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The Chemical Anthropocene: Glyphosate as a Case Study of Pesticide Exposures

Alessandra Arcuri* and Yogi Hale Hendlin***)

INTRODUCTION

Part of the Pandora's Box of unique changes humans have wreaked upon our environment with industrialisation, which has brought about the Anthropocene, is the unleashing of chemicals that harm humans and other organisms. Since World War II—arguably the best date to demarcate the most dramatic phase so far of the chemical Anthropocene—US chemical production has increased by 15 times, currently producing 30,000 pounds of chemicals *per person* each year.¹ Fewer than 200 of the 6700 chemicals produced in quantities of 25,000 pounds or greater in the US have been subject to rigorous toxicological testing,² and the US is no exception.³ Scientists now write about chemical

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1 Gian Carlo Di Renzo and others, 'International Federation of Gynecology and Obstetrics Opinion on Reproductive Health Impacts of Exposure to Toxic Environmental Chemicals' (2015) 131 *International Journal of Gynecology & Obstetrics* 219.

2 US Government Accountability Office, 'Chemical Regulation: Actions Are Needed to Improve the Effectiveness of EPA's Chemical Review Program' <www.gao.gov/products/GAO-06-1032T> accessed 25 March 2019; Sheldon Krinsky, 'The Unsteady State and Inertia of Chemical Regulation under the US Toxic Substances Control Act' (2017) 15 *PLOS Biology* <<https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.2002404>> accessed 10 June 2019.

3 Noelle Eckley and Henrik Selin, 'All Talk, Little Action: Precaution and European Chemicals Regulation' (2004) 11 *Journal of European Public Policy* 78; Steffen Foss Hansen, Lars Carlsen and Joel A Tickner, 'Chemicals Regulation and Precaution: Does REACH Really Incorporate the Precautionary Principle' (2007) 10 *Environmental Science & Policy* 395; European Commission, 'Study for the Strategy for a Non-Toxic Environment of the 7th Environment Action Programme: Final Report' <<https://>

'signatures' of the Anthropocene,⁴ the indelible mark left in the earth's geological record of humanity's history of chemical forays. The presence of certain chemicals and their isotopes in a place or organism indicate a relative age, becoming a sort of carbon-dating for human disruption of the earth's chemistry. While for generations release of chemicals into the environment did not elicit attention, as the quantity and the potency of the chemicals did not exceed the saturation points of natural environments, this has inverted in the chemical Anthropocene, with the planetary boundaries of chemicals exceeding the absorption and resilience of environments, just as other planetary boundaries such as nitrogen and phosphorous levels or ocean acidification now exist in unsafe operating spaces.⁵ As much as the release of greenhouse gases from fossil fuels, the unprecedented quantity and variety of chemicals created in the last century, mainly derived originally for warfare of one type or another, have fundamentally altered life(cycles) on earth.

This article examines the most applied agricultural chemical globally and the active ingredient in Monsanto's (now Bayer's) herbicide *RoundUp*^{®6}—glyphosate—as a case study to examine the overly narrow approach of current legal frameworks for pesticides evaluation and permissibility. Glyphosate, as with other chemicals, has encountered hurdles both corporate and institutional hindering rigorous testing and proportional regulation according to its risks. In chemical safety assessments, synergistic risks as well as consideration for non-human organisms and ecologies rarely form part of the legal and scientific frameworks analysing the safety or harm of chemicals like glyphosate. This decontextualisation of chemicals from their full effects on vulnerable populations and secondary interactions with other reactive elements in the environment generates a 'politics of separation' that detrimentally constrains the aperture of institutional requirements for chemicals such as glyphosate to be regarded as potentially dangerous.⁷ We also argue that technocratic institutions authorising herbicides, pesticides and other chemicals—when narrowly framed as they are today—can be seen as fora for promoting 'strategic ignorance',⁸ through the articulation of certain epistemologies of power. Certain sites that enable contestation, such as courts, we show, become venues for

publications.europa.eu/en/publication-detail/-/publication/89fbbb74-969c-11e7-b92d-01aa75ed71a1/language-en accessed 26 April 2019.

- 4 Christopher H Vane and others, 'Chemical Signatures of the Anthropocene in the Clyde Estuary, UK: Sediment-Hosted Pb, 207/206Pb, Total Petroleum Hydrocarbon, Polyaromatic Hydrocarbon and Polychlorinated Biphenyl Pollution Records' (2011) 369 *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 1085.
- 5 Stockholm Resilience Centre, 'How far are we pushing chemical boundaries?' <www.stockholmresilience.org/research/research-news/2017-06-09-how-far-are-we-pushing-chemical-boundaries.html> accessed 10 June 2019. On the concept of planetary boundaries see Johan Rockström and others, 'Planetary Boundaries: Exploring the Safe Operating Space for Humanity' (2009) 14 *Ecology and Society*, 32.
- 6 Charles M Benbrook, 'Trends in Glyphosate Herbicide Use in the United States and Globally' (2016) 28 *Environmental Sciences Europe* 3.
- 7 Alessandra Arcuri, 'Glyphosate' in Jessie Hohmann and Daniel Joyce (eds), *International Law's Objects* (OUP 2018).
- 8 Grégoire Mallard and Linsey McGoey, 'Strategic Ignorance and Global Governance: An Ecumenical Approach to Epistemologies of Global Power' (2018) 69 *The British Journal of Sociology* 884.

either subverting or generating scientific precaution and environmental justice claims by those most affected by questionable chemicals.

The legal frameworks determining risk in environmental toxicology frequently minimise risks and overestimate the certainty and accuracy of assessments, leading to downplaying the exposures of those populations most threatened by toxic chemicals. We identify two principle problems in existing legal frameworks on pesticides—anthropocentrism and compartmentalisation. Anthropocentric biases fail to take into account organisms outside of the *Vitruvian Man* version of the imaginary standard biologically and sociologically homogenous human subject, paying limited attention to susceptible nonhuman organisms such as amphibians, or vulnerable human populations such as pregnant mothers and infants, at the tails of the sensitivity curves for these chemicals. Such biases take as their model of analysis healthy and wealthy adults and leave little buffer room for the diverse health sensitivities of humans or other organisms more susceptible to toxicity. By compartmentalising the testing of these chemicals to single populations, regulatory frameworks often tend to look at effects of chemicals in isolation, without considering synergistic effects. Synergistic effects from multiple chemical exposures often occur in populations (female, low-socioeconomic status, immigrant, children etc) least provisioned to defend against these chemicals—and with the least political and legal power to voice their injuries. The ‘inverted quarantine’ of those with the least exposures to toxins, protecting themselves from chemical-filled commons through various often private insulation mechanisms, routinely leads to rulings invalidating the lived experiences of those most exposed to toxic chemicals.⁹ We inquire: how are current laws and policies surrounding glyphosate creating a politics of separation, whereby important concerns are systematically eluded in the decisionmaking process? We find that existing legal frameworks determine what constitutes a risk via standard models of sameness rather than acknowledgement of biological difference, as well as fail to take into account ecological analyses of chemical interactions with other extenuating environmental factors. A critical legal framework of prevention and subaltern participation is required to anticipate the problems of chemicals, replacing the current structure with a toxic-until-proven-safe model.

This article proceeds as follows. We first provide an overview of questions related to distributions of risks, depicting how understanding these risks is intrinsically linked with processes of justice. This discussion includes evaluating the systematic undervaluing of the effects of chemicals on nonhuman organisms. We then map the main regulatory frameworks for pesticides in Europe. Given that the EU legal framework is considered one of the most stringent systems for the authorisation of pesticides in the world,¹⁰ we focus on the

⁹ Andrew Szasz, *Shopping Our Way to Safety: How We Changed from Protecting the Environment to Protecting Ourselves* (University of Minnesota Press 2007).

