

# Governing Intersystemic Systemic Risks: Lessons from Covid and Climate Change

Veerle Heyvaert\* 

This article argues that contemporary regulation of climate change risks and zoonotic disease risks – two seminal risks of our era – is deficient because it fails to account for the most distinctive characteristics of their risk profiles. These risks are part of a special category of intersystemic systemic risks, which are ‘compound’ in nature: they possess the potential to cascade across different systems and entail a liability to exponential growth across numbers of linked systems. Moreover, climate change and zoonotic disease risks are globalised, ubiquitous and entrenched. Effective governance of intersystemic systemic risks demands proactive regulatory intervention at the early stages of risk creation, and reliance on a more balanced basket of regulatory measures than is currently available. For climate change as well as zoonotic disease risk control, this calls for greater investment in assessment requirements, a less permissive approach to planning and development consent, and a commitment to phase out unsustainable production processes.

Keywords: climate change, covid-19, risk regulation, systemic risk, environmental law, health governance

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## INTRODUCTION

This article argues that existing regulatory regimes fail to control the seminal risks of our era. This is because regulatory decision making overlooks the most distinctive characteristics of today’s key risks, which include climate change and zoonotic disease risks. In order to devise responsive regulatory strategies, regulators need to engage with the reality that zoonotic disease and climate change risks are part of a special category of risks. They are both exemplars of intersystemic systemic risks. What is special about such risks is that they are ‘compound’ in nature; they possess the potential to cascade across different systems and, hence, entail a liability to exponential growth across numbers of linked systems. Moreover, climate change and zoonotic disease risks are globalised, ubiquitous and entrenched risks. Together, this package of characteristics dramatically reduces the likelihood that conventional risk regulatory responses will be successful in managing the risks they target. To govern intersystemic systemic risks effectively, we need more proactive regulatory intervention at the early stages of risk creation, and reliance on a more balanced basket of regulatory

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measures than is currently available. For example, to govern climate change risk, we need to become more selective about which new developments are given the go-ahead at the planning stage, rather than persist with a permissive approach coupled with the assumption that any negative effects of development can be curtailed or offset as and when they transpire.

In putting forward the argument that the special characteristics of zoonotic disease and climate change risks warrant a rethinking of regulatory strategies, this article aims to make two contributions. First, within the discipline of risk regulation the article contributes to burgeoning scholarship on the governance of systemic risks. Understanding of the distinctive characteristics of systemic versus ordinary risks has developed rapidly in the past decade, and risk scholarship reflects a growing awareness that the particular features of systemic risks demand new governance strategies. Insightful recent studies emphasise the need for new risk assessment practices and for proactive systemic risk regulation.<sup>1</sup> However, few contributions to date go beyond general recommendations to analyse in depth how the various attributes of systemic risks affect and alter assumptions about regulatory effectiveness. That is what this article seeks to deliver. Based on a detailed risk profile of climate change and zoonotic disease risks, the article identifies the intersystemic potential of systemic risks as the key game-changer for the design of regulatory responses. It explains why the intersystemic dimension of systemic risks can and should steer regulators towards stronger investment in preventative regulatory strategies. The article makes the argument with respect to climate change and zoonotic disease risks, but the case could equally be made for challenges such as cybersecurity and biodiversity depletion.

Secondly, a recalibration towards early-stage intervention for intersystemic systemic risks requires significant legal and regulatory reform. On this score, the article contributes to the field of environmental and public law as it identifies the potential impact of a preventative re-orientation of climate change and zoonotic disease regulation in areas including environmental impact assessment law, planning law, habitats protection, and industrial permitting provisions.<sup>2</sup>

The article proceeds as follows. The next section develops a risk profile on the basis of the shared features of zoonotic disease and climate change risks, covering, among other aspects, their systemic and intersystemic dimension and their rootedness in globalisation. The third section presents a model for rational

1 See for example K. Lucas, O. Renn and C. Jaeger, 'Systemic Risks: Theory and Mathematical Modeling' (2018) 1 *Advanced Theory and Simulation* 5 and 8; United Nations Office for Disaster Risk Reduction, *Global Assessment Report on Disaster Risk Reduction* (Geneva: United Nations Office for Disaster Risk Reduction, 2019) 170, 292-296; M. Kranke and D. Yarrow, 'The Global Governance of Systemic Risk: How Measurement Practices Tame Macroprudential Politics' (2019) 24 *New Political Economy* 816; O. Renn et al, 'Systemic Risks from Different Perspectives' (2020) *Risk Analysis* 1; A. Haas et al, 'A Proposal for Integrating Theories of Complexity for Better Understanding Global Systemic Risks' (2020) *Risk Analysis* 1; OECD et al., 'Strategies to Govern Systemic Risks in W. Hynes, M. Lees and J. Müller (eds), *Systemic Thinking for Policy Making: The Potential of Systems Analysis for Addressing Global Policy Challenges in the 21st Century* (Paris: OECD Publishing, 2020); P.J. Schweizer, 'Systemic Risks. Concepts and Challenges for Risk Governance' (2021) 24 *Journal of Risk Research* 78.

2 Broader public policy ramifications for industrial and trade policy, too, are considered, but not discussed in detail.

decision making about the timing of regulatory interventions, and the fourth tests this model in the light of the risk profiles of climate change and zoonotic disease. The fifth section reflects on the ramifications of the analysis for legal and regulatory reform, and the final section concludes.

