenges, and the subtle but important public interest benefit exerted by a role as public servant and decision-maker.

In-house resourcing may lead to consideration of the challenges and emerging for example, concerning infrastructure investment and or dealing with chemical exposures over the longer term, than simply answering a short-term request by an external company to solve a short-term problem.

Politically, it may appear an easier option to simply not do the science. Regional industry stakeholders using a wide range of chemicals that may end up in water systems are left to themselves.

Unfortunately, regional stakeholders dependent on clean water are left with a level of acute risk, for example a foreign product rejection, or chronic risk, tourists are less likely to return to a lake toxic with blue-green algae and blog posts can quickly let future potential travelers know a visit is not worth the trouble.

In the public interest, it is vital that we dedicate nationally managed resources to data monitoring and interpretation. It is also vital we recognise that the New Zealand farming environment requires an assertive government acting in the public interest.

Traditionally, when there is discussion of environmental chemicals, it concerns the risk of immediate harm from a chemical toxin. However, an arguably greater risk is a natural environment faced with ongoing sub-lethal exposures that quietly erode food sources and organism fertility. Only the species that are resistant survive, and this can lead to unattractive and unsafe aquatic environments.

Many of the common chemicals in our environment are unmonitored. However, if a chemical – or the chemicals that are commonly applied together are too costly to monitor, perhaps these chemicals simply should not be approved for widespread use in the New Zealand environment.

In New Zealand, there is no standardised system for recording pesticide data so that we can build a national profile, nor to record common cumulative pesticide applications. Reports on record harvests can give and idea of the multiple treatments received by the crop and the herbicide treatments prior to sowing and before harvest.[34] [35]

The New Zealand Food Residues Surveillance Program and Total Dietary Survey are dependent on knowledge of specific active ingredient use in order to screen for the pesticides. Regional councils also, are dependent on knowing which pesticides are used by the prominent agrichemical users in their regions, whether forestry, arable and horticulture to aid testing of the environment for residue accumulation. Drinking water suppliers will test for listed values but may miss new and emerging chemicals.

There is much that can be done.

[34] Rural News 2015 http://www.ruralnewsgroup.co.nz/rural-news/rural-general-news/world-record-oilseed-crop-landed
[35] http://www.fwi.co.uk/arable/kiwis-set-to-strip-scots-of-barley-world-yield-record.htm

2. Chemical dominance: Intensification of chemical use

Failure to address complexity – multiple chemical contaminants

Basic science: authorise mixtures for use – transparently assess mixture synergies

Combinatory effects of multiple accumulants, and the potential for bioaccumulation of these mixtures, are ignored in regulatory assessment and not considered when setting environmental risk levels.[36]

To date, there has been little funding to support scientists who may have had the temerity to raise this as an issue.

Environmental exposure limits in New Zealand for hazardous substances are clumsy. A maximum level of 100 milligrams of the *substance* per litre of water/ per kilogram of dry weight of soil or sediment cannot possibly grasp the complexity of delicate environmental responses, particularly if pesticides are endocrine disruptors and can adversely harm at very delicate levels.[37]

Concern that current pesticides assessments are unable to represent accurately, toxicity of the authorised formulations, is based on the fact that the dominant international regulatory assessments are based solely on data selected by industry. These assessments do not reflect the growing body of published scientific literature that very clearly illustrates greater harm to the environmental and human health from low level exposures.

These assessments rely on a linear definition of toxicity that never consider the greater toxicity of the patented formulation sold to farmers and applicators. Laboratory-based standards such as the Lethal Dose, 50% (LD50) and the No Observable Adverse Effect Level (NOAEL) assume that the tested single active ingredient is the only one that environmental organisms are exposed to.[38]

Current monitoring standards cannot adequately grasp ecological complexity of the environment in which they operate. Drinking water standards, the most comprehensive water standards in New Zealand, are based on regulatory data which never considered mixture or formulation exposures. There is no consideration that multiple contaminants could adversely harm at lower levels than determined by regulators.

Our NZ EPA does not address formulation toxicity (including the adjuvants that are recognised as major pollutants, for example, organosilicon.) Despite the fact that the EPA has an obligation in law ensure safety of 'substances', the industry data supplied to the EPA, restricts itself to supplying studies of the active ingredient.

EPA does not publicly review the published literature relating to full formulation toxicity of a pesticide.

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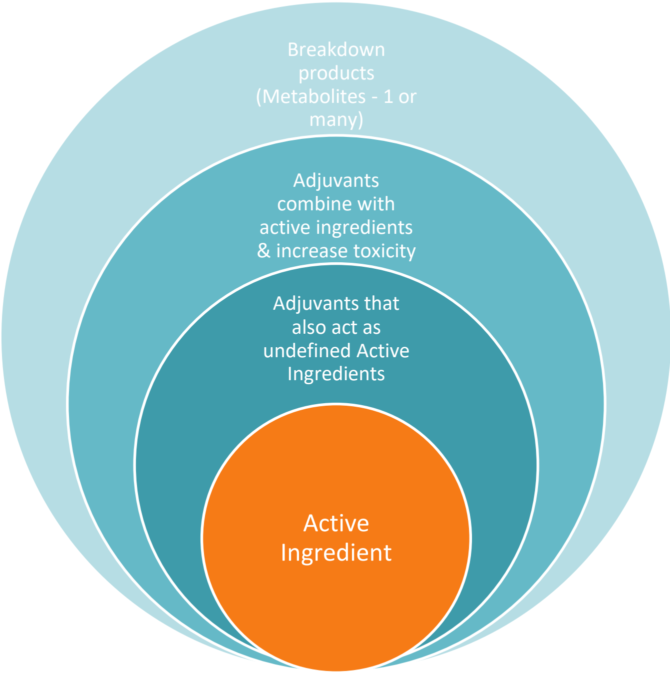
[36] For example, the water quality 'trigger' values for ecosystem protection used in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) guidelines.

[37] S.38 Maximum environmental exposure limits Hazardous Substances (Classes 6, 8, and 9 Controls) Regulations 2001 http://www.legislation.govt.nz/regulation/public/2001/0117/latest/whole.html?search=qs_act%40bill%40regulation%40deemedreg_sediment_resel_25_h&p=1#DLM39619

[38] Kleinman and Sainath Suryanarayanan Dying Bees and the Social Production of Ignorance. 2012 Science Technology Human Values 2013 38: 492, DOI: 10.1177/0162243912442575



Only the active ingredient is tested. The total toxicity of a single retail formulation to environmental and human health is underestimated.

A 2015 Consensus Statement cautioned that 'tolerable daily intakes for glyphosate in the U.S. and Germany are based upon outdated science.'[39]

Damage can happen at lower than currently estimated levels. A wide body of literature demonstrates that this harm can include endocrine disruption, including affecting and impairing reproduction and development, leading to smaller and smaller communities, and neurological damage, which may impair the ability of a species, and the predatory species of those species, to thrive. Babies and children are particularly affected.[40] [41] [42]

In addition to the human population, regulatory inability to consider the contaminant mixtures, or synergies in the environment, mean that, for example, regionally based scientists relying on the for example, EPA data, are unable to adequately estimate harm to microbes, algae, macrophytes (plants), invertebrates (insects, crustaceans, worms, snails and mussels) and fish species at much lower levels (than regulators consider). Information lag has resulted in scientific lag.

A recent amphibian study in nature.com advised that 'differences in the formulation additives revealed a great influence on toxicity, indicating the need to expand the evaluation from active chemical ingredients to entire products.' And concluded

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[39] Myers J P et al (2016). Concerns over use of glyphosate-based herbicides and risks associated with exposures: a consensus statement. Environmental Health 15(19). DOI 10.1186/s12940-016-0117-0. https://ehjournal.biomedcentral.com/articles/10.1186/s12940-016-0117-0

[40] Chemtrust 2017 Report: No Brainer: The impact of chemicals on children's brain development: a cause for concern and a need for action http://www.chemtrust.org.uk/wp-content/uploads/chemtrust-nobrainer-mar17.pdf

[41] Poisoning our Future: Children & Pesticides 2013 Pesticides Action Network Aotearoa Meriel Watts PhD. http://www.pananz.net/wp-content/uploads/2013/04/2013-PAN-AP-POISONING-OUR-FUTURE-Children-and-Pesticides-Book-v8-WEB-lo-res.pdf

[42] Kids on the Frontline http://www.panna.org/sites/default/files/KOF-report-final.pdf

2. Chemical dominance: Intensification of chemical use

‘Our results also indicate that existing risk assessment procedures for pesticide regulation are not protecting amphibians.’[43]We know also, that tadpoles are more vulnerable to stress when exposed to pesticides including Roundup.[44]

> ‘ a river cannot safely dilute persistent pollutants, such as organic chemicals, because these substances accumulate in the food web and in sediments.’[45]

What is the impact on fertility, whether in the aquatic environment or in human populations? What is the risk to developmental pathways in the children exposed chronically to contaminated drinking water?

Declining wild salmon in the South Island of New Zealand prompted Fish and Game to organise a symposium in 2017. [46] It is not clear whether scientists have had funding to enable them to consider impacts of sub-lethal pesticides, and the consequences for food sources and for salmon fertility that may impact wild salmon populations the anglers and fishers depend upon.

The result, without the science in place, is effectively a chemical industry that is protected and subsidised by mechanised, linear (only looking at one chemical in a mixture) systems thinking.

The current system is ill-equipped to predict long term risk to our most vulnerable assets, our clean water, our agricultural soils, and our children. It is unable to assess long term risk to the health of farmers, applicators and their families.

Example: Roadside use and applications to drainage systems

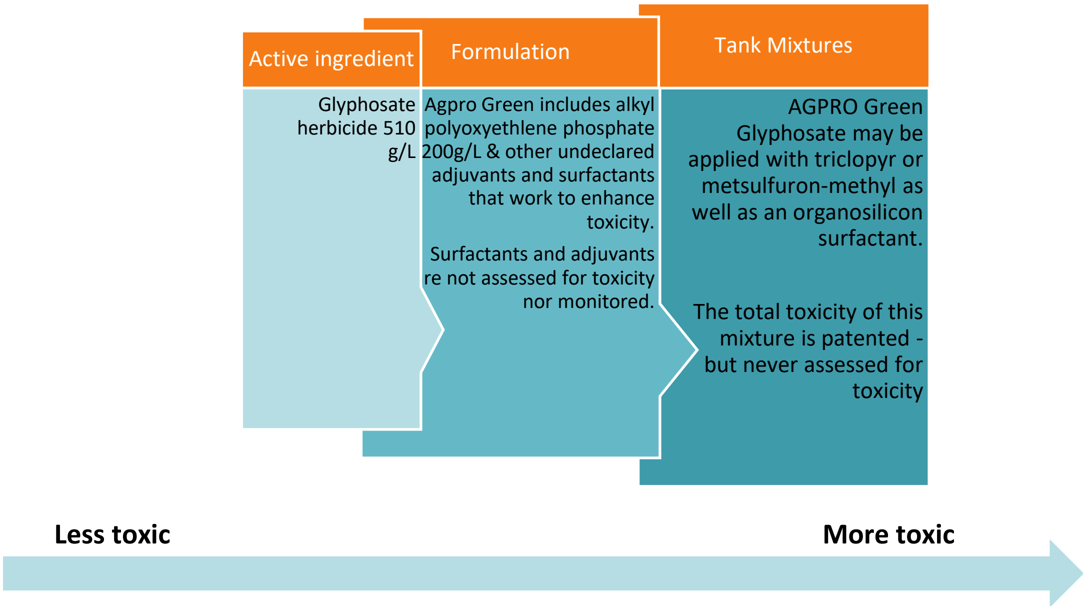
An Official Information Act request from the Western Bay of Plenty District Council dated 22 September informed the author that Agpro Glyphosate Green 510 was the primary formulation used for kerb and channel, with Agpro organosilicone surfactant added as a surfactant. Roadside spraying tank mixed Agpro Glyphosate Green 510, with another herbicide Meturon 250 (metsulfuron-methyl) and organosilicon.

In the Western Bay of Plenty, urban roads are treated four times per year, the state highway 5 times and local roads are treated 3 times per year. There is no notification for residents other than signage at the time the spraying is taking place.

Roadside spraying is along drains and ditches where water frequently runs into streams and rivers.

Despite heavy use New Zealand wide, neither glyphosate, metsulfuron-methyl nor the organosilicon adjuvant are tested in freshwater or groundwater for added chemical synergies that might harm aquatic flora and fauna.

[43] Terrestrial pesticide exposure of amphibians: An underestimated cause of global decline? Brühl CA, Schmidt T., Pieper S. & Alscher A. Scientific Reports 3, Article number: 1135 (2013) doi:10.1038/srep01135
[44] Relyea, R. A. The Lethal Impacts of Roundup and Predatory Stress on Six Species of North American Tadpoles. Arch. Environ. Contam. Toxicol. 48, 351–357 (2005).
[45] UNEP. 2016. A Snapshot of the World’s Water Quality: Towards a global assessment. United Nations Environment Programme (UNEP). https://uneplive.unep.org/media/docs/assessments/unep_wwqa_report_web.pdf
[46] https://fishandgame.org.nz/freshwater-fishing-in-new-zealand/salmon-forum-2/salmon-forum/



The ester in the Green Glyphosate mix, Alkyl polyoxyethylene phosphate, and nor the adjuvant organosilicon are not considered for toxicity, nor assumed to exert synergistic toxicity. Neither are monitored in the New Zealand environment.

Only metsulfuron-methyl is tested for in drinking-water.

Example: Forestry

Key New Zealand regions are planted in significant swathes of pine forest. In 2005, the Bay of Plenty Region had 22% of land area in exotic pine forestry plantations, second only to the Waikato region.

Herbicide treatments help establish radiata pine forest. A 2013 research article noted:

> 'Glyphosate was the most widely used active ingredient in pre-plant weed control with terbuthylazine and hexazinone used most widely for post-plant weed control. Together these herbicides comprise 90% of the estimated 447 tonnes of active ingredient that is annually used.'[47]

Glyphosate is primarily used in New Zealand to reduce vegetation competition prior to planting new forest. It is usually mixed with metsulfuron-methyl. A 2017 paper advises this is the primary use of glyphosate in New Zealand forestry, resulting in an application only once every 25-30 years. The paper also noted a review by Rolando which states glyphosate is the third most used herbicide in planted forestry, and that herbicide use patterns in the European Union are much lower than in New Zealand. [48]

Other mixtures include hexazinone and high rates of clopyralid prior to planting.[49]

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[47] Rolando et al 2013. A survey of herbicide use and a review of environmental fate in New Zealand planted forests. New Zealand Journal of Forestry Science 201343:17 https://doi.org/10.1186/1179-5395-43-17

[48] Rolando et al 2017. Review: The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests. *Forests* 2017, 8, 208; doi:10.3390/f8060208

[49] Relative persistence of commonly used forestry herbicides for preventing the establishment of broom (*Cytisus scoparius*) seedlings in New Zealand plantations. Harrington et al 2015. DOI https://doi.org/10.1186/s40490-015-0039-6

The Forest Stewardship Council (FSC) is an international best practice certification for responsible forest management which is active in New Zealand. FSC had listed terbuthylazine[50] and hexazinone as prohibited pesticides. Replacement chemicals for woody weed control post planting may include clopyralid, triclopyr and picloram mixtures.[51] A 2011 study considered that 'suitable replacements to hexazinone and terbuthylazine are haloxyfop, clopyralid, triclopyr and picloram (applied as a mix).' The study also included the organosilicone surfactant polydimethylsiloxane (Pulse) in the mix.[52]

As with many accreditation schemes, the FSC requires ongoing vigilance to maintain standards. It is as strong as each new interpretation, and vulnerable to exploitation of loopholes or gaps by parties seeking short term gain.[53] Unfortunately terbuthylazine is now permitted for use. [54]

Of the above listed chemicals, terbuthylazine, hexazinone (LOD <0.01) are included in the groundwater survey and detected regularly. Clopyralid, triclopyr and picloram (LOD <0.1) are also included, but have not been detected. Glyphosate, Haloxyfop and the organosilicone are not included in the groundwater survey.

Terbuthylazine is discussed further in Appendix 2A.

Example: Neurotoxic systemic neonicotinoid insecticides

New Zealand does not monitor the systemic, nicotine based neonicotinoid and fipronil insecticides in the environment. Neonicotinoids are the third most commonly used insecticides[55], and are automatically applied[56] to a high proportion of pasture seed and seeds used in arable (Eg. cereal and vegetable) farming. They are also intensively used in the floriculture industries. Neonicotinoid foliar sprays are heavily used in horticulture industries.