¹⁰ A report from the Commission reads: ‘The EU benefits from the *most stringent system in the world* for the authorisation and control of pesticides’ (emphasis added): Commission ‘Report from the Commission to the European Parliament and the Council on Member State National Action Plans and on progress in the implementation of Directive 2009/128/EC on the sustainable use of pesticides’ COM(2017) 587.

EU as a paradigmatic case.¹¹ In this context, we explain how the re-evaluation of glyphosate has unleashed changing forces for the reform of the existing regulatory frameworks. Following discourse elements of anthropocentrism and compartmentalisation, we argue that the case of glyphosate is illustrative of the politics of separation. We conclude by discussing initiatives of contestation of these unwarranted epistemological constraints through institutions of participatory and representative democracy as well as the judiciary.

ANTHROPOCENTRISM, CHEMICALS AND ENVIRONMENTAL JUSTICE

Part of living in democratic societies involves sharing social burdens, rather than requiring one segment of the population to disproportionately shoulder sacrifices.¹² Yet, the uneven distribution of environmental bads common in environmental injustice cases includes chemicals.¹³ Protections are lacking for vulnerable populations, including pregnant mothers, children and the elderly, as well as socio-politically disenfranchised and chronically exposed groups such as field workers and groundskeepers. Humans are most sensitive to contact with environmental chemicals during the embryonic, foetal and infant developmental periods, and thus toxic chemical exposures to pregnant mothers and young children are many times more sensitive (harmful) than for normal adults.¹⁴ Toxicity studies generally do not focus on these groups, even though these populations absorb an unfair share of the toxic load. Moreover, these same populations on average have less access to physical, material, economic, social, political and legal remedies (protective factors) than the average person. Privileged classes routinely have more access to information and through material measures create buffers between their own bodies and exposure to these chemicals.¹⁵ Based on extreme vulnerability for these populations, there are good grounds to set the threshold of safe exposure to the most impacted members of our society, rather than those most resistant.

Non-human organisms may experience harms from these chemicals at even lower doses. In one well-crafted study, Relyea and others observed the differential influence of glyphosate in amphibians (frogs) in the absence of their natural predator *versus* when predators were present, and demonstrated that while in the lab the pesticide

11 For the methodological soundness of focusing on specific cases see Bent Flyvbjerg, 'Five Misunderstandings About Case-Study Research' (2006) 12 *Qualitative Inquiry* 219.

12 Danielle S Allen, *Talking to Strangers: Anxieties of Citizenship since Brown v Board of Education* (University of Chicago Press 2004).

13 Andrew Szasz, *Ecopopulism: Toxic Waste and the Movement for Environmental Justice* (University of Minnesota Press 1994); Eckley and Selin (n 3); Philippe Grandjean and others, 'The Faroes Statement: Human Health Effects of Developmental Exposure to Chemicals in Our Environment' (2008) 102 *Basic & Clinical Pharmacology & Toxicology* 73; Liza Gross and Linda S Birnbaum, 'Regulating Toxic Chemicals for Public and Environmental Health' (2017) 15 *PLOS Biology* <<https://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.2004814>> accessed 10 June 2019; Sarah Marie Wiebe, *Everyday Exposure: Indigenous Mobilization and Environmental Justice in Canada's Chemical Valley* (University of British Columbia Press 2017).

14 Grandjean and others (n 13).

15 Szasz (n 13).

was relatively harmless on amphibians (and hence Monsanto trials deemed it safe for use on crops near riparian environments), in the wild the same frogs species' immune system was 15 times weaker in the presence of their predators (snakes), turning this experimentally 'safe' compound into a deadly poison.¹⁶ Such research in the field of ecologically situated toxicology demonstrates that *in vivo* experimentation will always be different than *in vitro*, sometimes with fatal consequences.

Yet, most toxicological studies and rule-making for the allowable levels of toxicity of a chemical in humans or other organisms do not take the most vulnerable or most exposed as the paradigmatic cases for their standards. Instead, toxicity standards are usually set as low as possible, putting those more sensitive, susceptible or in contact with the chemicals at risk. Because those most exposed to toxic chemicals happen to be the most politically marginalised, exposures to these populations are usually systematically under-prioritised and hence late identified.¹⁷

In 2014, 826 million kilograms of glyphosate were applied, a hundred-fold increase since 1974.¹⁸ Glyphosate targets an enzymatic pathway in plants. While this pathway does not exist in human cells, plants and bacteria share the shikimate pathway, and this includes the symbiotic bacteria that humans require to live. Direct exposure to the chemical especially seems to be bioactive.¹⁹ Of the 13,000 current open cases against Monsanto for glyphosate exposure, the vast majority come from janitors, farmers and groundskeepers who were exposed on a continued basis for years to the chemical.²⁰ These are people working mostly low-paying jobs. Thus, the need to apply protections to a class of people serially exposed dermally and respiring the chemical is additional and even more a health priority than for those exposed through ingesting it alone.

REGULATING PESTICIDES IN EUROPE: HOW THE GLYPHOSATE CASE IS SHAKING THE SYSTEM

Regulation 1107/2009 concerning the placing of plant protection products on the market establishes the main legal framework for pesticides in Europe.²¹ This Regulation

¹⁶ Rick A Relyea, 'The Lethal Impacts of Roundup and Predatory Stress on Six Species of North American Tadpoles' (2005) 48 *Archives of Environmental Contamination and Toxicology* 351.

¹⁷ Szasz (n 13); Gross and Birnbaum (n 13); William H van der Schalie and others, 'Animals as Sentinels of Human Health Hazards of Environmental Chemicals' (1999) 107 *Environmental Health Perspectives* 309; Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Harvard University Press 2011); Di Renzo and others (n 1).

¹⁸ Benbrook (n 6); Laura N Vandenberg and others, 'Is It Time to Reassess Current Safety Standards for Glyphosate-Based Herbicides?' (2017) 71 *J Epidemiol Community Health* 613.

¹⁹ Breanna Ford and others, 'Mapping Proteome-Wide Targets of Glyphosate in Mice' (2017) 24 *Cell Chemical Biology* 133.

²⁰ Claudio Butticé, 'Roundup Lawsuit 2018 Against Monsanto: Can Glyphosate Cause Cancer?' (*Drug-watcher*, 3 April 2019) <www.drugwatcher.org/roundup-glyphosate-lawsuit/> accessed 30 April 2019.

²¹ See Council and Parliament Regulation (EC) 1107/2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414 (EC Regulation on Plant Protection Products) [2009] OJ L 309/1.

aims at achieving a plurality of goals. On the one hand, it aims to protect human or animal health as well as the broader environment. On the other hand, it aims to facilitate market integration to improve Europe's agricultural production.²² Incidentally, by opting for the term 'plant protection products' instead of the more common term 'pesticide', the regulators may have chosen this euphemism to emphasise positive functions of these substances, rather than their health-endangering properties.²³

The Regulation establishes that active substances, safeners and synergists, are to be authorised in Europe following a procedure centrally supervised by the European Food and Safety Authority (EFSA). Most importantly, in order to be approved, active substances 'shall not have any harmful effects on human health, including that of vulnerable groups, or animal health, taking into account known cumulative and synergistic effects' and 'shall have no unacceptable effects on the environment', with particular regard to effects on watercourses, non-target species and biodiversity.²⁴ An applicant has to submit a dossier to a Rapporteur Member State (RMS, any country in the European Union) of her own choice. The RMS in turn assesses the dossier and submits its assessment to the Commission and to EFSA. The latter adopts its own conclusions, after having circulated the report to all member states for feedback and holding a period of public comment. Although the final pronouncement on whether a given substance is approved remains with the European Commission, the Commission's decision is typically heavily influenced by EFSA's conclusions. In the case of glyphosate, Germany through its Federal Institute for Risk Assessment (BfR), acted as the RMS and concluded that glyphosate is safe. Following the procedure prescribed in the Regulation, the positive assessment by BfR has been confirmed and adopted by EFSA.