Before proceeding to next section, a few methodological points need to be made about the third section, which constitutes the analytical core of this article. The section starts with a brief overview of the current distribution of regulatory measures in the field of zoonotic disease and climate change risk governance. It then reviews the appropriateness of existing regulatory arrangements with reference to Steven Shavell's 'prevent-act-harm' model – a rationalist 'law and economics' model that assesses the soundness of regulatory decision making against a yardstick of welfare maximisation.<sup>3</sup> Obviously, not everyone will agree that regulatory decision making should be driven by economic welfare maximisation considerations. Indeed, there is a vibrant literature arguing that, empirically, regulators do not make decisions based on a welfare-maximising rationality,<sup>4</sup> and an equally prominent body of work arguing that, normatively, they should not and decision making instead should be steered by alternative considerations, such as ideas and values.<sup>5</sup> Nevertheless, this article opts for a rationalist model on the basis of two key considerations. First, even if the reality of regulatory decision making is much less straightforward than consisting of a succession of economically informed rational choices, the field of regulatory practice in health and environmental policy is still dominated by an ethos of rationality.<sup>6</sup> Regulatory authorities are therefore still more likely to be swayed by rationalist arguments than by alternative justifications for intervention. Since this article argues for a change in regulatory decision making on intersystemic systemic risks and, in particular, for a recalibration towards more preventative action, it is important to do so in the language that is most likely to resonate in regulatory circles. The second consideration is equally pragmatic. One of

3 S. Shavell, 'The Optimal Structure of Law Enforcement' (1993) 36 *Journal of Law & Economics* 255.

4 See for example G.J. Stigler, 'The Theory of Economic Regulation' (1971) 2 *The Bell Journal of Economics and Management Science* 3 (on capture as a driver for regulation); R. Revesz and M.A. Livermore, *Retaking Rationality: How Cost-Benefit Analysis Can Better Protect the Environment and Our Health* (Oxford: OUP, 2008) 163 (on capture of environmental regulators leading to alleged over-regulation); M. Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge, MA: Harvard University Press, 2009); T. Prosser, 'Regulation and Social Solidarity' (2006) 33 *Journal of Law and Society* 364. J.S. Masur and E.A. Posner, 'Unquantified Benefits and the Problem of Regulation under Uncertainty' (2016) 102 *Cornell Law Review* 87.

5 See M. Sagoff, *Price, Principle and the Environment* (Cambridge: Cambridge University Press, 2004); D.A. Moss, 'Reversing the Null: Regulation, Deregulation, and the Power of Ideas' (2010) Harvard Business School BGIE Unit Working Paper No 10-080 at <https://doi.org/10.2139/ssrn.1706952>; D.A. Kysar, *Regulating from Nowhere* (New Haven, CT: Yale University Press, 2010); C. Parker and F. Haines, 'An Ecological Approach to Regulatory Studies' (2018) 45 *Journal of Law and Society* 136; A. Sinden, 'The Problem of Unquantified Benefits' (2019) 49 *Environmental Law* 73.

6 See S. Breyer, *Breaking the Vicious Circle: Toward Effective Risk Regulation* (Cambridge, MA: Harvard University Press, 1993); V. Heyvaert, 'Governing Climate Change: Towards a New Paradigm for Risk Regulation' (2011) 74 *MLR* 817; M. Weimer, 'The Origins of "Risk" as an Idea and the Future of Risk Regulation' (2017) 8 *European Journal of Risk Regulation* 10; K. Harrison, 'Regulatory Excellence and Democratic Accountability' in C. Coglianese (ed), *Achieving Regulatory Excellence* (Washington, DC: Brookings Institution Press, 2017).

the main objections to the deployment of rationalist models for health and, especially, environmental decision making is that their application introduces a range of biases against regulatory intervention. Values such as good health and a thriving environment are not easily expressed in economic terms, and it is a widely held view that this difficulty is much more likely to result in economic assessments *undervaluing* rather than *overvaluing* health and environmental protection.<sup>7</sup> Rationalist models therefore present a ‘hard case’ for the proponents of more proactive regulatory intervention,<sup>8</sup> if the case can be made on rationalist grounds, it should be all the more forceful when alternative considerations are filtered in.

## INTERSYSTEMIC SYSTEMIC RISKS

This article aims to challenge the appropriateness of existing regulatory strategies to manage two major social risks: climate change and zoonotic disease risks. Risk, in the context of this discussion, refers to the likelihood of adverse impacts of choices, activities or developments in society.<sup>9</sup> As a decision-making concept, ‘risk’ assumes the existence of a causal connection between such choices, activities or developments and adverse outcomes, and implies the possibility of intervention to influence outcomes.<sup>10</sup> Climate change risks, in this article, are understood in the garden variety meaning of the term – as adverse environmental and related consequences caused by what the United Nations Framework Convention on Climate Change (UNFCCC)<sup>11</sup> refers to as ‘dangerous anthropogenic climate change’ which is commonly attributed to emissions of greenhouse gases (GHGs), including carbon dioxide (CO<sub>2</sub>), into the atmosphere. The risk of zoonotic diseases, in turn, refers to the risk of a virus in non-human animals mutating through transmission and developing into a virus that causes disease and is contagious among human populations. The discussion in this article focuses on the risk profile of and the development of regulatory responses to that particular risk. The sprawling mass of regulatory measures introduced in the wake of the manifestation of covid-19 as a human disease, such as social distancing requirements, curfews, and requirements to wear a mask in certain public settings – while undeniably equally interesting from a risk regulatory perspective and deserving of their own examination in other work – will receive less attention in this discussion since they effectively target related but different

7 Sagoff, n 5 above; F. Ackerman and L. Heinzerling, ‘Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection’ (2002) 150 *University of Pennsylvania Law Review* 1553.