Compelling research increasingly recognises these systemic pesticides as more persistent and highly mobile than our regulators consider. A recent study discussing that neonicotinoids are much more long lived and that exposure is more extensive than previously thought, demonstrated that that the common neonicotinoid clothianidin can affect bee mortality, hygienic behaviour, and the ability of the hive to care for the queen. The paper indicated that fungicides also played an acutely harmful role in bee health.[57]

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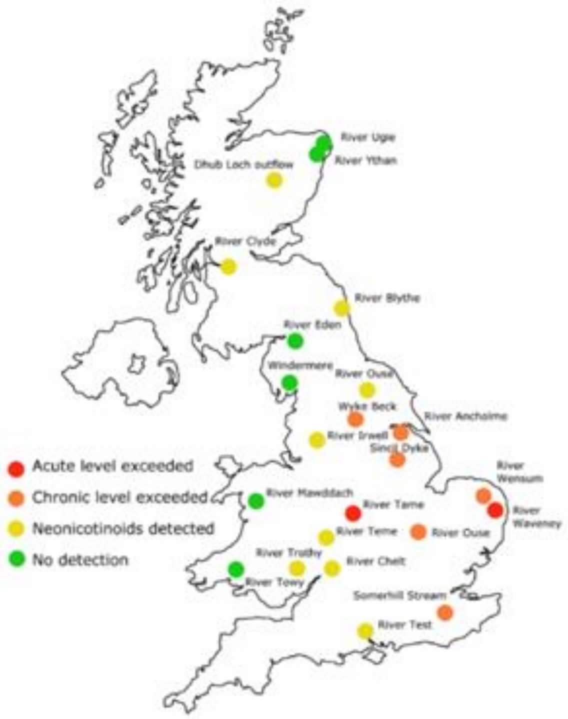
[50] Considered further in Appendix 2 A. Case study: Terbuthylazine R40 (carcinogen category 3)
[51] Alternatives to hexazinone and terbuthylazine for chemical control of *Cytisus scoparius* in *Pinus radiata*plantations in New Zealand Watt and Rolando 2014. DOI: 10.1111/wre.12081
[52] Preliminary screening of herbicide mixes for the control of five major weed species on certified Pinus radiata plantations in New Zealand. New Zealand Journal of Forestry Science 41 (2011) 165-175
[53] http://www.greenpeace.org/international/en/campaigns/forests/solutions/alternatives-to-forest-destruc/
[54] FSC PESTICIDES GUIDANCE ADDENDUM: LIST OF APPROVED DEROGATIONS FOR USE OF 'HIGHLY HAZARDOUS' PESTICIDES FSC-GUI-30-001a https://www.scsglobalservices.com/files/standards/fsc-gui-30-001a_v1-0_en_list_ofapproved_derogations_for_use_of_highly_hazardous_pesticides.pdf
[55]Systemic insecticides (neonicotinoids and fipronil): trends, uses, mode of action and metabolites. Simon-Delso et al 2014 *Environ Sci* Pollut Res DOI 10.1007/s11356-014-3470-y
[56] Note: Integrated Pest Management (IPM) requires that pesticides should be only applied when necessary, many pesticides today are applied prophylactically.
[57] Tsvetkov et al 2017 Chronic exposure to neonicotinoids reduces honey bee health near corn crops Science 356 (6345), 1395-1397. DOI: 10.1126/science.aam7470

It is increasingly apparent that perhaps only 5% of neonicotinoid pesticides are taken up by the plant, the rest is dispersed into the environment. Untreated crops planted after a neonicotinoid treated crops can also take up residual neonicotinoid.[58]

Buglife[59] reported results of U.K. testing in freshwater in December 2017. European legislation includes an EU Water Framework Directive 'Watch List.' As a result of the legislation, the U.K. initiated a 'pilot monitoring scheme for five commonly used neonicotinoids – Imidacloprid, Clothianidin, Thiamethoxam, Acetamiprid and Thiacloprid. Twenty-three sites were sampled in 2016, 16 in England, four in Scotland, three in Wales and three in Northern Ireland.'



Buglife (Invertebrate Conservation Trust): Heavy Neonicotinoid Insecticide Contamination Damaging British Rivers. December 2017. www.buglife.org.uk

86% of these sites were identified as 'contaminated with neonicotinoids, eight rivers in England exceeded recommended chronic pollution limits, and two were acutely polluted. Populations of mayflies and other insects in these rivers are likely to be heavily impacted, with implications for fish and bird populations.'

New Zealand legislation treats neonicotinoids as 'plant protection products' – PPPs. As such, neonicotinoid treatments on commonly available seeds used by farmers and the public are not required to be labelled with the active ingredients. Companies selling treated seeds, consider the ingredient formulations to be 'commercially sensitive.' However, the formulations tend to be a narrow range of patented neonicotinoid formulations. For example, the Poncho formulation (which contains the active ingredient clothianidin) may be the treatment. Farmers will have no idea that a chemical is contained that is dangerous to pollinators and birds.

Neonicotinoid active ingredients are only required to be labelled for application as a liquid for example when being used as a foliar spray. As an example of how neonicotinoids may be widely applied in New Zealand cereal growing regions, Poncho Votivo product (which contains the sol organism Bacillus *firmus*), has been developed as an insecticide for black beetle, greasy cutworm, Argentine stem weevil and parasitic nematodes. It is approved by the NZ EPA for use on wheat, maize, forage brassicas and grass seed.

The neonicotinoid insecticide formulations are patented for toxicity. However, these more toxic formulations of neonicotinoid insecticides never assessed by the EPA for greater toxicity, to the environment or to human health. A 2014 study revealed that the neonicotinoid Insecticide Confidor

[58] Wood, T.J. & Goulson, D. The environmental risks of neonicotinoid pesticides: a review of the evidence post 2013 Environ Sci Pollut Res (2017). doi:10.1007/s11356-017-9240-x
[59] https://www.buglife.org.uk/news-&-events/news/heavy-neonicotinoid-insecticide-contamination-damaging-british-rivers

(200gL/Imidacloprid) was 7 times more toxic than its active chemical, while Polysect (5g/L Acetamiprid was 21 times more toxic than the active chemical.[60]

The most comprehensive study on systemic pesticides, the Worldwide Integrated Assessment of the Impact of Systemic Pesticides on Biodiversity and Ecosystems (WIA), involved 29 scientists researching 1,121 peer reviewed papers over a five-year period. It was in released January 2015 as eight papers.[61]

The WIA paper clearly documented that neonicotinoids:

1. Can persist for years in soils and environmental concentrations may accumulate;
2. They are found in nectar, pollen, and exuded guttation drops (which bees drink) of treated crops and locally growing untreated wildflowers.
3. May kill or harm birds and mammals who consume treated seeds may (immune system damage, reduced fecundity, lethargy) at low doses

Further research is building an increasingly damning picture of these insecticides. In 2017 a paper[62] was released which looked at neonicotinoid use across three countries. The paper revealed that these insecticides impact honeybee health at extremely low 'sub-lethal' levels. The bees did not die, but the ability to maintain 'hive fitness' was impaired, with the chemicals exerting 'significant negative effects at critical life-cycle stages.' [63]

Persistence in the environment

When contaminant residues leach into a darkened groundwater environment, they take much longer to breakdown. The metabolites, or breakdown products of these synthetic organic compounds, which could comprise 50% of the original applied chemical are often much more toxic, and far more persistent in the environment than the original chemical purchased from the retailer.

Scientists and researchers are restricted by a narrowly defined policy, restricted research capabilities and policies that opaquely refer to chemicals but do not provide a mandate and flexible funding to adequately understand and address potential issues.

Emerging Issues: Antimicrobial Resistance & the role of Herbicides

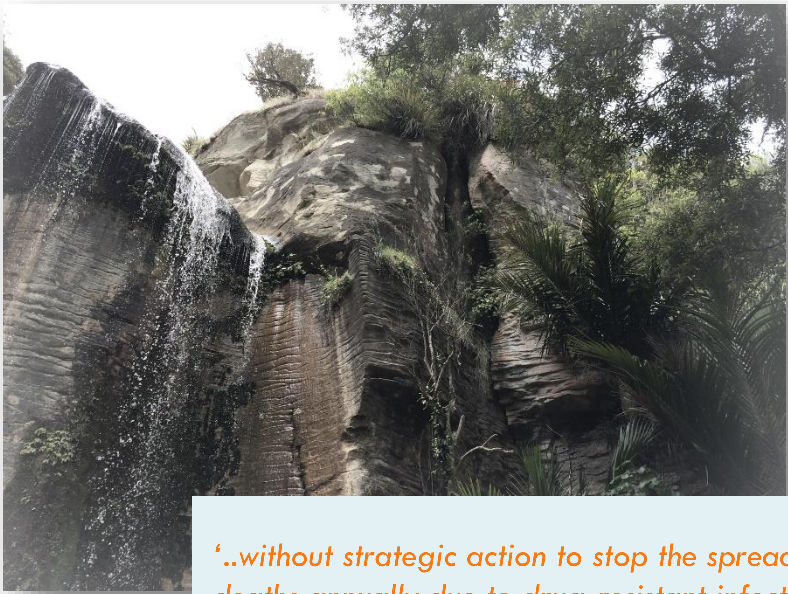
Antimicrobial resistance, unless addressed, if forecast to have a devastating impact on humanity. In 2016 the UK Prime Minister commissioned a Review on Antimicrobial Resistance, to assess the global impact of antimicrobial resistance and to make recommendations.

At the time of the report 700,000 people per year were dying as a result of antimicrobial resistance (AMR). The report estimated that without strategic action to stop the spread of AMR, there will be

[60] Ethoxylated adjuvants of glyphosate-based herbicides are active principles of human cell toxicity. Mesnage R, Bernay B, Séralini GE Toxicology. 2013 Nov 16; 313(2-3):122-8.
[61] https://link.springer.com/journal/11356/22/1/page/1
[62] Country-specific effects of neonicotinoid pesticides on honey bees and wild bees. Woodcock et al 2016. Science 30 Jun 2017: Vol. 356, Issue 6345, pp. 1393-1395 DOI: 10.1126/science.aaa1190
[63] https://www.nature.com/news/largest-ever-study-of-controversial-pesticides-finds-harm-to-bees-1.22229#/ref-link-1

10 million deaths annually due to drug-resistant infections by 2050, and at a cost per world citizen of USD10,000.[64]

Significant new research reveals the sub-lethal role herbicides play in increasing our vulnerability to antibiotic, or antimicrobial resistant strains of bacteria. The Lancet Commission on pollution and health stated 'Chemical herbicides account for nearly 40% of global pesticide use and applications are increasing.'[65] Over 650,000 tonnes of glyphosate are produced annually.



In 2015 scientists concluded that antibiotics are less effective in people exposed to both antibiotics and herbicides.[66]

'..without strategic action to stop the spread of AMR, there will be 10 million deaths annually due to drug-resistant infections by 2050.'

A New Zealand study released in 2017 went further. It discovered that when human pathogens *Salmonella enterica* and *Escherichia coli* where exposed separately to 2,4-D, dicamba and glyphosate herbicides at recommended residue levels, and currently used antibiotics, the bacteria cells produced more 'efflux pumps' effectively acting to resist the antibiotic. These efflux pump genes treated both herbicides and antibiotics as toxins. When flowing into a bacteria cell together, the cell would then immediately push the toxin out.

The antibiotic was then effectively neutralised, without a chance to do its work.   currently used antibiotics more likely to be killed by some antibiotics but also less likely to be killed by other antibiotics. The study also found co-formulants, or inert ingredients (surfactants that are not tested for safety), commonly used in herbicides and processed foods can also cause antibiotic resistance – at concentrations permitted in food. [67]

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[64] TACKLING DRUG-RESISTANT INFECTIONS GLOBALLY: FINAL REPORT AND RECOMMENDATIONS THE REVIEW ON ANTIMICROBIAL RESISTANCE CHAIRED BY JIM O'NEILLMAY 2016. https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf

[65] Landrigan et al 2017 The Lancet Commission on pollution and health. October 19, 2017 http://dx.doi.org/10.1016/S0140-6736(17)32345-0 http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(17)32345-0.pdf

[66] Kurenbach B, Marjoshi D, Amábile-Cuevas CF, Ferguson GC, Godsoe W, Gibson P, Heinemann JA. 2015. Sublethal exposure to commercial formulations of the herbicides dicamba, 2,4-dichlorophenoxyacetic acid, and glyphosate cause changes in antibiotic susceptibility in Escherichia coli and Salmonella enterica serovar Typhimurium. mBio 6(2):e00009-15. doi:10.1128/mBio.00009-15.

[67] Kurenbach et al 2017 Herbicide ingredients change Salmonella enterica sv. Typhimurium and Escherichia coli antibiotic responses. *Microbiology* DOI 10.1099/mic.0.000573 http://mic.microbiologyresearch.org/content/journal/micro/10.1099/mic.0.000573 PDF https://static.politico.com/53/55/a826dbcd41a9877f32685eda3708/heinemann-microbiology-ms-final.pdf

2. Chemical dominance: Intensification of chemical use

Professor Jack Heinemann from Canterbury University initially became interested in the possibility that herbicides might be involved in creating resistance after recognising a similarity between the chemical structure of dicamba, 2,4-D and salicylate. Acetylsalicylate causes multiple drug resistance in bacteria.[68]

It may appear confusing and somewhat breathtaking for councils, farmers and contract applicators applying prophylactic, routine applications of the agrichemical glyphosate to find that a chemical considered for them for so long to be 'benign' is not only patented as both a broad-spectrum antibiotic and an anti-microbial agent,[69] but a chemical now recognised as having a very real capability to contribute to AMR.

> *A result of herbicide exposure 'we were recording survival of bacteria at doses six times higher than normally would kill them, two times higher than is usually enough to undermine treatment and therapy.'*
>
> *Professor Jack Heinemann, NZ Farmers Weekly, December 4, 2017*

In 2013 the U.K.'s Chief medical officer to be a 'catastrophic threat,' a 'ticking time bomb' that was as dangerous as global warming.[70]

Erik Solheim, head of the United Nations Environment Programme in a recent UN Report discussing emerging areas of environmental concern, which highlights the sub-lethal low level impacts of these chemicals, which enable bacteria to select for resistance, stated in the report foreward:

> 'that discharge from municipal, agricultural and industrial waste in the environment means it is common to find antibiotic concentrations in many rivers, sediments and soils. It is steadily driving the evolution of resistant bacteria: a drug that once protected our health is now in danger of very quietly destroying it. [71]

Acting in the Public Interest: Fiduciary Obligations of Public Servants

It is important to make the connection between the actions of regulatory agencies and regional councils and their legal obligations as tax-payer paid (public servant) decision-makers acting under New Zealand law.

There is clear scientific evidence demonstrating greater risk from chemical mixtures than regulators consider, or greater environmental chemical complexity than councils are willing to consider.

Administrative law dictates that government employees have a fiduciary obligation to abide by their statutory purpose and to put the public interest first.

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[68] Herbicide Risk to resistance linked. R.Rennie. NZ Farmers Weekly. December 4 2017.

[69] Patented as a broad-spectrum antibiotic (US patent number 7771736) and then again as an "antimicrobial agent" (US patent number 20040077608 A1. PAN Germany. PAN Germany: Comments on EChA's CLH-Report regarding Genotoxicity. July 2016

[70] http://www.nytimes.com/2013/04/21/magazine/antibiotic-resistance.html

[71] UNEP (2017). Frontiers 2017 Emerging Issues of Environmental Concern. United Nations Environment Programme, Nairobi. Foreward

The statutory purpose of an Act under which a government agency and public servants work, define the powers of the agency. Rules and regulations then developed by that agency, under a specific Act, must be consistent with the original purpose of the Act.

Decision-makers must take relevant considerations (and within this, mandatory considerations) into account when acting in the public interest.

Professor Peter Gluckman stated 'policy formed without consideration of the most relevant knowledge available is far less likely to serve the nation well.'[72]

The purpose of the HSNO Act provides clear direction to protect New Zealand - to:

> …protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms.[73]

Restrictive NZ EPA policies that result in reliance on outdated protocols and guidelines that ignore established knowledge in science (for example, the contribution of endocrine disruption and oxidative stress to chronic disease), and prioritise industry supplied and unpublished data can act to prevent the decision-makers ability to act in the public interest. 'Policy rules must not impede the exercise of the decision-maker's statutory functions.' [74]

The NZ EPA's Chief Executive-initiated reassessments 'CEIR' list would be an excellent place to commence reassessment, with the EPA required, in the public interest, to limit reassessment consideration to studies publicly available and published in scientific literature to gauge the toxicity of the chemicals on the list, and of course, taking into consideration the published scientific literature that studies the greater toxicity of the (patented for toxic synergies) 'substance', or full formulation. [75]

The purpose of the Resource Management Act[76] (RMA) requires that New Zealand is 'sustainably managed' by persons with functions and powers under this Act – where:

> 5(2) 'sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while:
>
> (2) a. safeguarding the life-supporting capacity of air, water, soil, and ecosystems.'