Glyphosate appeared on the world stage as a central legal, political and scientific question in March 2015, when the International Agency for Research on Cancer (IARC), the respected and specialised cancer agency of the World Health Organization (WHO), classified glyphosate as 'probably carcinogenic to humans'.²⁵ The ripples of this pronouncement were felt widely. After the publication of the IARC Monograph, for example, the state of California followed suit and listed glyphosate as carcinogenic, implying that all glyphosate-based herbicides must be labelled as carcinogenic.²⁶ The IARC decision precipitated action at the federal level, including the US Environmental Protection Agency (EPA) initiating a reassessment of the chemical's safety. While in its interim decision of 2017 the EPA assessed glyphosate

22 See EC Regulation on Plant Protection Products, art 1.3.

23 The term pesticide comes from the Latin words *pest-* and *-cide* (killer).

24 See EC Regulation on Plant Protection Products, arts 4.2(a) and (e), 25.

25 Technically this is called Group 2A; see International Agency for Research on Cancer, 'Some Organophosphate Insecticides and Herbicides' (2015) <<https://monographs.iarc.fr/iarc-monographs-on-the-evaluation-of-carcinogenic-risks-to-humans-4/>> accessed 23 May 2019.

26 See Office of Environmental Health Hazard Assessment, 'Glyphosate Listed Effective July 7, 2017, as Known to the State of California to Cause Cancer' (26 June 2016) <<https://oehha.ca.gov/proposition-65/cnrn/glyphosate-listed-effective-july-7-2017-known-state-california-cause-cancer>> accessed 23 May 2019.

as sufficiently safe,²⁷ the Agency for Toxic Substances and Disease Registry's (ATSDR) April 2019 draft report aligns on many points with IARC's conclusions of risk.²⁸

Even more far-reaching, the IARC Monograph has provided scientific legitimacy in the launch of more than 13,000 lawsuits against Monsanto (now Bayer AG) in the US, which claim glyphosate-based herbicides have caused cancer to farmers and grounds-keepers with longstanding close contact with the products.²⁹ In the first three lawsuits, the jury awarded damages (between US\$70 and 80 million) and punitive damages up to US\$1 billion.³⁰ These trials are relevant not only for the individuals who developed non-Hodgkin's lymphoma after years of regular *RoundUp*® use, but also illuminate tension in the chemical regulatory processes, such as the EPA's decision to conclude that glyphosate is safe. By enabling the disclosure of a considerable amount of internal Monsanto emails and unpublished scientific studies, the trials are putting into question the credibility of some of the scientific evidence used to come to the conclusions that glyphosate is a safe substance.³¹ These doubts have been echoed by the media, which has referred to 'the Monsanto papers' in describing the documents revealed through discovery which indicate incestuous and at times questionable relations between industry and regulatory agencies.³²

- 27 For an overview see US Environmental Protection Agency, 'EPA Releases Draft Risk Assessments for Glyphosate' (18 December 2017) <www.epa.gov/pesticides/epa-releases-draft-risk-assessments-glyphosate> accessed 23 May 2019; see also US Environmental Protection Agency, 'EPA Takes Next Step in Review Process for Herbicide Glyphosate, Reaffirms No Risk to Public Health' (30 April 2019) <www.epa.gov/newsreleases/epa-takes-next-step-review-process-herbicide-glyphosate-reaffirms-no-risk-public-health> accessed 23 May 2019, reaffirming the safety assessment of glyphosate.
- 28 US Agency for Toxic Substances and Disease Registry, 'Toxicological Profile for Glyphosate: Draft for Public Comment' (2019) <www.atsdr.cdc.gov/toxprofiles/tp214.pdf> accessed 10 June 2019.
- 29 For an overview see Carey Gillam, 'Monsanto Roundup Trial Tracker—US Right to Know' (*US Right to Know*, 25 April 2019) <<https://usrtk.org/monsanto-roundup-trial-tracker-index/>> accessed 23 May 2019. At the time of writing, lawsuits are also been initiated in Canada in the form of class actions; see 'Quebec Woman Seeks Class-Action Lawsuit over Roundup Cancer Claim' (*CBC*, 24 May 2019) <www.cbc.ca/news/canada/montreal/quebec-monsanto-lawsuit-1.5147891> accessed 23 May 2019.
- 30 See the overview of cases at US Right to Know, 'Roundup (Glyphosate) Cancer Cases: Key Documents & Analysis' <<https://usrtk.org/monsanto-papers/>> accessed 10 June 2019; cf *DeWayne Johnson v Monsanto Company et al* [2016] No 3:2016cv01244—Document 52 (ND Cal 2016).
- 31 Anne Overstreet, '[Email from Overstreet Anne about Glyphosate IARC]' (23 March 2015) <www.industrydocuments.ucsf.edu/chemical/docs/#id=qypl0226> accessed 28 May 2019; René Vinas, 'RE: EFSA Comments Proposal' (10 August 2017) <www.industrydocuments.ucsf.edu/chemical/docs/#id=jybn0226> accessed 28 May 2019; Nathan Donley and Carey Gillam, 'The EPA Is Meant to Protect Us. The Monsanto Trials Proves It Isn't' *The Guardian* (London, 7 May 2019) <www.theguardian.com/commentisfree/2019/may/07/epa-monsanto-round-up-trial> accessed 28 May 2019.
- 32 Stéphane Foucart, 'Ce que les "Monsanto Papers" révèlent du Roundup' *Le Monde* (Paris, 18 March 2017) <www.lemonde.fr/planete/article/2017/03/18/ce-que-les-monsanto-papers-revelent-du-roundup_5096602_3244.html> accessed 23 May 2019; see also Stéphane Foucart, "'Monsanto Papers': des eurodéputés veulent la révision de l'expertise du glyphosate' *Le Monde* (Paris, 24 March 2017) <www.lemonde.fr/planete/article/2017/03/24/monsanto-papers-des-eurodeputes-veulent-la-revision-de-l-expertise-du-glyphosate_5100479_3244.html> accessed 23 May 2018.

The IARC Monograph conclusions have also triggered a process of re-evaluation of the safety of glyphosate by EFSA.³³ On 12 November 2015, EFSA published its revision, maintaining that glyphosate is 'unlikely to pose a carcinogenic hazard to humans'.³⁴ Yet even though EFSA did not deviate from its initial assessment, the policy effects of the IARC monograph are clear: the European Commission's re-authorisation for glyphosate provided only a five-year renewal rather than the customary ten-year licence³⁵—in addition to the European Commission advising a new set of precautionary measures on its use (eg banning the surfactant polyethoxylated tallow amine from glyphosate-based products and recommending glyphosate not be used in public gardens and playgrounds).³⁶ The 'Monsanto papers' have also prompted a cadre of European Parliamentarians to investigate the validity of certain studies proffered as evidence of the chemical's safety by EFSA and the European Chemicals Agency (ECHA) in their assessments.³⁷ In the wake of this controversy, the European Parliament set up a Special Committee on the Union's authorisation procedure for pesticides (PEST). In December 2018, PEST released a report advocating crucial reforms to the current regulatory framework.³⁸ To fully understand the scope of their proposed reforms, we first analyse the limits of current pesticide regulatory frameworks.