8 cf the similar approach in Revesz and Livermore, n 4 above, making a cost-benefit-based case for more environmental regulation.

9 cf OECD, *Emerging Risks in the 21<sup>st</sup> Century. An Agenda for Action* (Paris: OECD, 2003) 32; T. Aven and O. Renn, ‘On Risk Defined as an Event where the Outcome is Uncertain’ (2009) 12 *Journal of Risk Research* 1.

10 Heyvaert, n 6 above, 817–818. cf D. Garland, ‘The Rise of Risk’ in R.V. Ericson (ed), *Risk and Morality* (Toronto: University of Toronto Press, 2003) 50.

11 New York, NY (US), 9 May 1992, in force 21 March 1994 at <https://unfccc.int/resource/docs/convkp/conveng.pdf>.

risks from the risks of mutation. To keep the distinction clear, the article uses the term ‘zoonotic disease risks’ rather than ‘covid-19 risks’.

In order effectively to evaluate risk regulation, an essential first step is to obtain a good grip on the nature of the risks under examination. Different risks call for distinctive regulatory responses. For instance, high risks typically warrant more prescriptive regulation than low risks.<sup>12</sup> Risks with a very low likelihood of materialising but a severe impact if they do tend to be managed differently from more frequently occurring risks with relatively smaller-scale impacts (consider, for example, the pronounced differences in the regulation of air versus road safety).<sup>13</sup> Therefore, in order to understand the regulatory challenges posed by climate change and zoonotic disease risks, this section identifies and discusses the most distinctive aspects of their risk profiles. The next paragraphs will show that climate change and zoonotic disease are key exemplars of systemic risks. Moreover, they both display high levels of cross-sectoral spill-over potential, to the extent that they are more appropriately qualified as ‘intersystemic’ systemic risks. Additionally, climate change and zoonotic disease risks are co-products of globalisation, they are ubiquitous, persistent and, to a degree, locked in. As will be discussed in the fourth section of this article, each of these characteristics has important ramifications for the design of regulatory strategies.

## Systemic Risks

In 20<sup>th</sup> century health and safety regulation, risks were conventionally conceptualised as the negative side-effects of enterprise, to be controlled through the pursuit of a sustained regimen of case-by-case risk identification, assessment, and corresponding risk management.<sup>14</sup> This ‘divide and conquer’ approach to risk governance still dominates the design and operationalisation of a broad range of risk regulation regimes;<sup>15</sup> however from the mid-1980s onwards, the realisation grew that certain categories of risk displayed characteristics different from ‘conventional’ risks,<sup>16</sup> which magnified the threat they posed to society and introduced risk governance challenges that transcended the case-by-case managerial level.<sup>17</sup> The term ‘systemic risk’, first featured in a 1984 book by William Cline<sup>18</sup> and popularised in a 2003 OECD study on ‘Emerging Risks

12 For example J. Black and R. Baldwin, ‘When Risk-Based Regulation Aims Low: A strategic framework. Strategies for regulating low risks’ (2012) 6 *Regulation & Governance* 131.

13 Compare, for example, the relative ease with which a driving licence can be obtained (for example <https://www.gov.uk/apply-for-your-full-driving-licence>) with the much more demanding steps for obtaining a piloting licence (<https://www.caa.co.uk/general-aviation/learning-to-fly/>).

14 Heyvaert, n 6 above, 820–821.

15 See for example the prevailing approach to chemicals regulation, as discussed in K. Garnett and G. Van Calster, ‘The Concept of Essential Use: A Novel Approach to Regulating Chemicals in the European Union’ (2021) 10 *Transnational Environmental Law* 159, 164–166.

16 Renn et al, n 1 above, 1–2.

17 Lucas, Renn and Jaeger, n 1 above, 2.

18 W.R. Cline, *International Debt. Systemic Risk and Policy Response* (Washington, DC: Institute for International Economics, London: MIT distributor, 1984).

in the 21<sup>st</sup> Century’,<sup>19</sup> was coined to describe risks which pose threats ‘beyond localised harm’<sup>20</sup> and instead jeopardise ‘the critical functions of society’s well being’.<sup>21</sup> Systemic risks have the capacity to trigger impacts that cascade and replicate through a system – which term encompasses a variety of networked structures, from ecosystems and financial systems to public health, transport or the cybersphere – and thus cause a breakdown of the system as a whole, rather than of individual components.<sup>22</sup> The 2008 global financial crisis offered a brutal illustration of the potentially catastrophic force of systemic risks as unsustainable debt and insolvency ricocheted through the global financial system, threatening the stability and even sovereignty of nations and triggering a world-wide economic recession. Evidently, regulatory provisions in force at the time had been incapable of averting large-scale, cross-sectoral harm to society.<sup>23</sup>