[72] Prof. Gluckman. Towards better use of evidence in policy formation: a discussion paper. 2011. PMSCA. http://www.pmcsa.org.nz/wp-content/uploads/Towards-better-use-of-evidence-in-policy-formation.pdf
[73] Hazardous Substances and New Organisms Act. Part 2. Purpose of Act. Sn 4. http://www.legislation.govt.nz/act/public/1996/0030/latest/DLM381222.html
[74] Constitutional and Administrative Law in New Zealand, 4th Ed., P.A Joseph 23.2.5 P.959
[75] https://www.epa.govt.nz/industry-areas/hazardous-substances/reassessments-and-reviews/chief-executive-initiated-reassessments/
[76] Resource Management Act 1991 Sn.5 http://www.legislation.govt.nz/act/public/1991/0069/latest/whole.html#DLM231905

2. Chemical dominance: Intensification of chemical use

Regional Councils and government agencies failing to consider and research twenty first century challenges of chemical complexities in the environment, which threaten to undermine the health of a system, may be interpreted as failing to act under the purpose of the RMA.

Over-reliance by public servants on industry data (where plenty of public literature is available for scrutiny, but EPA or council staff instead exclusively rely data selected by the registrant, or corporate applicant), may lead to questions of bias in decision-making, and be judged unlawful if this reliance has ignored relevant considerations.

Under public and administrative law, actions of policy-makers and decision-makers can be found to be:

> '..invalid if the decision-maker fails to take into account relevant considerations, or is influenced by considerations that are legally irrelevant.'[77]

If the scope of decision-making is constrained, without due weight given to reasonableness; to the public interest; this leaves the Agency or decision-maker potentially exposed to judicial scrutiny.

The concern that relevant principles of administrative law may be dismissed or ignored, leading to deficiencies that have the result of obstructing or compromising Parliament's legislative purpose, are covered in more detail in *'Has Something Gone Wrong?'* Part 7, of the paper *Public Health Concern: Why did the NZ EPA ignore the world authority on cancer?*[78]

Well intentioned Acts of Parliament will leave us thwarted by complexity, if lower order protocols and guidelines restrain consideration of risk to a single active ingredient, ignoring the toxicity of environmental mixtures, keeping the locus of control with the chemicals who select and supply the (single active ingredient) data, and failing to keep pace with emerging science.

But who to turn to, to examine this situation, in the public interest?

The Ombudsman is unable to determine matters of scientific or political debate. The Parliamentary Commissioner for the Environment may have more resourcing to understand the challenges we face.

Whether it is to engage with the public law implications of a regulatory system that permit the registrant (chemical industry) to select and provide the studies – or to examine with urgency the need for regional councils to engage permanent scientists with a mandate to understand chemical toxicity within a given river basin, or catchment.

It all comes down to a moral and ethical choice to commit the resourcing for transparent, engaged, twenty-first century science resourcing in the public interest.

Old issues: Regulatory capture and industry reliance – 'regulation is acquired by industry'

It has long been recognised that regulators, dependent on a regulated industry supplying the data, will tend to build closer relationships with the industry they regulate. The toing and froing of

[77]Constitutional and Administrative Law in New Zealand, 4th Ed., Philip A Joseph, Thomson Reuters 2014. 23.2.3 (1) P.948

[78] Public Health Concern: Why did the NZ EPA ignore the world authority on cancer? Bruning J., Browning S., Green Party of Aotearoa New Zealand. 2017 https://www.greens.org.nz/sites/default/files/NZ%20Public%20Health%20-%20Glyphosate%20and%20Cancer%202017.pdf

requests for data lends itself to familiarity. Regulatory capture need not involve bribery and corruption, it can exist as a subtle form of control.

UN Special Rapporteur on the Right to Food, Hilal Elver in her report to the UN Human Rights Council in January 2017, drew attention to the influence of the chemical industry. An influence that may quietly effect legislation and policy more substantially than public farming lobby groups:

> The pesticide industry is dominated by a few transnational corporations that wield extraordinary power over global agrochemical research, legislative initiatives and regulatory agendas.[79]

A captured regulatory agency may simply not keep pace with new challenges and rely on outdated policies; a captured agency may only consider the science supplied by industry; it may rely on industry shaping the framework that is then to be regulated, for example, industry involvement in the development of risk assessment guidelines and providing the information that helps shape legislation and regulations.

> '… as a rule, regulation is acquired by the industry and is designed and operated primarily for its benefit.'[80]

Further, the regulatory agency responsible for hazardous chemicals management is distinctly separate from the Ministry of Health. Toxicologists in the hazard assessment agency considers the data, rather than health based professionals considering risk to public health. The silio-isation of creates an environment that effectively works in the business of facilitation for the chemical industry, rather than for the protection of health and the environment.

Agency failure to consider toxic synergies from patented products despite science recognising for decades the added toxicity in the patented product, and the fact that the agencies own legislation requires that substances are tested, appears to be the product of the environment described above.

Another example is lack of action by regulators to incorporate decades old scientific evidence that children are much more affected, and that chemicals harm the endocrine system at extremely delicate levels in regulatory assessment.

By failing to represent the true costs of the activity, claimed economic benefit is distorted. As a result, we tend to prioritise the needs of special interests, such as the agrichemical industry, that benefits most from light-handed regulation.

3. New Zealand Monitoring of Agrichemical Contaminants in Water

The 2017 OECD Environmental Performance Review of New Zealand 2017 warned that pollution of freshwater is spreading over a wider area and that the country's biodiversity is under threat.[81] It

[79] UN General Assembly. Human Rights Council Thirty-fourth session. Report of the Special Rapporteur on the right to food A/HRC/34/48 https://documents-dds-ny.un.org/doc/UNDOC/GEN/G17/017/85/PDF/G1701785.pdf?OpenElement

[80] George Stigler. The Theory of Economic Regulation." Bell Journal of Economics and Management Science. 1971

[81] OECD (2017), *OECD Environmental Performance Reviews: New Zealand 2017*, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264268203-en

suggested there was an opportunity to undertake major reform of national freshwater policy to safeguard water quality and availability.

At this stage, despite the fact that along with climate change, pollution has the potential to directly disrupt quality of life, there is no responsible authority or central database to adequately grasp the complexity of industrial or agricultural chemical profiles, recognised as 'chemical signatures' in New Zealand regions.

Without this overarching commitment to knowledge based research, scientists are unable to strategically contribute to informed policy in the public interest.

It is not unreasonable to believe that if the New Zealand government permits industry to use and discharge chemical contaminants – New Zealand government, as part of its role of safeguarding environmental and human health, should monitor these chemicals and limit them when there is evidence of accumulation in the environment.

New Zealand studies are few and far between

A rare freshwater stream 2013 study detected concentrations of 23 percent of the individual sediment samples above the EPA toxicity thresholds.[82] The insecticide chlorpyrifos, the most frequently detected chemical and a known neurodevelopmental toxicant, was not highest in stream sediments from conventional farms. The study authors suggested this may have been due to vapor drift.

'The presence of these toxic hotspots, although not common, may be partly responsible for the deterioration of macroinvertebrate communities in streams on conventional farms reported in an earlier Otago study.'

Dr Pourya Shahpoury

It is startling how little New Zealand monitors pesticides in the environment. Bay of Plenty Regional Council Marine Sediment Contaminants Survey provides a rare snapshot, considering PAHs, heavy metals and herbicides. The 2012 Survey screened for contaminants in sheltered sub-estuaries of Tauranga Harbour, downstream from intensive horticultural/agricultural land use.[83]

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[82] Shahpoury et al 2013. Chlorinated pesticides in stream sediments from organic, integrated and conventional farms. *Environmental Pollution.* http://dx.doi.org/10.1016/j.envpol.2013.06.035

[83] Bay of Plenty Marine Sediment Contaminants Survey 2012 Environmental Publication 2003/20; 2009/01; 2014/03 ISSN: 1175-9372 Prepared by S.G.Park.

A report such is this is limited not by the scientists preparing the data but the information the scientist relies on. As a result, out of date ANZECC (2000) Interim Sediment Quality Guidelines were used, there was no other option.

The Australian and New Zealand Environment Conservation Council (ANZECC) publishes the Australian and New Zealand guidelines for freshwater and marine water quality. The 2017 edition is due. It is critical the guidelines rely on published literature with full access to data, to arrive at trigger values.

Unfortunately, glyphosate and metsulfuron-methyl, two commonly used herbicides in the Bay of Plenty Region were not screened as part of the pesticide screening as they are not included in the multi-screen test.

The most common pesticide: How much glyphosate is in our environment?

Glyphosate is the dominant herbicide sold in New Zealand. Glyphosate can leach into groundwater.[84] European monitoring of surface waters has confirmed glyphosate is widely present.[85] Despite extensive application on NZ soils, glyphosate and its breakdown metabolite AMPA is not monitored in New Zealand freshwater or groundwater. Glyphosate is frequently accompanied by another herbicide, metsulfuron-methyl, and an organosilicone penetrants, either polydimethylsiloxane (Pulse) or polyether modified polysiloxane (AGPRO). None of these chemicals are monitored.

New Zealand local and regional councils are heavy sprayers of herbicides. Runoff from urban spraying can significantly contribute to herbicide detections in nearby sediments and freshwater. Glyphosate may be applied many times over the year in arable cropping operations. Livestock operations may apply glyphosate a couple of times a year to, perhaps 15% of their land annually prior to pasture renewal.

Glyphosate is only rarely tested by regional councils, in part due to the fact that it requires a separate test and so is more expensive than the standard multi-residue test which tests for a wide range of chemicals.

Waikato Regional Council (WRC) tested for glyphosate in groundwater in the summer of 2017, detecting only the persistent breakdown product, AMPA in one well.

Glyphosate has been detected in Auckland marine sediment at levels sufficient to damage marine fauna.[86] The Auckland Council Marine Sediment Contaminant Monitoring paper reported:

> Glyphosate residues were detectable at most sites, up to 1000 ng/g. The highest of the SoE/RDP locations was Meola Inner (950 ng/g) and the lowest were at Cox's Bay (< 40 ng/g) and Pakuranga Upper (90 ng/g). *(nanogram/gram is the same as PPB)*

New Zealand Environmental Protection Authority (EPA) has no idea how much glyphosate is used, and has no idea how much Kiwis are exposed to.

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[84] Battaglin WA, Meyer MT, Kuivila KM, Dietze JE. Glyphosate and its degradation product AMPA occur frequently and widely in U.S. soils, surface water, groundwater, and precipitation. JAWRA Journal of the American Water Resources Association. 2014;50(2):275–90.
[85] MONSANTO SURVEY OF GLYPHOSATE AND AMPA IN GROUNDWATERS AND SURFACE WATERS IN EUROPE. FINAL REPORT. 2012. http://www.glyphosate.eu/system/files/mc-files/iia_7.12_07_horth_2012.pdf
[86] Auckland Council Marine Sediment Contaminant Monitoring: Organic Contaminant Data Review 2003-2010. February 2014 Technical Report TR2014/001

In an OIA release dated 16 June, an NZ EPA Communications Advisor wrote 'We often get asked by journalists about the volume or extent of glyphosate use (which we can't answer).'

There are sparse published studies in New Zealand researching the impact of an agricultural chemical runoff on freshwater quality. A 2010 study which included glyphosate as a parameter, and conventional (standard chemical use), integrated and organic farming, demonstrated that conventional farming had the strongest adverse consequences for stream condition.[87]

Interestingly, organic and integrated farms both had higher densities of studied invertebrates than the conventional farm. The authors noted especially that:

> An integrated management system, which aims to reduce or eliminate the use of pesticides, increase beneficial pest predators, and encourage environmentally responsible soil, water and energy management, proved at least as effective as organic farming in mitigating potential adverse impacts of agriculture on streams.

The study authors noted that glyphosate was able to be detected (at lower levels) in organic farm stream sediment. They suggested this could be due to environmental persistence or volatility from spraying a distance from the farm.

The study confirmed that streams near conventional farms have less diverse stream populations, reflecting the farming intensity, and that less tolerant organisms are replaced by organisms that are more pollution tolerant. When samples were taken upstream of the chosen sites they did not have healthier environments. This perhaps reflected the fact that farming occurred both upstream and downstream of the study site. The fact that fluid dynamics enable chemicals to travel upstream might also be considered.

New Zealand has no idea of the quantity of glyphosate in the environment, and how it affects our aquatic flora and fauna.

NZ EPA: 'We often get asked by journalists about the volume or extent of glyphosate use (which we can't answer).'

The most common pesticide: How much glyphosate is in our bodies?

[87] Magbanua et al 2010. Responses of stream macroinvertebrates and ecosystem function to conventional, integrated and organic farming Journal of Applied Ecology 2010, 47, 1014–1025 doi: 10.1111/j.1365-2664.2010.01859.x http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2664.2010.01859.x/epdf

A research letter in the journal JAMA[88] found that in the USA over a 23 year time period, glyphosate in urine increased 15 fold. The information was obtained from a study of 100 people living in a Southern California community who provided samples between 1993 to 1996 and 2014 to 2016. The authors consider glyphosate exposures are primarily through glyphosate in the diet.

> Of study participants with detectable amounts of these chemicals, the mean level of glyphosate increased from 0.203 µg/L in 1993-1996 to 0.449 µg/L in 2014-2016. The mean level of AMPA went from 0.168 µg/L in 1993-1996 to 0.401µg/L in 2014 to 2016.[89]

The study author stated: 'The public needs to be better informed of the potential risks of the numerous herbicides sprayed onto our food supply so that we can make educated decisions on when we need to reduce or eliminate exposure to potentially harmful compounds.'

Glyphosate is in the diet of New Zealanders via the genetically modified crops found in processed foods in New Zealand. These foods can be imported or produced in New Zealand from imported ingredients (and not declared on the label). Vegetable oils including those made of soy and canola are permitted high glyphosate residues.

Non-genetically modified cereals imported or grown in New Zealand, are frequently sprayed with glyphosate before harvest (pre-harvest desiccation) to 'dry down' the cereal and make it easier for milling.

The science is not undertaken to understand exposure levels in New Zealand citizens. It is not expected that New Zealand dietary levels are as high as those in the USA. But it is expected our dietary levels will be somewhere between USA and European levels.[90] [91]

At this stage with the New Zealand Total Dietary Study is not including glyphosate (despite many submissions to the contrary[92]). The comment by MPI in the response to submission was that:

> 'Glyphosate was assessed for inclusion into the NZTDS, but has not been included, primarily because there are currently other, more comprehensive, MPI monitoring programmes that will be targeting glyphosate to determine compliance with regulatory limits.'

Some glyphosate testing appears to be undertaken via the Food Residues Surveillance Programme which was developed 'to investigate residues and contaminants in food for which there was no existing or suitable verification programme.'[93]

[88] Research letter. Mills et al 2017. Excretion of the Herbicide Glyphosate in Older Adults Between 1993 and 2016. *JAMA.* 2017;318(16):1610-1611. doi:10.1001/jama.2017.11726 https://healthsciences.ucsd.edu/som/fmph/research/studies/harp-project/Documents/jama_Mills_2017_ld_170034.pdf
[89] Exposure to Glyphosate, Chemical Found in Weed Killers, Increased Over 23 YearsY.Galindo October 24 2017. http://ucsdnews.ucsd.edu/pressrelease/exposure_to_glyphosate_chemical_found_in_weed_killers_increased_over_23_yea
[90] Detection of Glyphosate Residues in Animals and Humans Krüger et al 2014 , J Environ Anal Toxicol 2014, 4:2 http://dx.doi.org/10.4172/2161-0525.1000210
[91] Determination of Glyphosate residues in human urine samples from 18 European countries. June 2013. Medical Laboratory Bremen Report Glyphosate MLHB-2013-06-06 FOE Europe. https://www.foeeurope.org/sites/default/files/glyphosate_studyresults_june12.pdf
[92] New Zealand Total Diet Study 2015/16 Response to submissions on the Study Proposal Consultation MPI Information Paper No: 2015/16 https://www.mpi.govt.nz/news-and-resources/consultations/2016-nz-total-diet-study/
[93] http://www.foodsafety.govt.nz/policy-law/food-monitoring-programmes/food-act-1981/frsp/pesticides-fresh-frozen-produce.htm

3. New Zealand Monitoring of Agrichemical Contaminants in Water

Who has responsibility? Water Monitoring, TLA Obligations, Standards & Guidelines

Current freshwater monitoring is restricted to a narrow set of 9 values that do not reflect increasing chemical loads and the potential for leaching of these chemicals into drinking water sources.