GLYPHOSATE RISK ASSESSMENT, THE POLITICS OF SEPARATION AND THE ANTHROPOCENE

Observing the differences between the IARC and EFSA assessments offers insight into wider question of the limits of existing pesticide regulatory frameworks. As EFSA explained their reasoning for an approving evaluation in contradistinction to IARC's findings of likely carcinogenicity, EFSA emphasized that they only evaluated the active substance *in vacuo*. By contrast, IARC considered glyphosate *in toto* and *in situ*, including evaluations of the main ingredient with its admixtures in the

- 33 Commission, 'Request to consider the findings by IARC as regards the potential carcinogenicity of glyphosate or glyphosate containing plant protection products in the ongoing peer review of the active substance' (30 April 2015) SANTE/ E3/ DVB/ Wv/np.
- 34 See European Food Safety Authority, 'Conclusion on the Peer Review of the Pesticide Risk Assessment of the Active Substance Glyphosate' (2015) 13 *EFSA Journal* <<http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2015.4302/epdf>> accessed 27 May 2019, emphasis added.
- 35 Susana de Almeida Ribeiro, 'Glyphosate' (*Food Safety—European Commission*, 12 July 2017) <https://ec.europa.eu/food/plant/pesticides/glyphosate_en> accessed 23 May 2019.
- 36 See Commission Regulation (EU) 2016/1313 as regards the conditions of approval of the active substance glyphosate [2016] OJ L208; for a press release on the regulation see Commission, 'FAQs: Glyphosate' (29 June 2016) <http://europa.eu/rapid/press-release_MEMO-16-2012_en.htm> accessed 23 May 2019.
- 37 Letter by EU parliamentarians to the President of the European Commission Jean-Claude Juncker, Brussels, 23 May 2017.
- 38 European Parliament, 'Draft Report on the Union's authorisation procedure for pesticides, (2018/2153 (INI))' (17 September 2018) <www.europarl.europa.eu/sides/getDoc.do?pubRef=-%2F%2FEP%2F%2FNONSGML%2BCOMPARI%2BPE-627.625%2B01%2BD0C%2BPDF%2BV0%2F%2FEN> accessed 10 June 2019.

actual applied formulations.³⁹ Here, it warrants noting that while active substances are approved by European institutions, pesticides are approved at the Member State level. Once a pesticide has been approved by a Member State, approval in all other Member States can be obtained through mutual recognition.⁴⁰ A problem with such bifurcation is that active substances do not determine the hazard of pesticides alone. In the case of glyphosate, for example, it has been argued that some adjuvants pose greater risks than the active substance.⁴¹ And yet, approval of active substances greenlights approval for the admixtures these active substances interact with in their actual vended products (such as *RoundUp*®).⁴² This means that less scrutiny is given presale to the actual blended pesticides on the market.

The choice of separating the active substance from its co-formulants may be viewed as part of a politics of separation, through which legal institutions enable swifter decisions. As noted elsewhere:

The act of splitting ... enables the regulators to exclude arguments and decide more expeditiously ... pure substances are to be appraised not formulations; arguments in, arguments out. This politics of separation is expedient, as law ought to resolve conflicts, to decide. To decide comes from the Latin words *de-* and *caed' re*: to cut-off. Law needs to 'cut-off'. In resorting to science, law risks being lost in the 'thousands of ways' by which scientists 'manipulate, transform and test phenomena'; through the politics of separation, law regains one of its main traits, that is the ability of 'saying the last word'.⁴³

Yet, this very politics of separation appears at odds with the need of addressing the Anthropocene. Regulatory frameworks anchored in assessing isolated pure substances in the lab fail the litmus test of ecology and human bodies, messily complex and recalcitrant to the securities of the scientific lab. Such artificial isolation is prone to overlook the hazards generated by pesticides such as glyphosate when sprung on an environment filled with innumerable synergies.

This quarantining assessment (also termed 'itemisation' in risk regulation) of toxic substances from their synergies with other compounds or the multiple exposures people

³⁹ EFSA, 'EFSA explains risk assessment: Glyphosate' <www.efsa.europa.eu/sites/default/files/corporate_publications/files/efsaexplainsglyphosate151112en_1.pdf> accessed 27 February 2017, 2: 'This distinction between active substance and pesticide formulation mainly explains the differences in how EFSA and IARC weighed the available data.'

⁴⁰ See EC Regulation on Plant Protection Products, art 41.

⁴¹ Nicolas Defarge and others, 'Toxicity of Formulants and Heavy Metals in Glyphosate-Based Herbicides and Other Pesticides' (2018) *Toxicology Reports* 156.

⁴² According to Dr Robert Mesnage: 'Formulations are not adequately assessed because only their acute toxic effects are studied. Long-term health effects of pesticide residues from the complete commercial formulations are never tested': answer given by Robert Mesnage during the Pest Committee Meeting of 28 June 2018 'PEST EU Authorisation for Pesticides' (*European Parliament Committees*, 28 June 2018) <www.europarl.europa.eu/committees/en/pest/events-hearings.html?id=20180620CHE04421> accessed 10 June 2019.

⁴³ See Arcuri (n 7), quote within quotes refers to Bruno Latour, 'Scientific Objects and Legal Objectivity', a chapter of *La Fabrique du droit* translated by Alain Pottage in Alain Pottage and Martha Mundy, *Law, Anthropology, and The Constitution of the Social: Making Persons and Things* (CUP 2004).

actually encounter in real-world circumstances, has been long criticised.⁴⁴ The real world applications of these chemicals are subject to almost indefinite reactants,⁴⁵ unexpected vulnerabilities based on the diversity of human and other organisms' biological and ecological predicaments,⁴⁶ and other variabilities that can never be finally assessed—even if their consequences are dead serious. Yet, exactly because of the disjunction between the effects of a chemical in a laboratory versus its impact in the interactive environments in which it is applied, it is all the more regrettable risk regulators continue to rely on assessment frameworks ill-equipped to take into account life's conditions.

If anything, the Anthropocene is the sober acknowledgement that human artifice overflows its aim, creating reverberating unintended consequences far further in space and time than we ever imagined. The bifurcation between the theoretical safety of a chemical in a lab and the lived promiscuity of that chemical with its reagents as used in the world, is exacerbated by the fact that at the EU level there is no regulation of the total, combined, use of pesticides. Ignoring the total use of pesticides and their aggregate impact on human health and the environment is acting *as if* an assessment of low risks can be entirely resolved without knowing the impact of pesticides on the environment. True, Regulation 1107/2009 is complemented by Directive 2009/128/EC on the sustainable use of pesticides (*nota bene*, this directive is one of the few that replaces the euphemism 'plant protection product' with the word 'pesticide'). Yet, the sustainable use of pesticides appears to be relegated to Member States and their duty to develop National Action Plans on their own rather than via EU collaboration. Regrettably, out of 28 Member States only France has established targets for the reduction of the use of pesticides.⁴⁷ It goes without saying that isolating the analysis of the effects of active substances from the question of the quantity of pesticides released in the environment is inadequate for confronting the chemical Anthropocene. The politics of separation, in other words, enables the *compartmentalisation* of issues, which in turn facilitates the creation of ignorance vis-à-vis certain risks.

The contemporary field of agnotology can shed some light on how ignorance is often used strategically to close off or compartmentalise certain fields of inquiry disruptive of the status quo.⁴⁸ In her taxonomy of types of ignorance, Nancy Tuana reminds us that

44 For a lucid analysis and overview see Veerle Heyvaert, 'Governing Climate Change: Towards a New Paradigm for Risk Regulation' (2011) 74 *MLR* 817

45 Merrill Singer, *Introduction to Syndemics: A Critical Systems Approach to Public and Community Health* (John Wiley & Sons 2009); Committee on Incorporating 21st Century Science into Risk-Based Evaluations and others, *Using 21st Century Science to Improve Risk-Related Evaluations* (National Academies Press 2017); US Agency for Toxic Substances and Disease Registry (n 28).

46 Rick A Relyea, 'Predator Cues and Pesticides: A Double Dose of Danger for Amphibians' (2003) 13 *Ecological Applications* 1515; Relyea, 'The Lethal Impacts of Roundup' (n 16).

47 See Commission, 'Report from the Commission to the European Parliament and the Council on Member State National Action Plans and on progress in the implementation of Directive 2009/128/EC on the sustainable use of pesticide' COM(2017) 587 final, 5.