There is no exhaustive consensus on what precisely explains the difference in magnitude between conventional and systemic risks, but the following shared attributes of systemic risks are frequently emphasised in the literature. Systemic risks, it is said, typically emerge in a context of elevated complexity, uncertainty with regard to both causation and impact, and ambiguity.<sup>24</sup> Thus, systemic risks are associated with scenarios where risks are interdependent and interconnected at a cross-sectoral scale; where cause-effect relationships are non-linear and may involve poorly understood ‘tipping points’; where the distribution of negative impacts is unpredictable; and where agreement about the interpretation of available risk information is lacking.<sup>25</sup>

Considering the attributes and consequences associated with systemic risks, there is a powerful case to include climate change risks and zoonotic disease risks within this classification. Indeed, many of the seminal writings on the subject use both as textbook examples of systemic risks.<sup>26</sup> Climate change threatens the well-being of society at a level far beyond the individual, now and for future generations. Climate change risks also display the very cascading and self-replicating characteristics associated with systemic risks: the field of climate change is dotted with ‘tipping points’ – major adverse climatological consequences which in turn propel further climate catastrophes, such as the thawing of permafrost which will release trapped methane and thus exacerbate global heating.<sup>27</sup> The pervasively disruptive impact of zoonotic

19 OECD, n 9 above.

20 Renn et al, n 1 above, 2.

21 *ibid.*

22 G.G. Kaufman and K.E. Scott, ‘What Is Systemic Risk, and Do Bank Regulators Retard or Contribute to It?’ (2003) 7 *The Independent Review* 371, 371.

23 cf Haas et al, n 1 above, 4.

24 O. Renn, ‘New Challenges for Risk Analysis: Systemic Risks’ (2021) 24 *Journal of Risk Research* 127, 128–129.

25 cf C.M.L. Wong, ‘Temporality and Systemic Risk: The Case of Green Bonds’ (2021) 24 *Journal of Risk Research* 110, 111.

26 See for example OECD, n 9 above; Renn et al, n 1 above; I. Goldin and M. Mariathasan, *The Butterfly Defect. How Globalization Creates Systemic Risks, and What to Do About It* (Princeton, NJ: Princeton University Press, 2014); O. Renn, K. Lucas, A. Haas and C. Jaeger, ‘Things are Different Today: the Challenge of Global Systemic Risks’ (2019) 22 *Journal of Risk Research* 401, 402.

27 W. Steffen et al, ‘Trajectories of the Earth System in the Anthropocene’ (2018) 115 *Proceedings of the National Academy of Sciences* 8252.

disease risks, in turn, has become a cold hard reality for the world population in the past two years, and zoonotic disease risks, too, are prone to triggering a domino effect. The systemic risk dimension of covid-19, for instance, resonates in the UK government's lockdown mantra of late March 2020 and January 2021, which exhorted the public to 'stay home, protect the NHS, save lives'. Covid-19 is not only a risk to individuals' health; it jeopardises the public health system itself. Moreover, both the fields of climate change and zoonotic disease risk research exhibit the tell-tale attributes associated with the presence of systemic risk as they operate in a context of high complexity, uncertainty, and ambiguity.

Understanding the systemic quality of the risks associated with climate change and zoonotic disease is a vital step towards the development of effective risk governance but, this article argues, the work does not stop here. As systemic risks, both climate change and zoonotic disease risks share a number of particular features which need to be considered carefully in regulatory decision making. First, it is important to highlight complexity as a particularly prominent attribute of climate change and zoonotic disease risks. The transformative impact of globalisation, too, needs to be considered in this context. Thirdly, the fields of both climate change and zoonotic disease studies unquestionably contend with uncertainty, but the nature of this uncertainty is evolving and this, too, needs to be factored into the design of regulatory responses. Finally, in devising regulatory responses to climate change and zoonotic disease risks, it is important to appreciate that these risks are, to a degree, entrenched – the manifestation of certain adverse impacts can no longer be averted. The following paragraphs further explain each of these key features.

### **Intersystemic systemic risks**

The complexity dimension of systemic risks refers to their capacity to trigger further, cascading risks within but also beyond the original risk context.<sup>28</sup> Both zoonotic disease and climate change risks operate under intense complexity conditions and come with major threats of spilling over and triggering additional – and potentially equally systemic – risks in other social systems. We need only remind ourselves of the dramatic drops in GDP and radically altered growth predictions posted across the world in the past year<sup>29</sup> to appreciate that zoonotic disease risks threaten the economic as well as the physical health of nations.<sup>30</sup> Moreover, covid-19 could itself be understood as a systemic risk to the human environment that was fuelled by the manifestation of systemic risks to ecosystems in the form of accelerated habitats loss, biodiversity depletion

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28 Schweizer, n 1 above, 79–81.

29 See for example ONS data in the UK at <https://www.ons.gov.uk/economy/grossdomesticproductgdp/articles/coronavirusandtheimpactonoutputintheukeconomy/november2020>.