What are the key New Zealand policy documents surrounding water policy. Do they put in place policy instruments to identify and protect New Zealand water environments from accumulation of agricultural and industrial chemicals? Who is responsible for carrying out these policies?

Key Player: The Land and Water Forum

A key player in the development of New Zealand water policy is the Land and Water Forum. Their role is to bring together 54 non-government organisations, including 'a range of stakeholders consisting of industry groups, electricity generators, environmental and recreational NGOs, iwi, scientists, and other organisations with a stake in freshwater and land management. They are joined by central and local government participants in developing a common direction for freshwater management in New Zealand and provide advice to the Government.'[94]

Land and Water Forum have released four reports since 2010. These reports have not discussed risk of agrichemical contamination, nor potential for accumulation in New Zealand waterways and groundwater.

Report: Freshwater reform 2013 and beyond

The document 'Freshwater reform 2013 and beyond'[95] incorporated recommendations from the Land and Water Forum, to set in place the Government's proposals for reform of the freshwater management system for 'a generation'.

It did not discuss or address agricultural or industrial chemical degradation of our freshwater, despite acknowledging the 'increasing signs of potential risks for New Zealand's ecosystems, for the economy, for tourism and recreation, for food gathering and mahinga kai, and for our international reputation.'

The 2013 paper suggested attributes for a freshwater framework which included E. coli, Periphyton, Cyanobacteria

Policy Paper: National Policy Statement for Freshwater Management 2014

The governments' National Objectives Framework (NOF) guides New Zealand regional decision-making in the setting of freshwater objectives, referred to as the 'National Policy Statement for Freshwater Management 2014 (NPS-FW).'[96] The NPS-FW does not provide national guidelines for

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[94] The Land and Water Forum http://www.landandwater.org.nz/Site/About_Us/default.aspx

[95] Ministry for the Environment. 2013. *Freshwater reform 2013 and beyond*. Wellington: Ministry for the Environment. ME 1109. http://www.mfe.govt.nz/publications/fresh-water/freshwater-reform-2013-and-beyond

[96] New Zealand National Policy Statement for Freshwater Management 2014, which was u*pdated August 2017 to incorporate amendments from the National Policy Statement for Freshwater Amendment Order 2017.*
http://www.mfe.govt.nz/sites/default/files/media/Fresh%20water/nps-freshwater-ameneded-2017_0.pdf

management of chemical and industrial pollution in New Zealand freshwater that address greater challenges of agricultural and industrial chemical contamination.

The National Policy Statement for Freshwater Management 2014 sets out objectives for a national management framework. Among the objectives is 1A:

> To safeguard:
>
> a) the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, of fresh water; and
>
> b) the health of people and communities, as affected by contact with fresh water;
>
> in sustainably managing the use and development of land, and of discharges of contaminants.

"Freshwater quality accounting system" defines a system that,

> 'for each freshwater management unit, records, aggregates and keeps regularly updated, information on the measured, modelled or estimated:
>
> a) loads and/or concentrations of relevant contaminants;
>
> b) sources of relevant contaminants;
>
> c) amount of each contaminant attributable to each source; and
>
> d) where limits have been set, proportion of the limit that is being used.

The NPS-FW lists only nine attributes (defined as a 'measurable characteristic of fresh water, including physical, chemical and biological properties, which supports particular values') that have a minimum level – the national bottom line – for which the following may be present in freshwater:

The New Zealand National targets for water quality improvement are based on two human health attributes, E. coli and cyanobacteria – planktonic.[97]

Key Player: NIWA: Analysis of Water Quality in New Zealand Lakes and Rivers

The NIWA paper 'Analysis of Water Quality in New Zealand Lakes and Rivers'[98] considers eight variables:

> Physical: Water clarity; Ammoniacal nitrogen; Nitrate nitrogen;
> Chemical: Total nitrogen (unfiltered); Dissolved reactive phosphorus; Total phosphorus (unfiltered)
> Microbiological: Escherichia coli
> General river health: macroinvertebrate community composition/Index

NIWA runs the National Rivers Water Quality Network (NRWQN). The NRWQN, 'New Zealand's most comprehensive freshwater quality monitoring network' considers the same mix of attributes as NIWA and the freshwater standards.

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[97] New Zealand National Policy Statement for Freshwater Management 2014. APPENDIX 6: National target for water quality improvement
[98] National Institute of Water & Atmospheric Research Ltd. Analysis of Water Quality in New Zealand Lakes and Rivers Prepared for Ministry for the Environment February 2015. Report No. CHC2015-033 NIWA Project MFE15503.Larned et al.

Key Player: Regional Councils obligations to protect and enhance

Regional Councils have the primary obligation, and hence burden, in New Zealand, to protect our freshwater.

The National Objectives Framework outlined in the NPS-FW is the key document used by regional councils to conform to national water quality standards.

Most regional councils test to National Freshwater Standards, screening for the 9 attributes[99] specified. Regional Councils do not routinely test for pesticides in their freshwater and marine environments, though this may occasionally be done.

Regions benefit from employment derived by the agricultural industries (as the national government benefits from taxpayers) that lie within their boundaries, but they also suffer from the profound and constant stress on the environment that is a by-product of chemically driven agriculture.

Regional Councils also have responsibility to protect drinking water sources. 'The National Environmental Standard for Sources of Human Drinking Water (NES) is a regulation made under the Resource Management Act (1991)[100] that sets requirements for protecting sources of human drinking water (whether lakes, rivers or groundwater) from becoming contaminated.'[101] It requires that regional councils decline discharge or water permits if there is a risk to drinking water, it also ensures regional councils must ensure permitted activities in regional plans to not endanger drinking water supplies.

There appear to be two significant issues constraining regional councils. One is that Regional Council budgets are limited, resulting in scarce funding to undertake research, with the result that they have limited data to work from. The second is that key industry stakeholders in the agricultural sectors are significant regional political players and are embedded in regional decision-making.

As a consequence, despite a distinct legislative duty to protect and enhance the aquatic ecosystems, councils have ended up in a situation of cognitive dissonance where the chemicals used by regional agricultural industries are rarely researched in the environment, nor analysed for ecosystem toxicity.

The national government focus on the problem of 'nutrients' rather than chemical toxicity acts to further shape debate and keep it centred on 'nutrient' pollution, keeping wider discourse on chemical contamination out of the public arena.

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[99] See Appendix 1

[100] Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations 2007. SR 2007/396. http://www.legislation.govt.nz/regulation/public/2007/0396/latest/whole.html?search=ta_regulation_R_rc%40rinf%40rnif_an%40bn%40rn_25_a&p=3#DLM1106901

[101] http://www.mfe.govt.nz/fresh-water/what-government-doing/national-environmental-standards/sources-of-human-drinking-water

Without nationally driven leadership and funding, our most polluted regions, for example, Canterbury, and Rotorua Lakes, simply cannot do the science to understand the cumulative toxicity that is creating the complex environment that both tourists and locals, find unpalatable.

If a narrow range of toxic contaminants are considered, they will be the only parameters that might potentially be restricted. The problems outlined above, relating to accelerating chemical use and lack of national monitoring, impact regional council's ability to detect the contaminants that continue to dysbiosis and degradation and restrict them.

Rotorua Te Arawa Lakes Programme

The Rotorua Te Arawa Lakes Programme, a partnership between Te Arawa Lakes Trust, Rotorua Lakes Council and Bay of Plenty Regional Council. The Programme aimed at protecting the 12 Rotorua Te Arawa lakes, is budgeted at approximately $230 million and part-funded through a Deed of Funding Agreement with the Crown.[102] Appendix B of the funding deed outlines the roles and responsibilities.[103] This includes management of invasive pest plants.[104]

Despite the large budget, a commitment to analysing the greater chemical make-up of the freshwater and sediment, outside the NPS-FW, does not appear a part of the Programme. The 2016 Annual Work Programme advises that it undertakes sediment monitoring.[105] Monitoring by Bay of Plenty's Natural Environment Regional Monitoring Network (NERMN) may be restricted to the NPS-FM 9 attributes.

There appears no budget to research pesticide mixtures in lake sediment or freshwater from agricultural, regional council aquatic weed pesticide management and urban sources, nor the potential for growth of herbicide resistant aquatic species, including cyanobacteria. (See Appendix 2.C.)

> *The $230 million programme does not appear to include a budget to research and understand agricultural, industrial or urban chemical contaminant loads that may impact the 12 lakes.*

For example, Lake Tarawera, surrounded by pine forest plantations, has declining water quality. The Bay of Plenty Regional 2006 regional air plan notes that the Bay of Plenty Region holds 22% of land area in exotic pine forest plantations. This is second only to the Waikato.[106]

Pine forest plantations receive pulses of glyphosate before pine seedlings are planted and pulses of terbuthylazine and hexazinone after planting to stop vegetation overtaking young seedlings. Each year, different areas are logged then replanted. The chemical pulses into water systems are endless.

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102 BOPRC Long term plan. Integrated Catchment Management Group Te Rōpū Whakahaere Whaitua Awa https://www.boprc.govt.nz/media/448081/05-integrated-catchment-management-group-of-activities.pdf
103 https://www.boprc.govt.nz/media/295935/rotorua-te-arawa-lakes-strategy-group-meeting-agenda-friday-30august-2013-part-2.pdf
104 Aquatic pest plants 2013 brochure. https://www.boprc.govt.nz/media/321621/PP13-Aquatic-pest-Plants-WEB.pdf
105 https://www.boprc.govt.nz/media/518005/rdd-agenda-301316-part-4-pages-331-386.pdf
106 https://www.boprc.govt.nz/media/31055/Plan-060831-BOPRegionalAirPlan.pdf

Bay of Plenty Regional council staff have confirmed to the author there has not been any pesticide sampling of the twelve Rotorua Lakes in recent years.

Local Government

New Zealand local government's dominant role relating to water is management of drinking water supplies. As such, drinking water suppliers must adhere to the Drinking-water Standards for New Zealand 2005.[107]

The Local Government New Zealand (LGNZ) 2014 issues paper 'Exploring the issues facing New Zealand's water, wastewater and stormwater sector'[108] does not address chemical contamination as an emerging issue.

It does however mention that the Health Act 1956 was amended to replace previously voluntary drinking water standards with compulsory drinking water standards (DWS). The issues paper noted some councils (particularly rural) struggled to comply with the new DWS.

Drinking Water Standards

Central government and the Ministry of Health defers responsibility for detection of new contaminants to water suppliers. If standard detection methods, eg. Pesticide multi-residue analysis, does not include a chemical widely present in the environment, and/or the chemical does not have a maximum acceptable value (MAV) listed in the DWSNZ the chemical will not be tested, or screened for. [109] As such, glyphosate and metsulfuron-methyl, do not have MAVs and so are not commonly tested for.

Once it a chemical listed in the DWSNZ is found to exceed half the MAV, standard protocol is to regularly monitor for compliance. (Populations of over 500 are monitored for chemical determinand maximum acceptable values (MAVs).)

Drinking water suppliers are dependent on MoH for setting standards, if this is not done, suppliers will not screen.

New Zealand's drinking water standards are out of date. The Draft Users' Guide: National Environmental Standard for Sources of Human Drinking Water advises 'The DWSNZ are revised every two years and updated every five years.' The most recent revision was in 2008.[110]

There is no trigger to alert to an altered risk profile should a chemical be applied widely in the environment, but have no MAV, and so monitor it as a precaution.

The pesticides metsulfuron-methyl (in the Agpro Meturon product, CAS No. 74223-64-6) and glyphosate (CAS No. 1071-83-6) do not have a MAV. It is important to recognise that they also

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[107] Drinking-water Standards for New Zealand 2005 (Revised 2008) http://www.health.govt.nz/publication/drinking-water-standards-new-zealand-2005-revised-2008

[108] Local Government NZ. Exploring the issues facing New Zealand's water, wastewater and stormwater sector. October 2014. Prepared for LGNZ by Castalia Strategic Advisors http://www.lgnz.co.nz/assets/Publications/LGNZ-3-Waters-Issues-Paper.pdf

[109] Drinking-water Standards for New Zealand 2005 (Revised 2008) http://www.health.govt.nz/publication/drinking-water-standards-new-zealand-2005-revised-2008

[110] Ministry for the Environment. 2009. Draft Users' Guide: National Environmental Standard for Sources of Human Drinking Water. Wellington: Ministry for the Environment.

require separate tests (glyphosate is a separate screen, and metsulfuron-methyl requires a Sulfonylurea screen.) Both metsulfuron-methyl and glyphosate degrade into toxic and persistent metabolites. See Appendix 2(B)

Organosilicon surfactants, recognised as international pollutants and added to glyphosate and metsulfuron-methyl, are not considered toxic by regulatory authorities and do not have MAVs either. A recent paper stated 'impacts of organosilicon surfactant pollutants on humans need to beevaluated since their ubiquitous use in the developed world makes exposure inevitable.' [111]

Both glyphosate, metsulfuron-methyl and the Agpro organosilicone surfactant added into the mixture are widely applied on New Zealand roadsides, in forestry and in agriculture. Metsulfuron-methyl is applied with glyphosate to help combat resistance to glyphosate formulations.

The 2011 Australian drinking water standards[112] require metsulfuron-methyl to not exceed .04mg/L. Generous Australian guidelines for glyphosate advise the chemical would not be a health concern unless it exceeded 1mg/L.

The European Commission Council Directive 98/83/EC has set a maximum level of 0.10 µg/l (.01 ppb or 0.0001 mg/L) *for any pesticide in drinking water*. These pragmatic precautionary limit aims to protect children and reflects the fact that there are many data gaps in pesticide approvals.

European levels allow for accumulation, requiring that total pesticides in European drinking water must be below 0.5 µg/l. [113] If New Zealand were to follow the European lead it would be a significant step in protection of the New Zealand population.

Worryingly, outdated guidelines result in chemicals other than pesticides not being screened for, including those present in sewage (pharmaceuticals) and industrial waste. As time passes and these chemicals accumulate they become increasingly difficult to eradicate, it places additional stress on drinking water suppliers.

As freshwater and groundwater pollution increases internationally, sources of safe available freshwater narrow. New Zealand contracts for bottled drinking water are reflecting shrinking international sources of safe drinking water.

Perhaps ironically, industry contracts to assure future uncontaminated groundwater sources for export markets may do more to create political will, with the resultant effect of protecting the New Zealand public in the long term.

Weakened drinking water standards for rural communities?

Smaller suppliers in rural communities are the least able to deal with these chemical stressors from chronic (long term), sub-lethal exposure to accumulating pesticides that as a consequence of regional agrichemical use.

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[111] Chen et al 2017 Are organosilicon surfactants safe for bees or humans? Science of the Total Environment 612 (2018) 415–421 https://doi.org/10.1016/j.scitotenv.2017.08.175

[112] NHMRC, NRMMC (2011) Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra.

[113] Council Directive 98/83/EC http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:330:0032:0054:EN:PDF

Budgets to manage water supplies are restricted by relatively low populations.

A 2010 'Cost benefit analysis of raising the quality of New Zealand networked drinking water' considered risk based on transgressions detected by ESR in the 2007/2008 year.[114] It noted that:

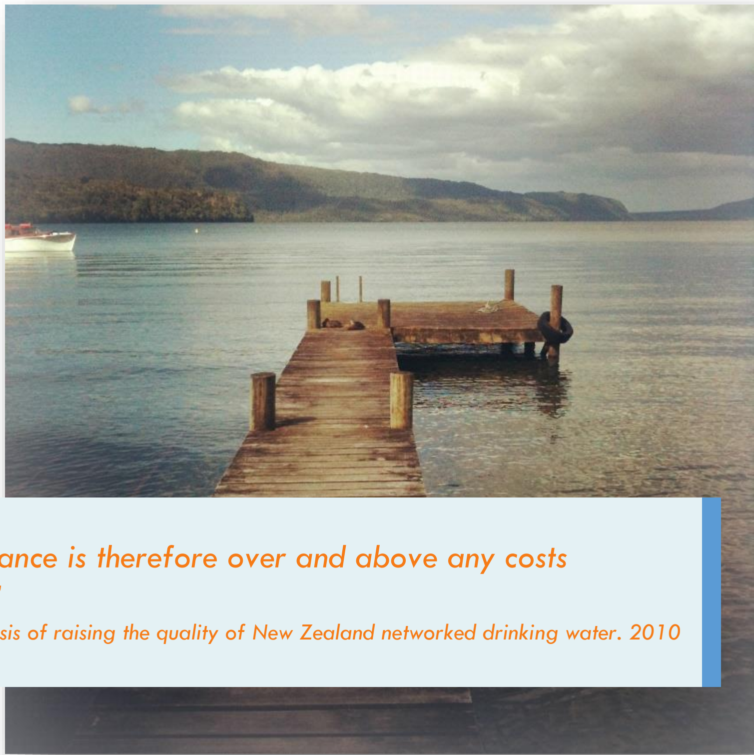
> 'The NZ focus on bacterial and protozoal contamination perhaps separates us from many other developed countries, where health concerns often focus on chemical contamination of waterways.'