48 Robert Proctor, 'Agnotology: A Missing Term to Describe the Cultural Production of Ignorance (and Its Study)' in Robert Proctor and Londa L Schiebinger (eds), *Agnotology: The Making and Unmaking of*

far being a passive or accidental object, ignorance is often actively produced, serves particular agendas and acts as a counterpoint to knowledge and its creation. In her description of ‘wilful ignorance’, she describes the scientific-political-economic nexus of experts who ‘do not know and they do not want to know’ how their lack of knowledge abets the procedures, institutions and outcomes from which they derive privilege. This type of ignorance involves a ‘systematic process of self-deception, a wilful embrace of ignorance that infects those who are in positions of privilege, an active ignoring of the oppression of others and one’s role in that exploitation’.⁴⁹

Applied to chemical regulation, the agnotological lens perceives the compartmentalisation of relevant if more difficult to measure forms of exposure as ethically and epistemologically problematic. For example, focusing on dietary instead of dermal or inhaled routes of exposure reduces the relevant set of data unnecessarily. Yet, the 2016 WHO Joint Meeting on Pesticide Residues (JMPR) only looked at dietary routes of exposure for glyphosate, ignoring other forms of exposure, like respiratory and dermal—precisely those types of exposure leading most claimants in the US glyphosate court cases to develop their particular types of cancers. The JMPR also only looked at the effects of glyphosate on mammals, and ignored those for amphibians, insects, fish and other phyla.⁵⁰

The current form of risk assessment confronting chemical evaluation likewise lacks attention to vulnerable groups and the anthropocentrism and androcentrism entrenched in this choice. In EFSA’s conclusion, for example, the term ‘vulnerable’ is mentioned only once, and reference to ‘pregnancy’ twice—referring to rabbits, not humans. Why is this, when it is well known that exposures of a vast array of chemicals to pregnant mothers can harm foetal development?⁵¹ Taking into account the chemical effects on the most vulnerable members of society instead of the most robust—and acknowledging that the different protecting factors and synergistic (or more apt, dysergistic) exposures render certain individuals much more jeopardised—is a necessary benchmark for justice in assessing the trade-offs of allowing chemical use.

The irony with these outcomes is that at the same time, European regulation does contain rules well suited to address the material and unintended hazard overflow indicative of the Anthropocene. As mentioned above, the criteria to approve active substances are *theoretically* very stringent. According to Article 4 of Regulation 1107/2009, only

Ignorance (Stanford University Press 2008); Robert Proctor, *Cancer Wars: How Politics Shapes What We Know and Don’t Know about Cancer* (Basic Books 1995).

⁴⁹ Nancy Tuana, ‘The Speculum of Ignorance: The Women’s Health Movement and Epistemologies of Ignorance’ (2006) 21 *Hypatia* 1, 11; see also Nancy Tuana, ‘Coming to Understand: Orgasm and the Epistemology of Ignorance’ in Proctor and Schiebinger, *Agnotology*; Shannon Sullivan and Nancy Tuana (eds), *Race and Epistemologies of Ignorance* (SUNY Press 2007).

⁵⁰ It is interesting to note that, according to David Eastmond who was on the JMPR glyphosate committee, the JMPR came to similar conclusions as IARC on many accounts: David Eastmond, ‘Glyphosate Hazard and Risk Assessment: A Comparison of the Approaches of Two International Agencies’ (42nd Annual Summer Meeting of The Toxicology Forum, Salt Lake City, July 2016).

⁵¹ Vandenberg and others (n 18); Jean D Brender and Peter J Weyer, ‘Agricultural Compounds in Water and Birth Defects’ (2016) 3 *Current Environmental Health Reports* 144.

substances which pose no hazard to human health, specifically including vulnerable groups, and have no unacceptable effects on the environment, can be approved. Moreover, Article 4 provides that when assessing the hazards, 'known cumulative and synergistic effects where the scientific methods accepted by the Authority to assess such effects are available' must be accounted for. From this vantage point, the European Regulation appears progressive, attending to three key elements: vulnerable groups; the more-than-human ecology; and synergistic effects. Despite this strong wording, however, it remains unclear how the health of vulnerable groups is being accounted for in the assessment, if at all; and, whether and how the effects on the environment receive sufficient attention.⁵²

CONTESTING GLYPHOSATE, REIMAGING REGULATORY RISK ASSESSMENT

Created as a chemical formula, in the socio-legal realm glyphosate morphed into a catalyst for contesting the practice and politics of risk assessment of pesticides. Contestation has materialised in different forms—ranging from street protests,⁵³ public debates⁵⁴ and engaged academic publications,⁵⁵ to full-fledged legal actions. Thus, it comes as no surprise that among the multitude of chemicals, the current *bête noire* of chemical oversight is glyphosate. Not only is glyphosate the most widely used herbicide compound in the world,⁵⁶ generating unprecedented profits with the dubious honour of being the 'first billion dollar product' of the pesticide industry,⁵⁷ it is also the primary herbicide compound applied to

- 52 The Report of EFSA mentions that Glyphosate has been found in groundwater above the parametric limits, but the report fails to expound the details and the implications of these findings; cf EFSA, 'Conclusion on the Peer Review' (n 34), Conclusion. According to Prof Van der Sluijs '[t]he current practice of approval of PPP [plant protection products] is not in line with the legislative requirements. For instance, water quality norms of PPP residues in surface water for substances such as imidacloprid have been exceeded on very large scale since 2004, without any consequences for the scale of use, nor for the authorisation itself: 'Answers by Prof. Dr. Jeroen P. van der Sluijs' (6 September 2018) 'PEST EU Authorisation for Pesticides' (*European Parliament Committees*, 28 June 2018) <www.europarl.europa.eu/committees/en/pest/events-hearings.html?id=20180620CHE0442> accessed 10 June 2019.
- 53 Christopher Vincent, 'Demonstration against Glyphosate Outside European Commission' *The Brussels Times* (Brussels, 19 July 2017) <www.brusselstimes.com/brussels/8731/demonstration-against-glyphosate-outside-european-commission> accessed 1 May 2019; Shenali Godakumbura, 'We Will Protest against Lifting Ban on Glyphosate: GMOA' (*Daily News*, 2 May 2018) <www.dailynews.lk/2018/05/02/local/149881/we-will-protest-against-lifting-ban-glyphosate-gmoa> accessed 1 May 2019.
- 54 Arthur Neslen, 'Controversial Glyphosate Weedkiller Wins New Five-Year Lease in Europe' *The Guardian* (London, 27 November 2017) <www.theguardian.com/environment/2017/nov/27/controversial-glyphosate-weedkiller-wins-new-five-year-lease-in-europe> accessed 1 May 2019.
- 55 See John Peterson Myers and others, 'Concerns Over Use of Glyphosate-Based Herbicides and Risks Associated With Exposures: A Consensus Statement' (2016) 15 *Environmental Health* <<https://ehjournal.biomedcentral.com/articles/10.1186/s12940-016-0117-0>> accessed 10 June 2019.
- 56 More specifically, glyphosate corresponds to '71% of total use worldwide from 1974–2014', with billion kilograms applied globally in the last decade: see Charles M Benbrook, 'Trends in Glyphosate Herbicide Use in the United States and Globally' (2016) 28 *Environmental Sciences Europe* <<https://enveurope.springeropen.com/track/pdf/10.1186/s12302-016-0070-0>> accessed 10 June 2019.
- 57 András Székács and Béla Darvas, 'Forty Years with Glyphosate' in Mohammed Nagib Hasaneen (ed), *Herbicides: Properties, Synthesis and Control of Weeds* (Intech 2012).

genetically modified organisms (GMOs), as most GMOs are made *explicitly* and *exclusively* to be resistant to glyphosate. Despite its singularity, glyphosate has spurred legal, social and political contestation with implications for the entire field of pesticide regulation. As a result, at least three sets of questions emerge: the credibility of the knowledge underpinning regulatory risk assessments; the insufficient focus on the quantities of pesticides applied in practice; and the methodological blinders that unduly limit the capacity to identify risks, such as insufficient attention to the synergistic effects of pesticides.