30 Goldin and Mariathan, n 26 above, 146–147. See <https://www.worldbank.org/en/news/press-release/2020/06/08/covid-19-to-plunge-global-economy-into-worst-recession-since-world-war-ii>.

and their attendant threats to global animal health.<sup>31</sup> In the same vein, climate change risks cascade within and across systems. Global heating threatens to set off accelerating cycles of biodiversity depletion, as changes in climatological conditions outpace the rate at which ecosystems can adapt to new conditions.<sup>32</sup> Beyond the environmental sphere, there is a growing awareness within financial and investment circles of the threats posed by major climatological catastrophes to the stability and viability of the global financial system.<sup>33</sup>

In sum, climate change and zoonotic disease risks are not ‘merely’ systemic; they have a wide cross-sectoral reach and are therefore arguably more aptly described as *intersystemic systemic risks*. This term better reflects the essence of the risk profiles of climate change and zoonotic disease risk and, importantly, it draws our attention to the dimensions of climate change and zoonotic disease risks that should have a determinative impact on the choice of regulatory responses.

### Globalisation risks

Zoonotic disease risks and climate change risks are both textbook examples of transboundary risks. These are risks which materialise within one jurisdiction and have negative consequences beyond borders, as in the example of sulphur dioxide emissions from British factories causing acid rain and deforestation in Norway throughout the 1970s and 1980s.<sup>34</sup> The key point about transboundary risks is that the regions that are negatively impacted depend at least partially on cooperation by the risk creator in order effectively to control the risk.<sup>35</sup> In the case of climate change, this dynamic is most starkly documented in the plight of small-island states such as Tuvalu and Vanuatu, which find themselves at existential risk of disappearance yet powerless to respond without a dramatic surge in commitment on the part of high-emitting countries across the globe.<sup>36</sup> With respect to zoonotic diseases, too, risks emerging within one jurisdiction jeopardise the safety of surrounding countries, and the level of risk to which the latter are exposed will be heavily influenced by the willingness and capacity of the source country to share information, to control the risk internally and to cooperate in the implementation of transnational containment measures.<sup>37</sup>

31 N. De Sadeleer and J. Godfroid, ‘The Story behind COVID-19: Animal Diseases at the Crossroads of Wildlife, Livestock and Human Health’ (2020) 11 *European Journal of Risk Regulation* 210.

32 J. Verschuuren, ‘Regime Interlinkages: Examining the Connections Between Transnational Climate Change and Biodiversity Law’ in V. Heyvaert and L.-A. Duvic-Paoli (eds), *Research Handbook on Transnational Environmental Law* (Cheltenham: Edward Elgar, 2021) 178.

33 G. Steele, ‘Confronting the ‘Climate Lehman Moment’: The Case for Macroprudential Climate Regulation’ (2020) 30 *Cornell Journal of Law & Public Policy* 109, 129.

34 A.A. Fraenkel, ‘The Convention on Long-Range Transboundary Air Pollution: Meeting the Challenge of International Cooperation’ (1989) 30 *Harvard International Law Journal* 452.

35 V. Heyvaert, *Transnational Environmental Regulation and Governance. Purpose, Strategies and Principles* (Cambridge: Cambridge University Press, 2019) 55–57.

36 J.M. Schultz, J.P. Kossin, C. Ettman, P.L. Kinney and S. Galea, ‘The 2017 Perfect Storm Season, Climate Change and Environmental Injustice’ (2018) 2 *The Lancet* E370–E371.

37 Goldin and Mariathan, n 26 above, 148–150, 161.



Yet the transboundary dimension of zoonotic disease and climate change risks goes beyond the border-crossing potential of adverse impacts. Indeed, the globalisation of production, supply chains, and trade constitute key factors in the very gestation and intensification of risks which, then, spill over across national boundaries.<sup>38</sup> The inherently transgressive character of risks resonates in the term ‘alien invasive species’ (AIS), which are a major trigger for the emergence and spread of zoonotic diseases.<sup>39</sup> AIS are species which have migrated from native regions into new and unfamiliar habitats. Their introduction is typically the result of intensified international trade in plants and animals, and of accelerated habitat encroachment and depletion caused by extensive land development for the purposes of agricultural and industrial exploitation which, in turn, tends to be fuelled by the intensification of global capital and investment flows.<sup>40</sup> AIS can threaten the biodiversity of the host environment, for example, by outcompeting local species for space and food, and by introducing new diseases into an environment which has not built up any resilience against them.<sup>41</sup> These are conditions that lend themselves supremely to the emergence of zoonosis.<sup>42</sup> The entwinement of globalisation and zoonotic disease risks is put into further relief when we consider a second major hearth of zoonotic disease, namely, high-intensity cattle farming and, particularly, poultry farming.<sup>43</sup> China is currently responsible for nearly 30 per cent of the world’s meat production, which inescapably implies large-scale reliance on intensive (and, from an animal welfare perspective, apocalyptic) production methods and the daily transport of staggering volumes of livestock and animal products across the globe.<sup>44</sup> The animal population density within agri-industrial and mass transport settings is conducive to the acceleration of infection cycles, which exponentially multiplies the risk of mutation and is a key factor in the transformation of initially mild viruses into much harder, and much more dangerous variants.<sup>45</sup>

The relationship between climate change risks and globalisation is somewhat less straightforward, as certain strands of the literature qualify globalisation as actually or potentially helpful in curbing climate change.<sup>46</sup> Such writings emphasise, for example, foreign investment in renewable energy, or the broader availability of more energy-efficient technologies, products and services

38 *ibid.* 9–33 and *passim*.