The 2010 paper noted that 'chemicals in drinking water breaching MAVs, other than arsenic, are of limited concern in NZ at this time.' It did not consider environmental persistence of chemicals in freshwater, sediment or groundwater, and the capacity for metabolites to persist in low light environments.

When chemicals that persist are not withdrawn from use, for example the triazine group of chemicals, they can then accumulate, presenting greater risk to local populations.

The paper acknowledged that health risk for chemicals in drinking water increases with extended exposure,[115] and acknowledged that the most common risk related to increased cancer.[116]

It outlined the increasing costs posed on the tax payer to keep water safe, and the need to consider upgrades on a case by case basis. For example, different chemicals require different treatment processes. Cost estimates to the paper by CH2M Beca Limited (Beca) advised costs to comply to chemical standards exceed costs to comply with microbiological (Eg. Bacterial) standards.[117]



> *'costs reported for chemical MAV compliance is therefore over and above any costs required for microbiological compliance.'*
>
> *Cost benefit analysis of raising the quality of New Zealand networked drinking water. 2010*

The paper considered that health risks most commonly related to development of cancers.

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[114] LECG. Cost benefit analysis of raising the quality of New Zealand networked drinking water. 2010. https://www.health.govt.nz/system/files/documents/publications/cba-raising-quality-of-networked-drinking-water-jun2010_0.pdf

[115] World Health Organization, Guidelines for Drinking Water Quality, third edition, Chapter 8

[116] World Health Organization, Guidelines for Drinking Water Quality, third edition, Chapter 12

[117] Maximum Acceptable Value for a determinand (eg. arsenic or atrazine) for chronic lifetime (70 years) of daily consumption.

The 2010 paper noted that proposed new Standards for Agricultural drinking water supplies would be changed. It appeared to assume that as rural supplies are largely used for crops and animals, they would not need to meet the current Standards.

The 2010 paper considered naturally occurring arsenic to pose the greatest health risk. It did not consider increased transgressions from ongoing industrial and agricultural emissions into existing drinking water sources.

Groundwater Monitoring: National Survey of Pesticides in Groundwater

While there is no national approach for monitoring freshwater systems nor understanding regional chemical signatures, ESR prepares the National Survey of Pesticides in Groundwater (NSPGW) for Regional Councils every four years. The NSPGW appears to be the sole nationally co-ordinated approach for monitoring agricultural chemicals in New Zealand waters.

The problem is, when groundwater levels start to increase, there is no policy or framework to implement measures to restrict the use of the chemical that may be increasing. There is no analysis to understand the accumulation and potential for that groundwater to become unsafe. Chemicals and their metabolites can remain locked up in darkened groundwater environments for years. The chemical terbuthylazine, the most commonly detected pesticide in New Zealand groundwater, continues to be the primary herbicide applied throughout New Zealand forestry regions.

The European Union has policies to identify 'sustained upward pollution trends' in groundwater.[118] If a threat is identified to groundwater, legislation demands that these trends must be reversed. Europe has also selected and regulated for substances that are of EU wide concern. No policies of this calibre exist in New Zealand.

A 1996-1999 Environment Waikato detected dieldrin at 300% of the acceptable value for public safety.[119] In the 2014 National Survey of Pesticides in Groundwater, some 20 years after the chemical was banned, dieldrin was detected in Waikato groundwater at above the acceptable value for public safety. [120]

Once vulnerable groundwater systems reach a cumulative level of toxicity from chemical mixtures (including e.g. nitrates), they will be rendered non-viable for agricultural and human uses.

More complex standards (threshold values) including minimum chemical properties must be put in place. Critically, monitoring of these standards must be publicly carried out and publicly released. These standards must reflect the changing chemical profile of our industry uses and monitoring must include health based assessment of cumulative toxicities of multiple chemicals, and the potential for synergistic action of these chemicals.

Without subtle understanding of the chemical mixtures in our surface and groundwater we cannot appreciate the overall toxicity that has the potential to impact the health of our families and our children and their future access to clean, safe drinking water.

[118] DIRECTIVE 2006/118/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006 on the protection of groundwater against pollution and deteriorationvalues http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006L0118
[119] Waikato Regional Council. https://www.waikatoregion.govt.nz/Environment/Natural-resources/Water/Groundwater/Monitoring-groundwater-quality/Pesticide-contamination-of-groundwater/
[120] National Survey of Pesticides in Groundwater 2014 ESR. B.Humphries and M.Close. https://www.marlborough.govt.nz/repository/libraries/id:1w1mps0ir17q9sgxanf9/hierarchy/Documents/Environment/Groundwater/Groundwater%20Reports%202015%20List/National_Survey_of_Pesticides_in_Groundwater_Report_final.pdf

Due to the persistence of many chemicals in groundwater, it is critical that this survey adequately assesses all regions, and major aquifers that are contained therein. Adequate funding is necessary for analysis of NZGWS results, in order to predict and prevent future chemical threats.

Regional councils may elect to not take part. For example, the Bay of Plenty and West Coast regional councils did not take part in the 2014. Bay of Plenty Regional Council informed the author the decision on whether or not to participate, is normally taken by staff.

Regional councils are charged with funding their portion of the survey, they also can apparently agree or not agree to including a particular pesticide in the survey. For example, glyphosate has been listed as a potential to include in the 2018. Due to the fact that it is a separate screen, it is unclear if it will be included. The surveys are taken every four years.

Navigating papers can make it difficult to understand risk. A recent review of glyphosate use in forestry stated that glyphosate has not been detected in groundwater. The survey cited by the study author does not detect for glyphosate. The 2017 review also mentioned that glyphosate was rarely detected in groundwater in Europe. It cited a 2004 study. [121] More recent information provides evidence of glyphosate in groundwater in Europe.[122]

Example: The Triazine family – mobile and persistent – and in our groundwater

Pesticide use in New Zealand has accelerated in the last 30 years and our groundwater systems in particular, appear to be accumulating highly mobile and persistent triazine group of pesticides. Many of these triazine pesticides have been banned in Europe and California, due to being highly mobile; persistent; endocrine disrupting and having the ability to act as reproductive toxicants.

Atrazine (ATR, simazine (SIM), cyanazine, prometryn, propazine (PRO) terbuthylazine(TBA), and terbutryn are classed as triazines, and recognised as persistent and highly mobile.

Other Triazine pesticides detected in New Zealand groundwater include Metribuzin, Terbuthylazine[123] and its metabolite Desethyl Terbuthylazine. Despite its listing in Europe as a likely carcinogen, terbuthylazine is permitted in New Zealand for use on grass and broadleaf weed control in forestry, established lucerne, maize, sweetcorn, orchards and peas.[124] It is the most commonly detected pesticide in New Zealand groundwater.

There is a paucity of data relating to other triazines present in New Zealand groundwater and health implications. Do they affect similar pathways? Do they act synergistically?

What affect does the combined presence of metabolites from the same Triazine family?

Pesticides in the same group tend to be toxic in similar ways. Published studies indicate that triazine pesticides may be endocrine disruptors at low levels. Recognising this, in 2016 California's Office of

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[121] Rolando et al 2017. Review: The Risks Associated with Glyphosate-Based Herbicide Use in Planted Forests. *Forests* 2017, 8, 208; doi:10.3390/f8060208

[122] SURVEY OF GLYPHOSATE AND AMPA IN GROUNDWATERS AND SURFACE WATERS IN EUROPE - UPDATE 2012. Helene Horth (Independent Adviser, Water Quality and European Policy & Legislation). http://www.glyphosate.eu/system/files/mc-files/iia_7.12_07_horth_2012.pdf

[123] Considered further in Appendix 2 A. Case study: Terbuthylazine R40 (carcinogen category 3)

[124] http://www.epa.govt.nz/search-databases/HSNO%20Application%20Register%20Documents/APP202269_APP202269%20Decision%20Document%20Final.pdf

Environmental Health Hazard Assessment (OEHHA*)* declared the following triazines reproductive toxicants and:

> 'provided notice that atrazine, propazine, simazine, des-ethyl atrazine (DEA), des-isopropyl atrazine (DIA) and 2,4-diamino-6-chloro-s-triazine (DACT)[1] would be added to the list of chemicals known to the state to cause reproductive toxicity for purposes of Proposition 65[125]

Triazine chemicals atrazine, propazine and simazine, detected in New Zealand groundwater and in California, act similarly and have similar metabolites.

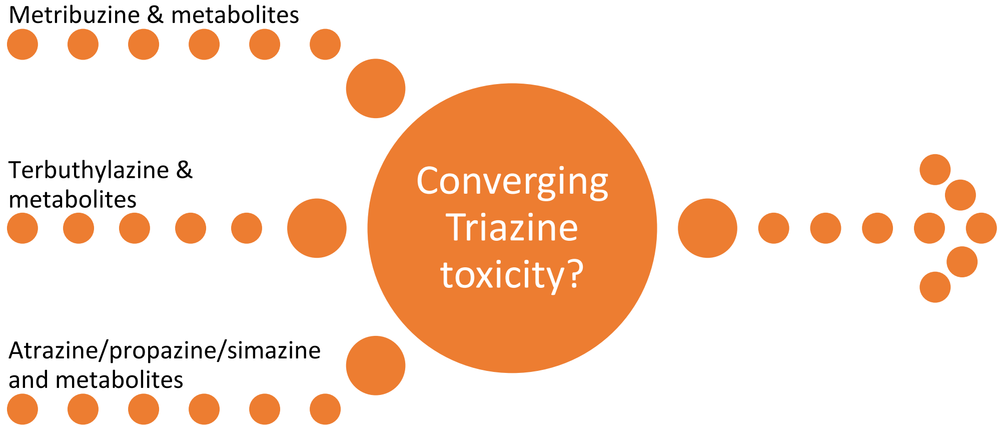
New Zealand does not assess for co-occurrence nor test all the prominent metabolites.

Simazine and Atrazine were removed from the European market in 2004 due to risk of leaching into groundwater. [126] The Official Journal of the European Union remarked:

> 'In particular available monitoring data were insufficient to demonstrate that in large areas concentrations of the active substance and its breakdown products will not exceed 0,1 µg/l in groundwater. Moreover it cannot be assured that continued use in other areas will permit a satisfactory recovery of groundwater quality where concentrations already exceed 0,1 µg/l in groundwater. These levels of the active substance exceed the limits in Annex VI to Directive 91/414/EEC and would have an unacceptable effect on groundwater.'[127] [128]

Despite being banned in Europe, atrazine is permitted in New Zealand for use as an herbicide. This includes permission to apply atrazine to human and animal feed crops.[129] Due to increasing weed resistance to atrazine, this ingredient may be mixed with other chemicals eg. Fluthiacet- methyl, for grain and maize silage. Fluthiacet- methyl is not approved for use in Australia or the EU.[130]

Terbuthylazine is discussed further in Appendix 2A.



[125] OEHHA July 15, 2016 https://oehha.ca.gov/proposition-65/crnr/atrazine-propazine-simazine-and-their-chlorometabolites-dact-dea-and-dia-0
[126] Commission Decision of 10 March 2004 concerning the non-inclusion of atrazine in Annex I to Council Directive 91/414/EEC EEC and the withdrawal of authorisations for plant protection products containing this active substance. Documents no 727 and 731.
[127] Simazine http://www.scc-gmbh.de/New_Regulations_Approvals_Agrochemicals/94_1_simazine_2004_247_EC_EN.pdf
[128] Atrazine http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004D0248&from=EN
[129] ERMA 2006 Decision document HSR06076 Atranex WG Herbicide: to import for release, containing 900 g/kg atrazine
[130] http://www.epa.govt.nz/search-databases/HSNO%20Application%20Register%20Documents/APP202170_APP202170_CADET_Staff_Report_FINAL.pdf

3. New Zealand Monitoring of Agrichemical Contaminants in Water

Triazine family of herbicides and breakdown metabolites

- Terbuthylazine
  - desethyl-terbuthylazine MT1 / GS26379
  - hydroxy-terbuthylazine MT13 / GS23158
  - 2-hydroxy-desethyl-terbuthylazine MT14 / GS28620
  - Terbuthylazine metabolites attributed EU codes LM1, LM2, LM3, LM4, LM5 and LM6
- Atrazine
  - Atrazine metabolite des-ethyl atrazine (DEA) G-30033
  - Atrazine metabolite des-isopropyl atrazine (DIA) GS28279
  - Atrazine metabolite 2,4-diamino-6-chloro-s-triazine (DACT)
  - Atrazine metabolite 2-hydroxyatrazine G-34048
- Metribuzin
  - Metribuzin metabolite deaminated, DA; diketo, DK;
  - Metribuzin metabolite Desaminodiketometribuzin DADK
- Simazine
  - Simazine metabolites 2-hydroxy-4,6-diamino-s-triazine, 2-hydroxy-4-amino-6-ethylaminos-triazine, and hydroxy-simazine; di-N-dealkylated;
  - Simazine metabolite 6-deisopropyl atrazine (DIA) G-28279
- Propazine
  - Propazine metabolite des-ethyl atrazine (DEA),
  - Propazine metabolite des-isopropyl atrazine (DIA)

4. Is it a subsidy? Understanding the real cost of agriculture

Regional councils surrounded by intense agrichemical use, are grappling with embedded stakeholders (for example forestry industry) and the complex negative externalities that contribute from degraded soil and water contamination.

Yet failure to protect freshwater risks food and water security, the externalities ripple out.

The current 'undone' science fails to address the economic and health benefits of preserving water in chemical free form which generates complex and positive outcomes in health, agriculture, development, export, education and tourism.

The current status-quo by default enables the voices of the lodged stakeholders to shout louder than the other industries that do not have such an immediate interest, but are, nevertheless, intricately entwined in the long-term well-being of the New Zealand landscape.

If we don't understand the externalities that create downstream harm and the costs to the New Zealand public, we 'are like pilots trying to steer a course without a reliable compass.'[131]

Former Parliamentary Commissioner for the Environment Dr Morgan Williams has suggested that British legislation on climate change to reduce emissions, may work well to assist New Zealand water policy. The UK requires 'five-year tranches of action within the British economy and society to reduce emissions, set at least 10 years in advance to put them outside the cycle of governments.'

The article in Stuff noted 'It was legislation that had majority support across the House. Other countries in Europe have similar laws either in place or on the way.'[132]

It is timely that economic analysis of chemicals used in the New Zealand environment is carried out by responsible government to understand the true economic costs, or externalities, that are growing with wider chemical exposures.

The challenges of endocrine disruption for example, and loss to IQ and health; health days lost; impact on aquatic species, particularly disruption to the aquatic food chain; kaimoana (including shellfish) restrictions; costs of research to understand increased chemical residues in groundwater and recognition of ultimate limits with accelerated leaching; implication for tourism and freshwater tourism activities; costs to New Zealand quality of life and future lifestyle expectations.

However, without a clear strategy that sits outside of narrow election cycles, that provides transparent direction that is not easily manipulated by stakeholder interests, action in the public interest will continue to be insufficient to protect against slow but steady environmental contamination.

The Cost of Endocrine Disruption

Analysis of potential for chemicals to act as endocrine disruptors at extremely low levels should be required in order to understand long term health impact - if a swimmability index is to truly protect health, and if the drinking water MAVs are to be safe for the New Zealand population.

A study released November 2017 calculated that cost of human exposure to preventable environmental chemicals equated to a health costs of 10% of global GDP. Functional deficits, especially regarding brain development and cognition greatly add to the global burden of disease.[133]

The study authors particularly noted in their conclusion:

> 'We highlight substances such as mercury, pesticides, brominated diethyl ethers, and several endocrine disrupting chemicals as serious health hazards that need to be confronted. Our results show that functional deficits, especially regarding cognition, greatly add to the total environmental Burden of Disease (BoD).'