While it is beyond the scope of this article to review the myriad instances of contestations and their implications, we now consider select initiatives, each illustrative of a different ambit where contestation has occurred. The first is the European Citizens' Initiative (ECI) launched in January 2017 to ban glyphosate.⁵⁸ Such an initiative is illustrative of contestation through participatory democracy. The ECI is a legal mechanism, established in 2011 by virtue of Regulation 211/2011, and it grants the right to group of EU citizens to formally request that the European Commission initiates a legislative proposal.⁵⁹ If banning glyphosate was the first request made by European citizens, the scope of the ECI was much broader. Interestingly, while the request to ban glyphosate was quickly dismissed by the Commission, other entailed requests have successfully led to concrete proposals for reforms. The second mode of contesting the current regulatory regime was initiated by the decision of the European Parliament to establish a dedicated committee—the above-mentioned PEST Committee—commissioned to scrutinise the current regulatory regime of glyphosate. This initiative is a manifestation of the working of representative democracy. Finally, contestation also has taken a legal turn, whereby a number of legal suits have been lodged to challenge EFSA's resistance to disclosing the industry studies which the agency heavily relied on in its risk assessment. These acts of contestation and their aftershocks have spurred change in several domains, as discussed in the remainder of this section.

Embedded Science and its Discontents

Under the current EU regulatory regime, the corporate applicant to benefit from authorising their chemical product, is the main supplier of the scientific studies to be evaluated by EFSA and ECHA. To complicate matters, industry studies are not available to the public, including when the public explicitly ask to access some of these documents,

⁵⁸ See European Commission, 'Press Release—Commission Registers "Ban Glyphosate" European Citizens' Initiative' (10 January 2017) <http://europa.eu/rapid/press-release_IP-17-28_en.htm> accessed 27 February 2017; the European Citizens' Initiative (ECI) was registered on 25 January 2017, ECI documents are available online see Commission, 'The European Citizens' Initiative Official Register: Commission's answer and follow-up' <<http://ec.europa.eu/citizens-initiative/public/initiatives/successful/details/follow-up/2017/000002/en?lg=en>> accessed 10 June 2019.

⁵⁹ For more information see Commission, 'The European Citizens' Initiative Official Register: Basic Facts' <<http://ec.europa.eu/citizens-initiative/public/basic-facts>> accessed 10 June 2019. For a comment on the ECI, see Anastasia Karatzia, 'The European Citizens' Initiative and the EU Institutional Balance: On Realism and the Possibilities of Affecting EU Lawmaking' (2017) 54 *CMLR* 177.

due to the justification of retaining commercial secrets. Thus, in this case, a company's chemical formulas are deemed more important than an open and transparent cross-examining scientific assessment of the documents on which regulatory assessments are made. Such architecture of knowledge production is problematic and prone to conflicts of interest.

The secrecy of the studies under the evaluation has been a source of concerns for many Europeans. In fact, EFSA has in more occasions refused access to some of these documents. In 2014, Mr Tweedale lodged a complaint against EFSA for denying access to industry studies. A similar complaint was also launched by four Members of the European Parliament (MEPs) (Ms Heidi Hautala and others) in 2016. In *Tweedale v EFSA*⁶⁰ and *Hautala and Others v EFSA*⁶¹ the General Court found that the studies of the applicant business operator to which EFSA refused access 'must be regarded as constituting information which "relates to emissions into the environment" and that an overriding public interest in disclosing the studies is deemed to exist', and thereby ordered disclosure of the requested studies. Beyond the victories for the individual claimants, one important implication of the Court's ruling is that it 'brings regulatory science back into the domain of public debate'.⁶²

The question of scientific credibility has also been raised by the European citizens who—through the ECI submitted to the Commission—requested reforms so as 'to ensure that the scientific evaluation of pesticides for EU regulatory approval is based only on published studies, which are commissioned by competent public authorities instead of the pesticide industry'.⁶³ This ECI further suggested that competent third-party scientists should perform the relevant toxicological studies through government commission, thus providing a scientific firewall between the profit-interested company and the scientific assay, while the costs should remain with the petitioning industry.⁶⁴ The Commission responded to this request by proposing a regulation on transparency and sustainability for EU risk assessments in the food chain.⁶⁵ While the

⁶⁰ Case T-716/14 *Anthony C Tweedale v European Food Safety Authority* [2019] (GC, 7 March 2019); for an in-depth discussion of the question of secrecy *versus* disclosure of information in the public interest see Emilia Korkea-Aho and Päivi Leino, 'Who Owns The Information Held By EU Agencies? Weed Killers, Commercially Sensitive Information And Transparent And Participatory Governance' (2017) 54 *CMLR* 1059.

⁶¹ Case T-329/17 *Heidi Hautala and Others v European Food Safety Authority* [2019] (GC, 7 March 2019).

⁶² Marta Morvillo, 'The General Court Orders Disclosure of Glyphosate-Related Scientific Studies: *Tweedale, Hautala*, and the Concept of Environmental Information in the Context of Plant Protection Products' *European Journal of Risk Regulation* (2019). 1-9. doi:10.1017/err.2019.31

⁶³ See European Commission (n 58).

⁶⁴ *Ibid* 2.

⁶⁵ Proposal for a regulation of the European Parliament and of the council on the transparency and sustainability of the EU risk assessment in the food chain amending Regulation (EC) No 178/2002 [on general food law], Directive 2001/18/EC [on the deliberate release into the environment of GMOs], Regulation (EC) No 1829/2003 [on GM food and feed], Regulation (EC) No 1831/2003 [on feed additives], Regulation (EC) No 2065/2003 [on smoke flavourings], Regulation (EC) No 1935/2004 [on food contact materials], Regulation (EC) No 1331/2008 [on the common authorisation procedure for food additives, food enzymes and food flavourings], Regulation (EC) No 1107/2009 [on plant protection products] and

Commission's proposal fails to meet the requests of the European citizens, it is a first step in changing the current system towards more stringent accountability and transparency. To correct some of its historical blind spots, the Commission proposes several measures, including establishing a common European Register of commissioned studies; the introduction of a duty of competent authority to make available without delay 'the scientific data, studies and other information supporting applications for authorisation';⁶⁶ and the establishment of procedures, in exceptional circumstances, according to which the authority can commission additional independent studies, to be financed through the EU budget.

Accusations of plagiarism have cast further doubt on the relationship between industry science and the authority's alleged independent evaluation of such studies.⁶⁷ In short, the German Federal Institute for Risk Assessment (BfR, the risk assessment body which initially conducted the evaluation of glyphosate for EFSA) Report contains several passages plagiarised from industry files, according to an investigation commissioned by some EU MEPs.⁶⁸ More precisely, the BfR appears to have copy-pasted the assessment of the European Glyphosate Task Force—the corporate group filing the application—of both published and industry studies. The Report finds that the BfR copied over 50 per cent of the Glyphosate Task Force chapters assessing published studies and more than 80 per cent of the chapters assessing industry studies from the industry's own materials. While BfR has denied the accusations,⁶⁹ it is uncontroversial that much of the report contains copy-pasted passages from industry documents (several without using quotation marks or other designations clarifying which sections were originally written by BfR scientists).⁷⁰ The Parliament, through its PEST Committee Report, reprimanded the uncritical copying of the industry studies, making the basic comment that 'should passages be taken from the [pesticide company's] application dossier a clear distinction should be made between the assessment of the authority and the assessment of the applicant'.⁷¹ The PEST Committee further stressed the

Regulation (EU) No 2015/2283 [on novel foods] <<http://ec.europa.eu/citizens-initiative/public/initiatives/successful/details/follow-up/2017/000002/en?lg=en>> accessed 10 June 2019.