39 E. Chinchio et al, ‘Invasive alien species and disease risk: An open challenge in public and animal health’ (2020) 16 *PLoS Pathog* e1008922.

40 Goldin and Mariathan, n 30 above, 147.

41 C. Bellard, P. Cassey and T.M. Blackburn, ‘Alien species as a driver of recent extinctions’ (2016) 12 *Biology Letters* 1.

42 *ibid.*

43 R. Cromie et al, ‘Responding to Emerging Challenges: Multilateral Environmental Agreements and Highly Pathogenic Avian Influenza H5N1’ (2011) 14 *Journal of International Wildlife Law and Policy* 206, 208.

44 S. Barber, ‘Nonhuman Animal Welfare in China: Evolving Rhetorical Strategies for Changing Law and Policy’ (2015) *Journal of International Wildlife Law and Policy* 309, 314.

45 Cromie et al, n 43 above, 208.

46 W. Antweiler, B.R. Copeland and M. Scott Taylor, ‘Is Free Trade Good for the Environment?’ (2001) 91 *American Economic Review* 877; A. Dua and D.C. Esty, *Sustaining the Asia Pacific Miracle: Environmental Protection and Economic Integration* (Washington, DC: Peterson Institute, 1997).

facilitated by international trade.<sup>47</sup> On balance, however, we are more likely to find globalisation associated with an increased risk of climate change, furthered by developments such as a countervailing and much more prominent trend of foreign investment in fossil fuels and fossil fuel-dependent sectors, rising transport-related GHG emissions, and the potential for carbon leakage.<sup>48</sup> In any event, whether the relation is portrayed as positive or negative, it is difficult to find authors who deny the existence of strong co-productive dynamics in the relationship between globalisation and climate change. Hence, like zoonotic disease risks, climate change risks can be qualified as ‘globalisation risks’.

### **Evolving uncertainty: climate change and covid-19 as fading swans**

Uncertainty is widely viewed as a core attribute of systemic risks and is, indeed, frequently associated with both climate change and zoonotic disease risks.<sup>49</sup> However, as with complexity, in order to understand the relevance of this attribute for the design of appropriate risk governance we need to go beyond referring to uncertainty in generic terms and instead consider its scope, dimensions and dynamics at a more granular level within the climate change and zoonotic disease risk context.

Uncertainty may, in first instance, refer to uncertainty about causal relationships between exposures and effects – say, uncertainty about whether non-ionizing radiation from electric cables causes leukaemia in children,<sup>50</sup> or whether dioxin particles cause disease in cattle.<sup>51</sup> With reference to climate change, cause-effect uncertainty would concern either the impact of anthropogenic GHG emissions on global temperatures, or the relation between global heating and negative environmental impacts, ranging from desertification and coastal erosion to biodiversity depletion and extreme weather intensification. Although this type of uncertainty was a major factor in the climate change debate up to the early ‘90s, and is still being kept alive in persistent pockets of climate denialism, mountains of peer-reviewed scientific analysis and successive generations of ever more wide-ranging and detailed reports of the Intergovernmental Panel on Climate Change make unequivocally clear that there is *no* uncertainty about the connection between GHG emissions and global heating.<sup>52</sup> By the same token, our understanding of both the range

47 For example M. Koengkan, Y.E. Poveda and J.A. Fuinhas, ‘Globalisation as a motor of renewable energy development in Latin America countries’ (2020) 85 *GeoJournal* 1591.

48 See for example M. Bu, C.-T. Lin and B. Zhang, ‘Globalization and Climate Change: New Empirical Panel Data Evidence’ (2016) 30 *Journal of Economic Surveys* 577; Goldin and Mariathan, n 26 above, 129, 133–137; Rainforest Alliance Network, *Banking on Climate Chaos. Fossil Fuel Finance Report 2021* March 2021 at <https://www.ran.org/wp-content/uploads/2021/03/Banking-on-Climate-Chaos-2021.pdf>.

49 Renn et al, n 1 above, 3.

50 *R v Secretary of State for Trade and Industry Ex P Duddridge* [1995] 10WLUK 71.

51 *Graham and Graham v ReChem International Ltd* [1996] Env LR 158.

52 IPCC Fifth Assessment (AR5) report, ‘Climate Change 2013: The Physical Science Basis, Summary for Policy Makers (SPM)’ at <https://www.ipcc.ch/site/assets/uploads/2018/03/>

and scale of impacts of global heating has become exponentially more detailed and robust to the point where the manifestation of global catastrophic impacts under business-as-usual scenarios can no longer legitimately be considered open to question.<sup>53</sup> In a similar vein, knowledge about the drivers of zoonosis is robust – there is very little contestation about connections between man-made interferences in natural habitats, AIS, and intensive animal farming on the one hand, and the manifestation of zoonotic diseases on the other.<sup>54</sup>