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[131] Stiglitz et al 2008. Report by the Commission on the Measurement of Economic Performance and Social Progress.
[132] A national strategy for water is needed, scientist says. C.Sivignon. *Stuff.* Dec 8 2017. http://www.stuff.co.nz/environment/98419845/climate-change-faster-than-expected-says-scientist-dr-morgan-williams
[133] P Grandjean & M Bellanger 2017. Calculation of the disease burden associated with environmental chemical exposures: Application of toxicological information in health economic estimation. *Environmental Health.* https://doi.org/10.1186/s12940-017-0340-3

An earlier paper by Leo Trasande and colleagues considering European exposures to endocrine disruptors[134] concluded that there was a substantial probability of very high disease costs across the lifespan associated with endocrine exposure in the EU. It calculated that endocrine disruption annually cost €163 billion (1.28% of EU GDP). The paper noted that organophosphate and organochlorine pesticides (in addition to other compounds) can interfere with a variety of endocrine pathways, including estrogen, androgen, thyroid, retinol, aryl hydrocarbon, and peroxisome proliferator-activated receptor pathways. It advised:

> 'Potential consequences of exposure to EDCs include infertility and male and female reproductive dysfunctions, prostate and breast cancer, birth defects, obesity, diabetes, cardiopulmonary disease, neurobehavioral and learning dysfunctions, and immune dysregulation.'

Dedicated nationally funded research to build a profile of endocrine disruptors in surface and groundwater should also be required. Internationally, scientists are illustrating the increasing costs (externalities) faced by countries from increased environmental contamination and resultant exposure to endocrine disruptors.

As yet, there is no substantial framework or funding allocation to address this very real health based, economic threat from endocrine disrupting chemicals that the New Zealand public are broadly exposed to.

Is it a subsidy? Returning public good extension services

Farmers are frequently perceived as stakeholders with special benefit. However, farmers also suffer from undone science. The published literature may illustrate that pesticides mixtures contribute to depression, contribute to soil degradation and reduced farm viability. The published literature is adamant that children living near farms are more likely to be adversely affected from pesticides toxicity.

Modelling to understand the true cost of food, and acknowledge farmers role of guardians of increasingly fragile and dwindling resources, arable soil and freshwater systems, and the necessity to incorporate measures to protect these resources long term, is woefully inadequate when we consider the priority humanity places on consuming safe and nutritious food and water.

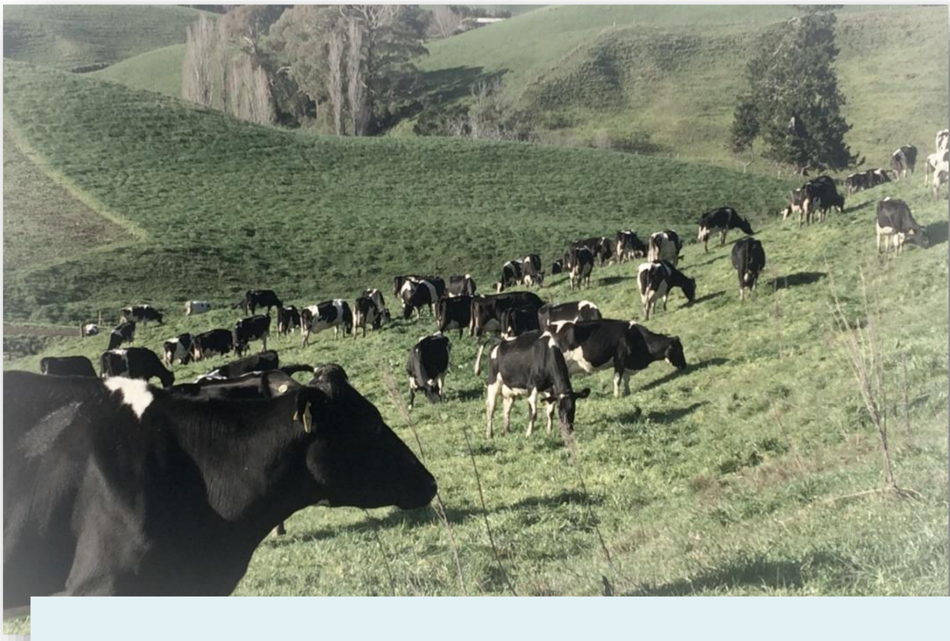
Media may be quick to label such actions a subsidy. However if such actions are vital to achieve sustainable development goals, and to keep the New Zealand environment within a 'safe operating space', perhaps it is time the New Zealand public acknowledged that farming has a cost. The cost can be detrimental, with cheap chemical agriculture combining to pollute as farmers strive for the cheapest cost per acre, in order to fulfil consumer demands for cheap food.

Alternatively, we can restrict the negative externalities and take strategic steps to ensure the New Zealand agricultural environment is regenerative, and that farmers have sufficient income to farm in such a way that maintains soil quality and restricts accumulation of synthetic chemical mixtures in the New Zealand freshwater environment. Perhaps this might not be considered subsidization,

[134] Burden of disease and costs of exposure to endocrine disrupting chemicals in the European Union: an updated analysis. 2016 doi: 10.1111/andr.12178

rather, strategic transition that holds as a priority, the protection of New Zealand freshwater and food security.

Environmental bioaccumulation of legacy pesticides and other highly mobile[135] and persistent[136] toxic chemicals, have the potential to impact New Zealand economic and health performance in the short and long term.



However, if the science provided to farmers is from advisers' dependent on short term profit, these deeper issues that may have been previously been put forward by an independent, publicly funded extension or advisory service will not be explored.

It is possible to transition to a culture that builds robust, viable thriving farms. That regenerative practices to maintain topsoil and protect freshwater form a kind of 'commons' in New Zealand's best interest.

Transparency and best practice

It is essential that New Zealand expert bodies work together in the public domain to establish transparent regulations. That monitoring and testing is carried out via publicly available testing methodologies, and that results from chemical testing are transparently published for regional communities to understand and act upon.

Europe have put in place policies to identify 'sustained upward pollution trends' and require if a threat is identified to groundwater these trends must be reversed. The reversal obligation

[135] Mobile chemicals have greater potential to runoff with surface water and leach into freshwater and groundwater.
[136] Persistent chemicals are resistant to environmental degradation through chemical, biological, and photolytic processes. Extremely persistent chemicals are recognised as POPs – Persistent Organic Pollutants (POP) or Persistent Bioaccumulative and Toxic (PBT). There are many chemicals that are not yet POPs or PBTs that are persistent and accumulating, including simazine and terbuthylazine. Due to lack of funding for non-commercial toxicity research, data regarding environmental toxicity etc for many persistent chemicals is lacking.

establishes that any significant and sustained upward trend will have to be reversed when reaching 75% of the values of EU-wide groundwater quality standards and/or threshold values.

National standards should not just respond to current contaminant threats but should look to the future to understand future contaminants that may reduce the quality of life that New Zealand is proud of.

'Undone Science'

An increasing body of scientific literature documents that narrow regulatory parameters and guidelines are creating a situation of 'undone science.' [137] A paper discussing gaps in science concerning neonicotinoid pesticides and colony collapse disorder, outlined increasingly recognised frameworks that give rise to systemic ignorance through the lens of 'undone science' (Hess 2007; Frickel et al. 2010), 'knowledge gaps' (Frickel and Vincent 2007), 'strategic ignorance' (McGoey 2012), and 'scientific cultures of nonknowledge' (Boschen et al. 2010).

'Undone science refers to the kinds of research that get systematically ignored, left unfunded, or incomplete, but is recognized by other actors as being worthy of serious consideration.'

Recognised as the 'social production of ignorance' or 'non-knowledge,' the resultant knowledge gaps can facilitate an environment where 'ignorance emerges from within the rules, procedures and protocols.'

As a result, strategic actors, for example chemical industry stakeholders, can 'utilize these differing paradigms of nonknowledge in strategic and flexible ways toward advancing their own interests.'

Thought academic scientists, regulators, and agrochemical companies generate particular forms of ignorance that serve to shape the guidelines used within regulatory requirements to establish toxicity. If the science is not compulsorily done for regulators, it will likely not be done as there is little funding for independent scientific enquiry regarding the hundreds of thousands of environmental chemicals.

The case of glyphosate serves to illustrate the challenges arising from undone science. A 2015 scientist Consensus Statement[138] expressed concern that 'uncertainty can arise from gaps in the scope and quality of a pesticide's toxicology dataset, or uncertainty in exposure assessments. '

The paper noted that current regulatory protocols result in findings that are later demonstrated to be incorrect. For example, glyphosate is more persistent in the environment than previously

Recognised by scientists as the 'social production of ignorance' or 'non-knowledge,' the resultant knowledge gaps can facilitate an environment where 'ignorance emerges from within the rules, procedures and protocols.'

Kleinman and Sainath 2013

[137] Kleinman and Sainath Suryanarayanan Dying Bees and the Social Production of Ignorance. 2012 Science Technology Human Values 2013 38: 492, DOI: 10.1177/0162243912442575

[138] Myers J P et al (2016). Concerns over use of glyphosate-based herbicides and risks associated with exposures: a consensus statement. Environmental Health 15(19). DOI 10.1186/s12940-016-0117-0. https://ehjournal.biomedcentral.com/articles/10.1186/s12940-016-0117-0

considered, and the 'prediction that glyphosate would never be present widely in surface water, rainfall, or groundwater has also been shown to be inaccurate.'

Precautionary Principle

There will always be knowledge gaps. It is critical we acknowledge this, if we are to protect environmental and human health and account for future uncertainty, helps to illustrate why the precautionary principle is such an elegant and well-designed public interest principle.

Whether or not a government or regulatory agency choses to adopt the precautionary principle in decision-making will frequently reflect the relative influence and power of stakeholder interests. It will also reflect the moral and political objectives within the organisation.

Industry as a primary stakeholder will dedicate considerable energy to ensuring a decision best fits their industry goals.

European regulators have incorporated the precautionary principle in a wide variety of decisions that have the capacity to impact human and environmental health.

'Net benefit' analysis in New Zealand is yet to address the implications of future cumulative loadings of multiple persistent chemicals that, if current trajectories continue, may render freshwater, drinking water and groundwater unsuitable for livestock or humans. Current analysis does not consider the greater vulnerability of children, simplistically basing results on exposures to 70kg adults.

Arguably, if New Zealand is to restore and regenerate aquatic environments, attention must be paid to the synergies of introduced pollutants, and the inherent toxicity that our water courses are exposed to. If this is ignored, the only species that will evolve, are species resistant to the chemical.

This leaves rural communities much more vulnerable than urban communities.

5. Pivot to the European Union

Freshwater: Environmental Water Quality Standards

Europe directly addresses chemical contamination in 2008 legislation, and bases community policy on the environment on the precautionary principle. Their environmental quality standards on water policy states:

> Article 1. 'Chemical pollution of surface water presents a threat to the aquatic environment with effects such as acute and chronic toxicity to aquatic organisms, accumulation in the ecosystem and losses of habitats and biodiversity, as well as a threat to human health. As a matter of priority, causes of pollution should be identified and emissions should be dealt with at source, in the most economically and environmentally effective manner.'[139]

> Article 2. 'Community policy on the environment is to be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should, as a priority, be rectified at source and that the polluter should pay.'

European Priority Substances

> *EU Legislation: 'environmental damage should, as a priority, be rectified at source and that the polluter should pay'*
>
> *DIRECTIVE 2008/105/EC*

Priority Substances and Certain Other Pollutants according to Annex II of Directive 2008/105/EC

The European Union have selected and regulated for substances that are of EU wide concern, referred to as 'Priority Substances and Certain Other Pollutants according to Annex II of Directive 2008/105/EC.'

Thirty-three substances or groups of substances are on the list of priority substances[140] for which environmental quality standards were set in 2008,[141] including selected existing chemicals, plant protection products, biocides, metals and other groups like Polyaromatic Hydrocarbons (PAH) that are mainly incineration by-products and Polybrominated Biphenylethers (PBDE) that are used as flame retardants.

> 'Within this list, 11 substances were identified as priority hazardous substances and therefore subject to cessation or phasing out of discharges, emissions and losses within an appropriate timetable not exceeding 20 years. A further 14 substances were identified as being subject to later review'.[142]

The list of priority substances is provided in Appendix 3.

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[139] DIRECTIVE 2008/105/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2008. Environmental quality standards in the field of water policy. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0105&from=EN
[140] Priority substances under the Water Framework Directive.
[141] DIRECTIVE 2008/105/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2008 Annex 1 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0105&from=EN
[142] Additional toolsFacebookTwitter YouTube Print versionDecrease textIncrease text
Priority substances under the Water Framework Directivehttp://ec.europa.eu/environment/water/water-dangersub/pri_substances.htm#list

Regional Focus: River Basin Management Plan

European legislation requires regions to identify substances of regional concern. The legislation requires a River basin management plan (RBMP) for each river basin district. Summary of economic analysis of water use, this enables various districts to be monitored for different stressor pollutants, and provides a complete analysis of protection programmes, control and remediation measures.

Member states are required to monitor sediment and biota at an adequate frequency to ensure adequate long-term trend analysis. Thirty-three priority hazardous substances (or groups of substances) have been identified for monitoring.

European legislation also provides for substances of *regional* concern. For example, within this framework is a river basin management plan (RBMP) for each river basin district. This requires a summary of economic analysis of water use, this enables various districts to be monitored for different stressor pollutants, and provides a complete analysis of protection programmes, control and remediation measures.

New Zealand regions, as part of fulfilling their legislative obligations should be required to publicly analyse the multiple chemical and contaminant threats typical to their regions and monitor the specific chemicals and industries that exist in their regions. National funding should be provided to facilitate data management to create a national profile of surface water pollution, national and regional threats, and this should be transparently published.

European Drinking water standards

The European Commission Directive sets standards for the most common potentially harmful organisms and substances that can be found in drinking water. A total of 48 essential parameters must be monitored and tested regularly. The 48 parameters, including microbiological, chemical and indicator parameters are detailed in Annex 1 of the Directive.[143]

European standards (Part B – Chemical Parameters) for pesticides require that a single pesticide must not be detected at more than 0.10 µg/l, and total pesticides present must not be more than 0.50 µg/l.

This is simpler than New Zealand's system, which carries a wide variety of MAVs and requires a great deal of analysis and understanding of MAVs in order to trigger action. It is precautionary and protects against new pesticides which may not be listed in (for example, out of date) literature, which may not have sufficient data to require authorities to take action to protect the public.

Parameters for E. coli and Enterococci are required to be absent from water to assure safety.

[143] Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, OJ L 330, 5.12.1998. L330/41 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31998L0083&from=EN

6. Recommendations:

It is dawning on us that Maori were right all along. Water is alive. Like the human body, if it is not kept clean and healthy, it will become sick and may lose its *mauri*, its 'life giving principle' and die.

It is increasingly apparent that New Zealand is vastly unprepared to protect the freshwater, groundwater and marine environment from chemical contamination. The first step, of identifying threats, is not in place.

If New Zealand regulators are to approve of new technologies in the form of toxic chemicals in the environment, our scientific and regulatory environment should *inter alia* have in place the monitoring systems, the technology, the data – to clearly understand the effect of these complex systems in our dynamic aquatic environments.

Water cannot be healthy if it is sterile, nor so polluted that it cannot maintain system balance.

Current knowledge gaps result from a failure to interpret complex chronic risk. Slow, exponential increases in risk must be understood, as multiple chemicals impact multiple pathways at steadily increasing levels – it requires a complex systems approach that is light-years away from the current linear methodologies.

Our linear, blinkered approach to water policy that is conveniently unable to regulate a chemical environment that it has no knowledge of. Our freshwater policy leaks like a sieve.

The NPS:FW framework science does not provide guidance to enable to scientific community to assess the complexity of the chemical environment. Current rules and guidelines relating to pesticides assessments are ill-equipped to protect the public and the aquatic food-chain. Our substantial failures commence with authorisation of a formulation that is patented for synergies, without the regulator assessing the toxicity of the patented synergy. It ends with the complex mixtures in our freshwater, but no knowledge of their interaction and levels at which they damage aquatic health, and the inevitable accumulation of toxic metabolites into a darkened groundwater environment.

The current freshwater objectives are helpless to protect its first objective: Te Mana o te Wai – water quality and vitality. The NPS:FW states

> 'te Mana o te Wai recognises the connection between water and the broader environment – Te Hauora o te Taiao (the health of the environment), Te Hauora o te Wai (the health of the waterbody) and Te Hauora o te Tangata (the health of the people);

Perhaps a world struggling to cope with the fallout from chemical pollution, will help facilitate change that works in the public interest, and respects the common-sense of Maori custom and culture.