⁶⁶ *Ibid.*

⁶⁷ Simon Marks, 'Researchers accuse German authority of plagiarism in glyphosate review' (*Politico*, 15 January 2019) <www.politico.eu/article/bfr-glyphosate-germany-researchers-accuse-german-authority-of-plagiarism-in-glyphosate-review> accessed 30 May 2019; Weber and others, 'Detailed Expert Report on Plagiarism and Superordinated Copy Paste in the Renewal Assessment Report (RAR) on Glyphosate' (2019) <www.greens-efa.eu/files/doc/docs/298ff6ed5d6a686ec799e641082cdb63.pdf> accessed 10 June 2019; see also Stefan Grobe, 'Researchers accuse German authority of plagiarism in glyphosate review' (*Euronews*, 17 January 2019) <www.euronews.com/2019/01/17/researchers-accuse-german-authority-of-plagiarism-in-glyphosate-review> accessed 30 May 2019.

⁶⁸ Weber and others (n 67).

⁶⁹ Bundesinstitut für Risikobewertung, 'Glyphosate Assessment: BfR Rejects Plagiarism Accusations' (20 September 2019) <www.bfr.bund.de/en/press_information/2017/34/glyphosate_assessment__bfr_rejects_plagiarism_accusations-201890.html> accessed 30 May 2019.

⁷⁰ See Weber and others (n 67).

⁷¹ European Parliament, 'Draft Report' (n 38) 22.

importance of transparency and independent review, recommending EFSA and the Commission to continue working on these issues.⁷²

The Commission's proposed reforms, together with the rulings of the European Court and the recommendations of the PEST Committee, are promising developments to enhance the credibility of the knowledge used in regulatory risk assessments. But it remains to be seen whether these developments are sufficient to mitigate the risks that vested interests will engineer policy-relevant science to meet their own desiderata, as in recent history.⁷³

Incidentally, the question of the credibility of the scientific studies used for regulatory review is far from being exclusively a European one. In the US, the EPA, for example 'considers industry-sponsored studies "scientifically more robust than are the studies generated by people in academia"', according to the agency's senior policy analyst William Jordan.⁷⁴ The EPA has insisted that using industry-funded science to evaluate an industrial chemical is better science than leaving out or quarantining such interested studies, preferring industry studies over independent academic research. This is not new for the EPA. With atrazine, the most-used agrichemical prior to glyphosate, more than 80 per cent of the studies reviewed were not peer-reviewed, and over half of the 6611 studies reviewed were funded by atrazine's maker Syngenta and its affiliates.⁷⁵ This might explain why the US EPA deems atrazine safe, while since 2003 it has been banned in the European Union and Switzerland, where the herbicide is made and Syngenta is headquartered. As mentioned earlier, the US court cases against Monsanto (now Bayer AG) have revealed through discovery hundreds of thousands of pages of previously secret industry documents, possible conflicts of interests and even possible ghost-writing that may have vitiated existing risk assessments at the EPA.⁷⁶ Against this backdrop, one can only hope that the current work done to improve the EU risk assessment practices will spur reforms in other jurisdictions as well.

Contesting Compartmentalisation and Anthropocentrism

As discussed in the previous section, some of the major pitfalls of the current assessment practices pertain to the lack of attention to the total use of pesticides in the

⁷² *Ibid* 23.

⁷³ For a general study relating to the problems of undue industry influence on regulatory science see Thomas McGarity and Wendy Wagner, *Bending Science: How Special Interests Corrupt Public Health Research* (Harvard University Press 2008).

⁷⁴ Danielle Ivory, 'EPA Relies on Industry-Backed Studies to Assess Health Risks of Widely Used Herbicide' (*Scientific American*, 28 July 2010) <www.scientificamerican.com/article/epa-atrazine-herbicide/> accessed 20 March 2019.

⁷⁵ *Ibid*; similarly, long after DDT was officially banned for use in the United States in 1972, it was still manufactured and exported internationally throughout the 1980s. Remarkably on the ethics of producing and exporting chemicals known domestically to be harmful to the population, is beyond the scope of this paper.

⁷⁶ Donna Farmer and Michael Koch, '[Email from Heydens, William F to Koch, Michael S Regarding IARC Planning]' (*Chemical Industry Documents*, 5 February 2015) <www.industrydocuments.ucsf.edu/chemical/docs/#id=gxmn0226> accessed 30 May 2019.

environment and to the isolation of active substance from the co-formulants. Glyphosate has critically triggered the contestation of consolidated risk assessment practices because of methodological blinders or what we refer to as the problem of compartmentalisation. The Report of the PEST Committee of the European Parliament, mentioned above, possibly carves a way out of compartmentalisation, calling for ‘the Commission to conduct an epidemiological study on the real-life impacts of plant protection products on human health’.⁷⁷

The PEST Committee has also engaged with the lack of attention to vulnerable groups. Assuming that a substance is universally safe, regardless of the specific vulnerabilities of those encountering it, constructs a straw toxicological man. Toxicology studies need to be done based on the most vulnerable and exposed members of the population, not the most resistant. The PEST Report acknowledges the exposure of vulnerable groups and recommends an outright prohibition of the use of pesticides in ‘in areas used by the general public or by vulnerable groups’.⁷⁸ In this context, it is interesting to note that several Member States have already adopted measures banning the use of glyphosate from public spaces.⁷⁹ This is an important development. While the Report may be a pest to chemical manufactures, at long last it attends to diversity in public health. And yet, one may ask whether the question of vulnerability should not gain even more prominence in the assessment process, as those most vulnerable to any given chemical exposure act as sentinels for chemical toxicity.

Finally, the question of rationales for reducing the total amount of pesticide used is also central to these events. The ECI, for one, has demanded for reforms ‘to set EU-wide

⁷⁷ See European Parliament, ‘Draft Report’ (n 38) para 18.

⁷⁸ *Ibid* para 13.

⁷⁹ Partial prohibitions on the sale glyphosate-based herbicides are reported to have been adopted, for example, in Belgium, The Netherlands, France, the UK, Spain and Italy. For an overview of these measures see respectively for Belgium, ‘Glyphosate sales to non-professionals banned in Belgium’ (*GMWatch*, 4 October 2018) <www.gmwatch.org/en/news/latest-news/18489-glyphosate-sales-to-non-professionals-banned-in-belgium> accessed 30 May 2019; for France, ‘France takes Roundup weed-killer off market after court ruling’ (*Phys.org*, 15 January 2019) <<https://phys.org/news/2019-01-france-roundup-weed-killer-court.html>> accessed 30 May 2019; in the Netherlands glyphosate is not allowed on public terrains and parks or public gardens, with the exception of railroads and airports where the substance can still be used: see, Government of the Netherlands (webpage) ‘Mag ik gewasbeschermingsmiddelen met glyfosaat gebruiken?’ <www.rijksoverheid.nl/onderwerpen/bestrijdingsmiddelen/vraag-en-antwoord/mogen-gewasbeschermingsmiddelen-waar-in-glyfosaat-zit-worden-gebruikt> accessed 30 May 2019; for the UK, Thomas George, ‘Bury Council bans use on cancer-linked weed killer, glyphosate, used in parks and playgrounds’ *Bury Times* (Bury, 17 May 2019) <www.burytimes.co.uk/news/17646808.bury-council-bans-use-of-cancer-linked-weed-killer-glyphosate-used-in-parks-and-playgrounds> accessed 30 May, 2019; for Spain, ‘Spanish towns and regions agree to ban glyphosate in public areas’ (*GMWatch*, 22 March 2016) <www.gmwatch.org/en/news/archive/2016/16820-spanish-towns-and-regions-agree-to-ban-glyphosate-in-public-areas> accessed 30 May 2019; for Italy, ‘Italy places important restrictions on the use of glyphosate’ (*Pesticide Action Network Europe*, 24 August 2016) <www.pan-europe.info/press-releases/2016/08/italy-places-important-restrictions-use-glyphosate> accessed 30 May 2019; for a broader overview of where glyphosate is prohibited in the world, see ‘Where is Glyphosate Banned?’ (*Baum Hedlund Aristei Goldman PC*, May 2019) <www.baumhedlundlaw.com/toxic-tort-law/monsanto-roundup-lawsuit/where-is-glyphosate-banned/> accessed 10 June 2019.