A second dimension of uncertainty relates to incomplete knowledge about the anticipated frequency, scale and severity of adverse impacts.<sup>55</sup> This type of uncertainty, which could be labelled ‘impact’ or ‘intensity uncertainty’, is often associated with ‘grey swans’ – risks that are somewhat more plausible than completely unpredictable ‘freak accidents’, but that materialise too rarely or irregularly to afford probabilistic assessment.<sup>56</sup> Grey swans are framed in a narrative of exceptionalism – they fall between routine, and routinely managed, risks and those which cannot, and therefore should not, be countenanced. This position easily puts them at risk of being overlooked and under-managed. The subprime mortgage market collapse which triggered the 2008 global financial crisis was said to be a grey swan, although questions have since been raised whether, in an attempt to exculpate itself, the financial sector had not overplayed the unexpectedness of the harm.<sup>57</sup>

Climate change impacts and zoonotic diseases, too, are regularly portrayed as grey swans: as theoretically conceivable yet practically unforeseeable calamities that transpire through an exceptional confluence of circumstance and coincidence.<sup>58</sup> Covid-19 seemingly hurled itself into our lives, an unforeseeable bombshell laying waste to all plans and aspirations that typically herald the dawn of a new decade. Mere months before, we looked in horror as, suddenly, large swathes of western Australia were engulfed in flames, and we remembered experiencing similar horror at the sight of devastating fires ripping through the Amazon the year before.

The exceptional, unforeseeable character of climate change disruption and zoonotic disease spread chimes with our lived experience of sudden and deeply disruptive events. The exceptionalism bias in our risk perception is further fuelled by media accounts, which tend to emphasise the rare and unusual, ‘bat-crossed-with-a-pangolin’ reporting angles over the more mundane.<sup>59</sup> Yet

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WG1AR5\_SummaryVolume\_FINAL.pdf; Working Group I Contribution to the Sixth Assessment Report (2021) at <https://www.ipcc.ch/report/ar6/wg1/#SPM>.

53 *ibid.*

54 S. Morse et al, ‘Prediction and Prevention of the Next Pandemic Zoonosis’ (2012) 380 *The Lancet* 1956, 1957.

55 cf Renn et al, n 1 above, 4.

56 S. Dow, ‘Uncertainty: A Diagrammatic Treatment’ (2016) 10 *Economics* 1, 9.

57 *ibid.*, 17–18. For critiques voiced, see for example W. Hutton, ‘Now we know the truth. The financial meltdown wasn’t a mistake – it was a con’ *The Guardian* 19 April 2010 at <https://www.theguardian.com/business/2010/apr/18/goldman-sachs-regulators-civil-charges>.

58 E. Colombo, ‘From Bushfires to Misfires: Climate-related Financial Risk after *McVeigh v. Retail Employees Superannuation Trust*’ (2021) *Transnational Environmental Law* 1. <https://doi.org/10.1017/S204710252100025X>

59 D. Ropeik, ‘Understanding factors of risk perception’ (2002) 56 *Nieman Reports; Cambridge* 52.

perceptions can be deceiving and, arguably, the exceptionalist lenses through which we view climate change casualties, epidemics and pandemics warp rather than inform our understanding of the risks. For example, on the issue of climate change, it is increasingly a stretch to present extreme weather events as exceptional. Instead, intense, prolonged heatwaves have become a staple of European continental summer months.<sup>60</sup> Climate change has predictably intensified hurricanes, and thereby routinised the occurrence of high-impact extreme weather incidents.<sup>61</sup> Large-scale, uncontrollable forest fires roar through California with sobering regularity. The case may seem less obvious for zoonotic disease risks, however the most cursory glance at the scientific data and commentary reveals that the genuinely unexpected aspect of the covid-19 pandemic was that an incident of this scale did not happen sooner. Within the past ten years, the world has received repeated warnings of the risk of a global pandemic, as highly contagious diseases such as H1N1 (swine flu), ebola, H7N9 (avian flu), and nipah achieved epidemic or even pandemic status. This is only the tip of the iceberg: the World Health Organization archive on zoonotic disease outbreaks records a minimum of 59 and a maximum of 204 zoonotic disease outbreaks for every one of the past 25 years.<sup>62</sup>

The upshot is that, even if it remains prohibitively difficult to predict the timing, location and scale of *particular* climate impacts, or *singular* instances of viral mutation, we do have a rapidly growing body of knowledge about the *overall* frequency and intensity of adverse events.<sup>63</sup> This has at least two major ramifications. First, it calls into question the continued appropriateness of perceiving climate change and zoonotic disease risks as grey swans – given their ubiquity and persistence in the past two decades, their plumage has well and truly faded. Secondly, it means the gravitational point of uncertainty surrounding both climate change and zoonotic disease is shifting from ‘if’ to ‘when and where’; from uncertainty about the overall impact of risk towards uncertainty regarding precisely when and where these adverse events will take place (‘distribution uncertainty’). This is important to bear in mind because, as will be argued below, different dimensions of uncertainty demand different regulatory responses.

60 F. Ma, X. Yuan, Y. Jiao and P. Ji, ‘Unprecedented Europe Heat in June– July 2019: Risk in the Historical and Future Context’ (2020) 47 *Geophysical Research Letters*.

61 cf Steele, n 33 above, 121.

62 1196 – 115; 1997 – 77; 1998 – 92; 1999 – 88; 2000 – 118; 2001 – 112; 2002 – 105; 2003 – 190; 2004 – 117; 2005 – 162; 2006 – 138; 2007 – 115; 2008 – 72; 2009 – 152; 2010 – 92; 2011 – 59; 2012 – 86; 2013 – 128; 2014 – 204; 2015 – 156; 2016 – 144; 2017 – 98; 2018 – 91; 2019 – 109; 2020 – 72. Data available via <https://www.who.int/data/collections>.