Travelers visit New Zealand to enjoy it's comparably unspoilt nature. The contribution of travel and tourism to GDP in 2016 was 17.5%.[144]

[144] https://knoema.com/atlas/New-Zealand/topics/Tourism/Travel-and-Tourism-Total-Contribution-to-GDP/Contribution-of-travel-and-tourism-to-GDP-percent-of-GDP

> 'Tourism is New Zealand's largest export industry in terms of foreign exchange earnings. It directly employs 7.5 per cent of the New Zealand workforce.'[145]

In 2016 6.5% of kiwis were employed in agriculture, 20.16% if kiwis were employed in industry and 73.33% of kiwis were employed in the services sector.[146]

Forestry accounts for 2.8% of GDP and employs 20,000 people.

Growth in demand for fresh contaminant free drinking water for export is surging. Concern for New Zealand's freshwater quality has exploded. Concern for food safety, particularly relating to childhood chronic disease[147], is resulting in demand for organic food production outstripping conventional food. The New York Times reported in 2016 that 'Companies can't get enough organic ingredients to satisfy consumer desire for organic and nongenetically modified foods.'[148]

The art of policy is to balance competing interests and ensure prosperity for all. But without clearly prioritising long term water security, addressing soil degradation, and recognising new emerging interests that economically benefit from a less toxic environment, highly resourced short term special interests can build relationships and strategically shape policy.

It is recommended that New Zealand at a minimum:

- Pivot from use of the word 'nutrient' and engage with 'chemical contamination'
- Recognises the adverse externalities of intensive chemical based agriculture (far more intensive than twenty years ago).
- Adopts the Freshwater Rescue Plan[149]
- Acknowledges the greater potential cost of chemical contamination (in comparison to bacterial) to drinking water providers and especially acknowledge the fact that rural communities are not equipped with suitable resourcing and infrastructure to adequately remove complex chemical mixtures from drinking water. Without strategic political and scientific willpower bacteriological 'Havelock-North's' will continue to grow in frequency and size. But it is critical to acknowledge that the cost of chemical contamination to smaller communities represents a challenge that is near impossible to mitigate, once toxicity levels exceed what independent, public health scientists recognise as safe levels.
- Recognises potential impact of combined stressors of climate change and concentration of chemical pollution shrunken water sources and potential to accelerate water scarcity in key New Zealand regions
- Establishes a taxpayer funded Independent Emerging Organic Contaminants Strategy Group with a health based focus

[145] http://www.tourismnewzealand.com/about/about-the-industry/
[146] https://www.statista.com/statistics/436457/employment-by-economic-sector-in-new-zealand/
[147] https://www.kirkusreviews.com/book-reviews/michelle-perro/whats-making-our-children-sick/
[148] Paying Farmers to Go Organic, Even Before the Crops Come In S.Strom. 2016.*The New York Times* https://www.nytimes.com/2016/07/15/business/paying-farmers-to-go-organic-even-before-the-crops-come-in.html
[149] https://www.freshwaterrescueplan.org/the-plan/

6. Recommendations:

- Recognises the long-term relationships and co-dependencies between the NZ EPA and the chemical industry that may delay adoption of new scientific knowledge and restrict health based decision-making in the public interest

- Acknowledges and institutes toxicity assessment of patented full formulations including adjuvants and commonly applied chemicals (eg. Organosilicone penetrants)

- Requires regulatory assessment of chemicals to exclusively use transparent, published literature (meta-analyses and reviews must also be publicly available) and the patented 'substance' or full formulation. Automatically cease to base re-assessments on data selected and supplied by industry (NZ EPA's Chief Executive-initiated reassessments 'CEIR' list may be a good place to start).

- Provides greater funding for nationally directed groundwater testing and analysis to consider previously unresearched contaminants (sylfonylureas, glyphosate); consider a wider range of metabolites (as per the EU); assess potential for co-accumulated toxicity from pesticides (and metabolites) in common chemical class or chemicals that act via similar pathways.

- Undertakes a serious and transparent analysis of the European Union legislation that provides for measures to protect chemical pollution of surface waters, requiring management of water basins and protection of groundwater. It is also recommended that at a minimum, New Zealand acts to synchronise with EU policies and regulations, rather than reinvent the wheel.

'Delay and denial have been endemic in the history of environmental law...what the world is suffering is not a lack of science or law, but a lack of environmental urgency' [150]

[150] Professor Klaus Bosselmann, Centre for Environmental Law, University of Auckland.Otago Daily Times 14 Jan. 2010.

7. Abbreviations

ADI	Acceptable Daily Intake
DWSNZ	Drinking Water Standards New Zealand
EPA	New Zealand Environmental Protection Authority
ESR	Institute of Environmental Science and Research (Crown Research Institute)
FAO	Food and Agriculture Organisation
FERA	UK Food and Environment Research Agency
GDP	Gross Domestic Product
MAV	Maximum Acceptable Value
MPI	Ministry of Primary Industries
MRL	Maximum Residue Limit
NPS-FW	New Zealand National Policy Statement for Freshwater Management 2014.
NSPGW	National Survey of Pesticides in Groundwater
NZ EPA	New Zealand Environmental Protection Authority
TLA	Territorial Local Authorities
WHO FAO JMPR	World Health Organisation and Food and Agricultural Organisation Joint Meeting on Pesticides Residues

8. Appendices

Appendix 1 National Bottom Lines

New Zealand National Policy Statement for Freshwater Management 2014.

NEW ZEALAND NATIONAL BOTTOM LINES.

APPENDIX 2. ATTIBUTE TABLES. Page 30.

ATTRIBUTE	NBL Annual Median	NBL Annual Maximum
1. Phytoplankton (Trophic state) *Lakes* mg/m3 (milligrams chlorophyll-a per cubic metre)	12	60
2. Total Nitrogen. *Lakes* mg/m3 (milligrams per cubic metre)	750 (Seasonally Stratified and Brackish)	800 mg/m3 (Polymictic)
3. Total Phosphorus. *Lakes*	50	
4. Periphyton (trophic) 'slime'. *Rivers* mg chl-a/m2 (milligrams chlorophyll-a per square metre)	200 (Exceeded no more than 8% of samples)	200 (Exceeded no more than 17% of samples)
5. Nitrate (Toxicity). *Rivers* mg chl-a/m2 (milligrams chlorophyll-a per square metre)	6.9	9.8 Annual 95th percentile
6. Ammonia (Toxicity). *Lakes and Rivers* mg NH4-N/L (milligrams ammoniacal-nitrogen per litre)	1.30	2.20
7. Dissolved Oxygen (summer NBL). *Rivers below point sources.* mg/L (milligrams per litre)	5.0 (7 day mean minimum)	4.0 (1 day minimum)
8. Escherichia coli (E. coli). *Lakes and Rivers* E. coli/100 mL (number of E. coli per hundred millilitres)	None. For other targets see page 39 [2]	
9. Cyanobacteria (Planktonic). *Lakes and lake fed rivers* Biovolume - mm3/L (cubic millimetres per litre)	NBL 1.8 mm3/L biovolume equivalent of potentially toxic cyanobacteria	OR 10 mm3/L total biovolume of all cyanobacteria

[1] NBL: National Bottom Line. New Zealand National Policy Statement for Freshwater Management 2014 Appendix 2.151

[2] New Zealand National Policy Statement for Freshwater Management 2014. E.coli standards in lakes and rivers Page 39152

Appendix 2 'Undone Science'

A. Case study 'Undone science': Terbuthylazine R40 (carcinogen category 3)

The ecotoxic herbicide Terbuthylazine is one of the two most common herbicides used in vegetation management in plantation forestry in New Zealand.[153] It was the most commonly detected pesticide in the 2014 New Zealand groundwater study, and was detected in groundwater in Northland, Waikato, Gisborne, Tasman, and Southland. At the highest level it was detected at 17% of the MAV.

Yet there is no mechanism in place in New Zealand to reduce its use or to send caution for future use. Somewhat disconcertingly, a nearly full-strength product containing 900g/L terbuthylazine was approved in 2014.[154]

The decision document released by the NZ EPA did not consider its widespread presence in New Zealand groundwater.[155]

The international daily intake limits are based on unpublished studies, assessed before 2003.

Effective risk analysis should be required to consider cumulative exposures from pesticides that act similarly. As an example, Terbuthylazine is a member of the triazine[156] group of herbicides which were the most frequently detected group of herbicides in the 2014 groundwater study. Many triazine herbicides are considered endocrine disruptors, acting as reproductive toxicants.[157]

Triazine herbicides were repeatedly detected in the NZ groundwater study above the European maximum level for pesticides in drinking water, 0.1 µg/L. (The groundwater study reports mg/m3, both units represent parts per billion.)

Terbuthylazine (CAS no. 5915-41-3) evaded NZ regulatory scrutiny as it was pushed through via a transfer notice in June 2006 prior to the HSNO Act coming to life.[158]

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[153] Wang et al 2009. Sorption of the herbicide terbuthylazine in two New Zealand forest soils amended with biosolids and biochars https://link.springer.com/article/10.1007/s11368-009-0111-z

[154] EPA Sept 2014 APP202269 Application to import Timberwolf 900 Herbicide. http://www.epa.govt.nz/search-databases/HSNO%20Application%20Register%20Documents/APP202269_APP202269%20Decision%20Document%20Final.pdf

[155] http://www.epa.govt.nz/search-databases/HSNO%20Application%20Register%20Documents/APP202269_APP202269%20Decision%20Document%20Final.pdf

[156] University of Florida. IFAS Extension. F. Fishel Pesticide Toxicity Profile: Triazine Pesticides. https://edis.ifas.ufl.edu/pdffiles/PI/PI15800.pdf

[157] Atrazine, Propazine, Simazine and their Chlorometabolites DACT, DEA And DIA Listed as Reproductive Toxicants. OEHHA. Proposition 65 effective October 1, 2015 https://oehha.ca.gov/proposition-65/crnr/atrazine-propazine-simazine-and-their-chlorometabolites-dact-dea-and-dia-listed

[158] ENVIRONMENTAL RISK MANAGEMENT AUTHORITY HAZARDOUS SUBSTANCES (CHEMICALS) TRANSFER NOTICE 2006 PURSUANT TO THE HAZARDOUS SUBSTANCES AND NEW ORGANISMS ACT 1996 http://www.epa.govt.nz/Publications/Transfer-Notice-72-2006.pdf

Toxicity assessments for the chemical are out of date. The WHO FAO JMPR do not appear to have considered Terbuthylazine since 1992.

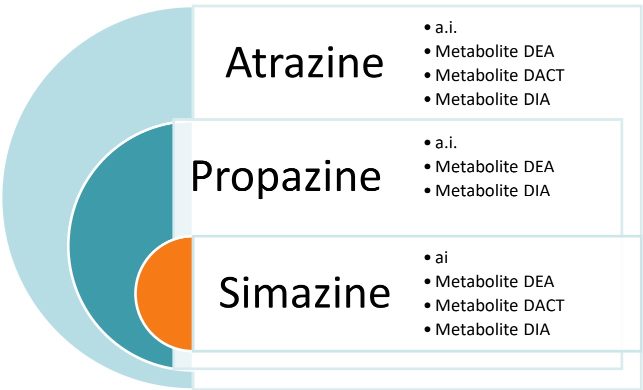
Europe peer reviewed in terbuthylazine in 2011.[159] The European assessment considered that Terbuthylazine should have a Category 3 Carcinogenicity status: Limited evidence of carcinogenic effect. The carcinogenicity status of terbuthylazine is worryingly controversial. The classification proposed by RMS (UK) for terbuthylazine had been 'carcinogenic category 2/H351 / R40 / suspected of causing cancer.'

Unpublished research supplied by the chemical companies to the European Chemicals Agency contend that the development of mammary tumours in rodents when dosed terbuthylazine, should be dismissed due to industry claims that tumours from chlorotriazine compounds (atrazine) studies have occurred by a mode of action that is not relevant to humans.[160]

However there is scarce published independently produced scientific literature to support the fact that terbuthylazine does not cause cancer and the data supporting the ECHA carcinogenicity finding (4(11) is not released to the public. The 'independent' scientists who were asked to review the study have a history of conducting industry paid research.

Terbuthylazine is listed on the NZ EPA Chief Executive-initiated Reassessments list.

Persistent and toxic Metabolites



Metabolites co-occuring in groundwater or drinking water should be assessed based on European standards.

The chemical is persistent and highly mobile, it is important that the breakdown products, the metabolites of Terbuthylazine should be monitored in water. It is known that metabolites can exert similar toxicity to the parent compound.

Europe considers a wide range of terbuthylazine metabolites should be monitored, including hydroxy-terbuthylazine (Ref MT13 and GS 23158) and desethyl-hydroxy-terbuthylazine / 2-hydroxy-desethyl-terbuthylazine (MT14 and GS28620). [161]

IUPAC lists metabolites potential groundwater contaminants; warning that metabolites desethyl-terbuthylazine (MT1 and GS26379) and hydroxy-terbuthylazine (MT14) have potential for environmental pollution.[162]

Data to establish the toxicity of Metabolites LM2 (MT28), LM3, LM4, LM5 (MT23) and LM6 is currently too limited to establish parameters. It would appear, in the public interest, that monitoring

[159] Peer Review of the pesticide risk assessment of the active substance terbuthylazine
[160] ECHA Committee for Risk Assessment. Annex 2. June 2015 Response to comments document (RCOM). CLH-O-0000001412-86-66/F https://echa.europa.eu/documents/10162/aa4c05ae-3a21-4659-9190-09a7b3e3c964
[161]Peer review of the pesticide risk assessment for the active substance terbuthylazine in light of confirmatory data submitted. EFSA Journal. June 2017 http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2017.4868/full
[162] International Union of Pure and Applied Chemistry http://sitem.herts.ac.uk/aeru/iupac/Reports/623.htm#none

of these metabolites, in the absence of data to dismiss toxic effects, would be in the public interest. At this stage, New Zealand appears to limit monitoring of Terbuthylazine metabolites to Desethyl Terbuthylazine (MT1).

B. Case Study 'Undone science': Glyphosate; metsulfuron-methyl and organosilicon surfactants

These two herbicides and the accompanying organosilicon surfactant are widely applied as a mixture in the New Zealand environment. None of these have been monitored routinely.

A. Metsulfuron-methyl and its metabolites, (in particular IN-A4098) are not monitored in New Zealand groundwater, surface water nor drinking water.

The sulfonylurea herbicide metsulfuron-methyl is recognised as mobile and having high leachability.[163]

Its metabolite methyl 2-(aminosulfonyl)benzoate (Ref: IN-D5803) also recognised as Ester sulphonamide and methyl saccharin is highly toxic but not persistent.

However the metabolite 2-amino-4-methoxy-6-methyl-1,3,5-triazine (Ref: IN-A4098), also recognised as N-demethyl triazine amine, AE F059411, and CGA 150829 – is toxic to humans, highly leachable, moderately mobile and persistent.[164]

The European Commission December 2015 Review Report for metsulfon-methyl[165] ruled that genotoxicity could not be ruled out (and requested further data, due 30 September 2016[166]), that leaching could occur above the European limits.

In Europe metsulfuron-methyl is included on Europe's 'candidate for substitution' list of substances that may be toxic to human health, bioaccumulative, persistent etc.[167]

> The Commission, however, considers that metsulfuron-methyl is a candidate for substitution pursuant to Article 24 of Regulation (EC) No 1107/2009. Metsulfuron-methyl is considered a persistent and toxic substance in accordance with points 3.7.2.1 and 3.7.2.3 respectively, of Annex II to Regulation (EC) No 1107/2009, given that the half-life in fresh water is higher than 40 days and the long-term no-observed effect concentration for freshwater organisms is less than 0,01 mg/L. Metsulfuron-methyl therefore fulfils the condition set in the second indent of point 4 of Annex II to Regulation (EC) No 1107/2009.