mandatory reduction targets for pesticide use, with a view to achieving a pesticide-free future'. This request has yielded some concrete results, broadening the horizon of the evaluative process. In this case, the response of the Commission can be seen as a first move to address concerns about the use of pesticides more generally. The massive use of pesticides in the EU and globally aggravates the problems of the Anthropocene. In this context, the Commission has proposed the adoption of EU-wide harmonised risk indicators concerning the 'data on pesticide sales and the properties of the active substances in them' to further implement Article 15 (1) of Directive 2009/128/EC.⁸⁰ The current system, which implicitly excludes this type of information from risk assessment practices, fosters a sort of 'strategic ignorance'.⁸¹ Against such wilful ignorance, ad hoc forms of resistance have emerged. For example, one prank by the Green Party of the European Parliament tested the glyphosate levels in MEPs' urine, and found that 48 consenting MEPs from 13 different countries had glyphosate levels 17 times higher than the allowable EU levels.⁸² Shifting the attention from the effects of isolated substances to the total quantity of pesticides applied in practice as a slider for dosing pesticide quantity for human contamination may be a much needed development in the current system. While it is premature to assess the efficacy of such a development, it could be argued that if one wants to seriously address the crisis of the Anthropocene, for which the United Kingdom in May 2019 declared a 'climate emergency', more robust measures are needed, such as adopting strict reduction targets and *in situ* toxicology testing. The policy challenge, therefore, for regulating glyphosate or any other chemical, is bound up with confronting the 'sociotechnical imaginaries' dividing government agencies and academic institutions engaged in environmental science, toxicology, economics and policymaking.⁸³

CONCLUSION

A critical legal framework of prevention is required to anticipate the problems chemicals pose. To adequately address the diversity of human and more-than-human populations exposed to these chemicals in various manners requires a wildly more creative, transdisciplinary and field-based longitudinal evidence base than standard narrow lab-based toxicological studies. If as a society we aver our care for the most vulnerable, we need to create chemical policy reflecting these priorities.

The chemical Anthropocene, with glyphosate as but one of its more intensive markers, has so far been challenged by a whack-a-mole approach to regulation. As

⁸⁰ See the dedicated website of the Commission, European Commission, 'Pesticides – sustainable use (risk indicators)' <<https://ec.europa.eu/info/law/better-regulation/initiatives/Ares-2018-1507786>> accessed 10 May 2019.

⁸¹ See Mallard and McGoey (n 8).

⁸² Nelly Baltide, 'We Are Pissed Off' (*The Greens European Free Alliance*, 12 May 2016) <<https://www.greens-efa.eu/en/article/we-are-pissed-off/>> accessed 10 May 2019.

⁸³ Sheila Jasanoff and Sang-Hyun Kim (eds), *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power* (The University of Chicago Press 2015).

the science against glyphosate safety mounts and lawsuits threaten its chemical manufacture's profits, the next generation of GMO crops are being keyed to the pesticide dicamba, sold commercially as *XtendiMax*[®]—and poised to be the next glyphosate.⁸⁴ Regulatory agencies have historically been quick to approve products but slow to reconsider regulations after the decades of accumulated harms become apparent. The entrenched asymmetries between population and ecological health and fast-to-market new chemicals is exacerbated by the seeming lack of institutionalised precautionary policy, with chemical companies worried that if they do not roll-out new products, their competitors will. Law and the courts play a crucial role not only in cleaning up the fallout from chemical injuries, as this paper has described, but in setting up regulatory schemes requiring that new agrochemicals do not reproduce past harms or create new ones. One option many municipalities have taken⁸⁵ is to require reduction in the amount of pesticides applied, to mandate ecologically appropriate green chemistry products, or find biological ways for plants to develop induced system resistance to weeds or predatory insects as is common around the world. Regulatory systems must also break free from the fetters of one-size-fits-all approaches to exposure and harm thresholds (anthropocentrism) and test pesticides not only in the lab but also in real lived environments in interaction with their co-formulants (overcoming compartmentalisation). Some welcome developments in this direction—however halting—are emergent in

84 Lydia Mulvany, 'The Other Monsanto Chemical Bayer Investors Should Watch' (*Bloomberg*, 17 August 2018) <www.bloomberg.com/news/articles/2018-08-17/the-other-monsanto-chemical-that-bayer-investors-should-watch> accessed 1 May 2019; Joel Rosenblatt and Margaret Cronin Fisk, 'What's Next in Court for Bayer Toxic Chemical Claims' (*Bloomberg*, 25 February 2019) <www.bloomberg.com/news/articles/2019-02-25/what-s-next-in-court-for-bayer-toxic-chemical-claims-quicktake> accessed 1 May 2019; Tassilo Hummel, 'Bayer Can Absorb Roundup Costs of 5 Billion Euros, but Not 20 Billion—Moody's' (*Reuters*, 30 April 2019) <<https://uk.reuters.com/article/uk-bayer-glyphosate-credit-ratings-idUKKCN1S60SU>> accessed 1 May 2019. Dicamba, a potential endocrine disruptor (see L Zhu and others, 'Dicamba Affects Sex Steroid Hormone Level and mRNA Expression of Related Genes in Adult Rare Minnow (*Gobiocypris Rarus*) at Environmentally Relevant Concentrations: Dicamba Affects Sex Steroid Hormone Level and mRNA Expression' (2015) 30 *Environmental Toxicology* 693), has already been banned in several US states such as Arkansas and Missouri, due to crop damage on other fields due to windblown 'drift'. Because of 'drift', farmers without genetically-modified crops resistant to dicamba have seen their plants 'vaporiz[ed]'. Monsanto sued Arkansas in 2017 to stop the ban, but their case was dismissed (see Bryce Gray, 'Missouri and Arkansas Ban Dicamba Herbicide as Complaints Snowball' (*stltoday*, 7 July 2017) <www.stltoday.com/business/local/missouri-and-arkansas-ban-dicamba-herbicide-as-complaints-snowball/article_2f0739e8-1b7f-5759-81b2-d78b7e249bac.html> accessed 27 May 2019).

85 Barry Holtzclaw, 'Gilroy's schools banned Roundup in 2016' (*Gilroy Dispatch*, 4 April 2019) <<https://gilroydispatch.com/2019/04/04/gilroys-schools-banned-roundup-in-2016/>> accessed 27 May 2019; Jonathan Latham, 'University of California System Halts Use of Glyphosate Herbicide' (*Independent Science News*, 17 May 2019) <www.independentsciencenews.org/news/university-of-california-system-halts-use-of-glyphosate-herbicide/> accessed 27 May 2019; 'Dutch Parliament Bans Glyphosate Herbicides for Non-Commercial Use' (*Sustainable Pulse*, 4 April 2014) <<https://sustainablepulse.com/2014/04/04/dutch-parliament-bans-glyphosate-herbicides-non-commercial-use/>> accessed 27 May 2019; Carey Gillam, 'NYC Leaders Join Calls for Ban on Monsanto Herbicide' (*EHN*, 19 April 2019) <www.ehn.org/monsantos-herbicide-defense-falling-on-deaf-ears-as-nyc-leaders-join-calls-for-ban-2634974362.html> accessed 28 May 2019.

EU law. Until our laws incentivise the creation and use of ecologically compatible bio-chemistry instead of ecocidal chemistry, the most vulnerable among us will continue to suffer, and our society will become further dependant on products that undermine health, leaving an indelible trail of injury in the geological record.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the author.