163 International Union of Pure and Applied Chemistry http://sitem.herts.ac.uk/aeru/iupac/Reports/470.htm#none
164 International Union of Pure and Applied Chemistry http://sitem.herts.ac.uk/aeru/iupac/Reports/1092.htm
165 COMMISSION STAFF WORKING DOCUMENT Metsulfuron-methyl. SANTE/10319/2015 Rev11 December 2015. Final. Review report for the active substance metsulfuron-methyl finalised in the Standing Committee on Plants, Animals, Food and Feed at its meeting on in view of the renewal of the approval of metsulfuron-methyl, as a candidate for substitution, in accordance with Regulation (EC) No 1107/2009
166 http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0139&from=EN
167 COMMISSION IMPLEMENTING REGULATION (EU) 2015/408 of 11 March 2015 on implementing Article 80(7) of Regulation (EC) No 1107/2009 of the European Parliament and of the Council concerning the placing of plant protection products on the market and establishing a list of candidates for substitution. http://extwprlegs1.fao.org/docs/pdf/eur142579.pdf

C. Case Study 'Undone science': Glyphosate, water weeds and cyanobacteria

Many councils use glyphosate isopropylamine to manage aquatic weeds. A 'best practice' review advised that applicators generally use 360 g per L glyphosate isopropylamine as a soluble concentrate. [168]

The manual states glyphosate it is ineffective against submerged plants and 'does not adequately control alligator weed, Manchurian wild rice, phragmites, purple loosestrife, sagittaria, Senegal tea or spartina. It is less effective against rhizomatous species and, as it is non-selective, *it can easily damage non-target plants.*

The Best Practice review states:

> 'It does not bioaccumulate, biomagnify, or persist in a biologically available form in the environment and, as the mechanism of action is specific to plants, it is relatively nontoxic to animals (Solomon and Thompson 2003). In most situations glyphosate is inactivated on contact with soil and has no residual activity'

While glyphosate and its toxic metabolite AMPA may not be as persistent and mobile as some pesticides, the chemicals do indeed accumulate in groundwater.[169] Published data also demonstrates glyphosate is more persistent and toxic to aquatic organisms than the NZ EPA acknowledges.[170]

It is increasingly apparent glyphosate may play a role in declining water quality. Glyphosate may restrict the ability of aquatic fauna to regenerate. Short term applications to undesirable weed species may have greater unintended effects than considered by NZ regulators and councils, and prevent an already dysregulated aquatic environment from regenerating.

Plants and insect life that are tolerant, or resistant to glyphosate, may thrive, while other beneficial (native) populations collapse. Periphyton communities include algae, cyanobacteria, heterotrophic microbes. They form a considerable part of the start of the aquatic food chain and feed invertebrates, tadpoles, small fish.

It may not just be fertiliser runoff providing the phosphorous fuelling algal bloom.

Many cyanobacteria species can be resistant to glyphosate.[171] The toxic planktonic cyanobacterium Microcystis aeruginosa, which can produce neurotoxins and hepatotoxins, can evolve resistance to glyphosate.[172]

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[168] Review of Best Management Practices for Aquatic Vegetation Control in Stormwater Ponds, Wetlands, and Lakes August 2013 Technical Report 2013/026. https://www3.nd.edu/~aseriann/BMP_Aquatic%20Vegetation.pdf

[169] SURVEY OF GLYPHOSATE AND AMPA IN GROUNDWATERS AND SURFACE WATERS IN EUROPE - UPDATE 2012. Helene Horth (Independent Adviser, Water Quality and European Policy & Legislation). http://www.glyphosate.eu/system/files/mc-files/iia_7.12_07_horth_2012.pdf

[170] Watts MA et al 2016. Glyphosate Monograph. PAN International. Page 6 http://pan-international.org/wp-content/uploads/Glyphosate-monograph.pdf

[171] Arunakumara et al 2013. Metabolism and degradation of glyphosate in aquatic cyanobacteria: A review. African Journal of Microbiology Research. Vol. 7(32), pp. 4084-4090, 9 August, 2013 DOI: 10.5897/AJMR12.2302. https://www.researchgate.net/publication/258312690_Metabolism_and_degradation_of_glyphosate_in_aquatic_cyanobacteria_A_review

[172] López-Rodas et al 2007. Resistance to glyphosate in the cyanobacterium Microcystis aeruginosa as result of pre-selective mutations. Evolutionary Ecology DOI: 10.1007/s10682-006-9134-8

The phosphorous content can boost weed species that successfully have resisted the more toxic formulation. There is very real evidence that cyanobacteria (blue-green algae) use glyphosate (which is a phosphonate) as a phosphate source.[173 174]

In 2009 Argentinian scientists confirmed that Roundup applied to water increases total phosphorous in periphyton communities. However, as Roundup degrades, the periphyton community 'mix' alters, with cyanobacteria benefitting from the additional phosphorous. The paper noted that phosphorous represents 14% of glyphosate's molecular weight.

A 2007 study observed a higher proportion of periphytic cyanobacteria, and a 40-fold increase in planktonic picocyanobacteria abundance following addition of Roundup.[175]

A study in 2011 indicated that 'glyphosate has both positive and negative influences on phytoplankton community structure, serving as a nutrient source to microbes able to tolerate the herbicidal effects of the compound while killing those less tolerant.'[176]

This is supported by a Chinese paper which considered that organophosphorous pesticides, including glyphosate-isopropylammonium could stimulate growth in the cyanobacteria strain that was studied.[177]

As such, any commitment to investigating aquatic environments should scrutinise glyphosate levels in freshwater and sediment as a result of glyphosate runoff from roadside (including drain) applications, forestry, cropping and other agriculture.

It is noteworthy that Western Bay of Plenty Council applies glyphosate between 3 and 5 times annually along all roadsides and their drains.

D. Case Study 'Undone science' ECAN and degraded rivers and lakes

Despite heavy use of agricultural pesticides in the Canterbury Region, ECAN does not monitor pesticides in freshwater systems. The Canterbury Region is the dominant cereal cropping region in New Zealand.[178] The region's rivers and lakes are severely degraded, and the situation is not improving. [179 180]

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[173] M. Cummings, Dr. G Bullerjahn Phosphate Utilisation by Great Lakes (Cyanobacteria). Department of Biological Sciences. https://outside.vermont.gov/agency/agriculture/vpac/Shared%20Documents/January_2014/MCummings_cyanobacteria_algae_poster09.pdf

[174] HuiminQiu et al 2013. Physiological and biochemical responses of Microcystis aeruginosa to glyphosate and its Roundup® formulation. Journal of Hazardous Materials Volumes 248–249, 15 March 2013, Pages 172-176 https://doi.org/10.1016/j.jhazmat.2012.12.033

[175] Lipok J, Owsiak T, Młynarz P, Forlani G, Kafarski P 2007. Phosphorus NMR as a tool to study mineralization of organophosphonates- the ability of Spirulina spp. to degrade glyphosate. Enzyme Microb Technol 41:286–291. doi:10.1016/j.enzmictec.2007.02.004

[176] Saxton M.A.; Morrow E.A.; Bourbonniere R.A.; Wilhelm SW. Glyphosate influence on phytoplankton community structure in Lake Erie. Department of Microbiology, University of Tennessee, National Water Research Institute, Environment Canada

[177] Sun et al 2013. Ecological risks assessment of organophosphorus pesticides on bloom of *Microcystis wesenbergii* International Biodeterioration & Biodegradation Volume 77, February 2013, Pages 98-105 https://doi.org/10.1016/j.ibiod.2012.11.010 https://www.sciencedirect.com/science/article/pii/S0964830512003046

[178] Millner JP, Roskruge NR 2013. The New Zealand arable industry. In Dymond JR ed. Ecosystem services in New Zealand – conditions and trends. Manaaki Whenua Press, Lincoln, New Zealand. P.104 https://www.landcareresearch.co.nz/__data/assets/pdf_file/0005/77036/1_8_Millner.pdf

[179] http://www.radionz.co.nz/news/regional/284039/canterbury-lakes-given-bad-report-card

[180] http://www.stuff.co.nz/environment/91920587/once-a-world-class-canterbury-fishery-now-rivers-of-green

8. Appendices

A strategy to restore water in Managed Aquifer Recharge (MAR) to the Hinds/Hekeo Plains water catchment[181] reported success. Groundwater levels have increased by five metres and nitrate concentrations have decreased around Mid Canterbury's pilot managed aquifer recharge site.[182] [183]

The water was drawn from the Rangitata River. 'The water comes from the Ashburton District Council's unused stock water allocation via the Rangitata Diversion Race (RDR) and Valetta Irrigation Scheme.' Stuff also reported that the regions light shallow soils have contributed to the problem.

> 'Communities in the Selwyn and Hinds areas have some of the highest rates of ecoli diseases in the world, and the highest rate of campylobacter, cryptosporidia and giardia. We have the highest rates of zoonoses (disease spread from animals to humans) in the world in some of the irrigated/dairy catchments such as these'……'The project will use clean Rangitata River water to soak into the aquifer in an area of high nitrate concentrations, diluting the nitrate, providing better reliability for groundwater takes, as well as allowing natural ecosystems to regenerate.'[184]

Chemicals and their metabolites have potential to accumulate in dark groundwater environments. The Rangitata river has not been tested for pesticides.

Responses below from ECAN dated 14 November 2017, from the author, requesting if the following pesticides classes, which include pesticides used widely in agriculture, roadsides and forestry were monitored in Canterbury freshwater environments:

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[181] https://mapviewer.canterburymaps.govt.nz/?webmap=136ab530038a4e229a5d54bdbd9f8897

[182] Hinds/Hekeao managed aquifer recharge trial releases first report 31 Aug 2017. https://www.ecan.govt.nz/get-involved/news-and-events/zone-news/ashburton/managed-aquifer-recharge-pilot-achieves-two-out-of-three-goals/

[183] Water project shows big wins. August 30 2017. http://www.guardianonline.co.nz/news/water-project-shows-big-wins/

[184] Managed aquifer recharge gives hope to Mid Canterbury's declining water quality. June 28 2016 http://www.stuff.co.nz/business/farming/81174560/managed-aquifer-recharge-gives-hope-to-mid-canterburys-declining-water-quality

A. ***freshwater and sediment monitoring data (for the previous 5 years) for the following pesticide screens in the Canterbury region.***

B. ***Please in particular confirm if Lakes Rotorua, Ellesmere/Te Waihora and Forsyth/Wairewa; and the Selwyn, Kaiapoi, Avon and Heathcote rivers are screened for these tests. If not included in the listed rivers or lakes, other areas specifically defined as 'caution' by LAWA would be triggered for testing of the above pesticide screens.***

1. Glyphosate and AMPA residues in freshwater and/or sediment

2. Organonitrogen and Organophosphorus and Pesticides (ONOP) in Water and Soil.

3. Multiresidue Pesticides (MR) in Water and Soil.

4. Acidic Herbicides in Water and Soil

5. Sulfonylureas (metsulfuron is widely applied on NZ roadsides)

6. Semi-Volatile Organic Compounds (SVOC)

7. Organochlorine

Environment Canterbury has not collected any freshwater (water or bed sediments) data for any of the listed pesticides screens in the last five years. This means there are no Environment Canterbury data for Lakes Rotorua, Ellesmere/Te Waihora and Forsyth/Wairewa; and the Selwyn, Kaiapoi, Avon and Heathcote rivers.

In regard to Environment Canterbury data for the listed contaminants in soil, Environment Canterbury do not have any data. The contaminated sites team note that 'Most of the data we see for soil and groundwater are generated from detailed site investigations undertaken by environmental consultants. The majority of those investigations are aimed towards fulfilling regulatory requirements arising from the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.'

C. Groundwater Monitoring: Please can you advise which specific wells were included in the 2014 National Survey of Pesticides in Groundwater and which specific wells will be selected for the 2018 National Survey of Pesticides in Groundwater.

The five wells in Canterbury sampled in December 2014 for the National pesticide survey were J38/0068, K37/0468, L36/0107, M35/1382 and N33/0206. The well details and reasoning behind their selection are set out in the file note attached. As reported by Close and Humphries (2016) Journal of Hydrology (NZ) 55(2): 73-88, no pesticides were detected in any of the wells in Canterbury.

The Canterbury wells for the 2018 National pesticide survey have not yet been selected. The national survey wells will likely be a subset of around 50 shallow wells that we are planning to sample for our 10-yearly Regional Survey of pesticides in groundwater next year. We will be collecting the samples in spring 2018.

D. Groundwater Monitoring: Please can you confirm that glyphosate and its metabolite AMPA will be screened in the 2018 National Survey of Pesticides in Groundwater

The national survey of pesticides is coordinated by ESR and the testing paid for by the regional councils. Glyphosate and AMPH analyses (AsureQuality lab) have been proposed by ESR for the 2018 survey. Whether or not it ends up being included will depend on whether the councils are prepared to cover the additional analytical costs.

Appendix 3 European Water Policy – Priority Substances

This list is contained in the following European legislation[185], on pages 348/92 and /93:

DIRECTIVE 2008/105/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council

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[185] DIRECTIVE 2008/105/EC http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0105&from=EN

LIST OF PRIORITY SUBSTANCES IN THE FIELD OF WATER POLICY

Number	CAS number [1]	EU number [2]	Name of priority substance [3]	Identified as priority hazardous substance
(1)	15972-60-8	240-110-8	Alachlor	
(2)	120-12-7	204-371-1	Anthracene	X
(3)	1912-24-9	217-617-8	Atrazine	
(4)	71-43-2	200-753-7	Benzene	
(5)	not applicable	not applicable	Brominated diphenylether [4]	X [5]
	32534-81-9	not applicable	Pentabromodiphenylether (congener numbers 28, 47, 99, 100, 153 and 154)	
(6)	7440-43-9	231-152-8	Cadmium and its compounds	X
(7)	85535-84-8	287-476-5	Chloroalkanes, $C_{10\text{-}13}$ [4]	X
(8)	470-90-6	207-432-0	Chlorfenvinphos	
(9)	2921-88-2	220-864-4	Chlorpyrifos (Chlorpyrifos-ethyl)	
(10)	107-06-2	203-458-1	1,2-dichloroethane	
(11)	75-09-2	200-838-9	Dichloromethane	
(12)	117-81-7	204-211-0	Di(2-ethylhexyl)phthalate (DEHP)	
(13)	330-54-1	206-354-4	Diuron	
(14)	115-29-7	204-079-4	Endosulfan	X
(15)	206-44-0	205-912-4	Fluoranthene [6]	
(16)	118-74-1	204-273-9	Hexachlorobenzene	X
(17)	87-68-3	201-765-5	Hexachlorobutadiene	X
(18)	608-73-1	210-158-9	Hexachlorocyclohexane	X
(19)	34123-59-6	251-835-4	Isoproturon	
(20)	7439-92-1	231-100-4	Lead and its compounds	
(21)	7439-97-6	231-106-7	Mercury and its compounds	X
(22)	91-20-3	202-049-5	Naphthalene	
(23)	7440-02-0	231-111-14	Nickel and its compounds	
(24)	25154-52-3	246-672-0	Nonylphenol	X
	104-40-5	203-199-4	(4-nonylphenol)	X
(25)	1806-26-4	217-302-5	Octylphenol	
	140-66-9	not applicable	(4-(1,1′,3,3′-tetramethylbutyl)-phenol)	
(26)	608-93-5	210-172-5	Pentachlorobenzene	X
(27)	87-86-5	231-152-8	Pentachlorophenol	

Number	CAS number (1)	EU number (2)	Name of priority substance (3)	Identified as priority hazardous substance
(28)	not applicable	not applicable	Polyaromatic hydrocarbons	X
	50-32-8	200-028-5	(Benzo(a)pyrene)	X
	205-99-2	205-911-9	(Benzo(b)fluoranthene)	X
	191-24-2	205-883-8	(Benzo(g,h,i)perylene)	X
	207-08-9	205-916-6	(Benzo(k)fluoranthene)	X
	193-39-5	205-893-2	(Indeno(1,2,3-cd)pyrene)	X
(29)	122-34-9	204-535-2	Simazine	
(30)	not applicable	not applicable	Tributyltin compounds	X
	36643-28-4	not applicable	(Tributyltin-cation)	X
(31)	12002-48-1	234-413-4	Trichlorobenzenes	
(32)	67-66-3	200-663-8	Trichloromethane (chloroform)	
(33)	1582-09-8	216-428-8	Trifluralin	

(1) CAS: Chemical Abstracts Service.
(2) EU number: European Inventory of Existing Commercial Substances (Einecs) or European List of Notified Chemical Substances (Elincs).
(3) Where groups of substances have been selected, typical individual representatives are listed as indicative parameters (in brackets and without number). For these groups of substances, the indicative parameter must be defined through the analytical method.
(4) These groups of substances normally include a considerable number of individual compounds. At present, appropriate indicative parameters cannot be given.
(5) Only Pentabromobiphenylether (CAS-number 32534-81-9).
(6) Fluoranthene is on the list as an indicator of other, more dangerous polyaromatic hydrocarbons.'