63 cf P. Sonali and D. Nagesh Kumar, ‘Review of Recent Advances in Climate Change Detection and Attribution Studies: a Large-scale Hydroclimatological Perspective’ (2020) 11 *Journal of Water and Climate Change* 1.

## Locked-in risks

A final shared tenet of the risk profile of both zoonotic disease and climate change risks is that a certain quantum of adverse impact is already inescapable. Even if all high-emitting countries massively ramped up their GHG emissions reduction plans and set the world on an accelerated course towards net-zero before the 2050 target date implied in Article 4(1) of the Paris Agreement,<sup>64</sup> over half a degree Celsius of anthropogenic global heating would continue due to past GHG emissions.<sup>65</sup> The risk is locked in. This phenomenon is less well-known with regard to zoonotic disease risks, but it is equally real. As documented by Peter Daszak, president of the EcoHealth Alliance for the analysis and prevention of pandemics, to date 111 viral families have been discovered, of which 25 families are known to contain viruses with zoonotic potential. The 25 comprise an estimated 1.67 million viruses that exist in mammals and birds, with a number ranging between 630,000 and 827,000 estimated to have the capacity to infect humans.<sup>66</sup> Given the numbers involved, it is apparently wholly implausible that non-human to human cross-contamination will be avoidable in all cases; a degree of zoonotic disease risk is already locked into current global virome conditions.

## WHEN TO INTERVENE

There is near-universal agreement that major social risks such as zoonotic disease and climate change risks need to be governed, and that regulation has a vital role to play in risk governance.<sup>67</sup> This realisation inescapably triggers a need to identify the most appropriate, most effective regulation strategies. Doing so is of paramount importance because regulation is a valuable and scarce resource which should be developed and applied judiciously, a caution which holds true regardless of whether it is addressed to small government enthusiasts or proponents of an expansive welfare state.

Regulatory strategy demands extensive decision making on issues ranging from regulatory instrument choice (including the familiar debate on the relative pros and cons of so-called ‘traditional command-and-control regulation’ and of incentive-based alternatives such as emissions trading regimes and carbon taxes)<sup>68</sup> to deterrence versus compliance-focused enforcement. Within this

64 Paris Agreement, Art 4(1): ‘1. In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century ...’

65 R.A. Kerr, ‘How Urgent Is Climate Change?’ (2007) 318 *Science* 1230.

66 D. Carroll, P. Daszak et al., ‘The Global Virome Project. Expanded Viral Discovery Can Improve Mitigation’ (2018) 357 *Science* 872.

67 See for example N. Stern, *The Stern Review: The Economics of Climate Change* (Cambridge: Cambridge University Press, 2007) 349.

68 For example B. Ackerman and R. Stewart, ‘Reforming Environmental Law’ (1985) 37 *Stanford Law Review* 1333; P. Grabosky, ‘Regulation by reward: on the use of incentives as regulatory

discussion, one important set of questions revolves around the best timing for regulatory interventions. Timing-related questions span from determining the most opportune moment to introduce regulatory requirements<sup>69</sup> (for example, if a decision has been made to double the price of disposable plastic bags, at what point should it be introduced?) to deciding whether to regulate early or late in innovation cycles.<sup>70</sup> Alternatively, timing questions may ask towards which point in the life cycle of social risks regulators should direct their attention; whether they should seek to stop risks from emerging in the first place, or instead focus on controlling the negative impacts of extant risks. It is this dimension of ‘when to intervene’ that forms the focus of this article.

### Interventions along the risk gestation chain

Which stage or stages along the chain of decision-making and production processes in which significant risks are co-produced, should regulatory measures target? There is an enormous variety of options available, as exemplified in both the cases of zoonotic disease and climate change risks.

One pathway towards controlling the risk of zoonotic diseases, is to adopt regulatory interventions that aim to prevent viruses crossing and mutating between animal species. Such interventions could be scheduled at the stage of decision making about the future use and development of land. Considering the close correlation between habitat encroachment and disruption on the one hand, and viral mutations on the other, the likelihood of development enhancing zoonotic risk could be a required consideration in planning consent applications. Alternatively, zoonotic disease prevention measures could be incorporated into sectoral regimes, such as nature conservation regulation. For example, as reported in Farnese,<sup>71</sup> Article 3.4 of the Bonn Convention on Migratory Species of Wild Animals requires its signatory states:

b) to prevent, remove, compensate for or minimize, as appropriate, the adverse effects of activities or obstacles that seriously impede or prevent the migration of the

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instruments’ (1996) 17 *Law & Policy* 257; R. Baldwin ‘Regulation Lite: The Rise of Emissions Trading’ (2008) 2 *Regulation & Governance* 193; N. Gunningham, ‘Environment law, Regulation and Governance: Shifting Architectures’ (2009) 21 *Journal of Environmental Law* 179; A. Bowen and S. Fankhauser, ‘Good Practice in Low-carbon policy’ in A. Averchenkova, S. Fankhauser and M. Nachmany, *Trends in Climate Change Legislation* (Cheltenham: Edward Elgar, 2017) 123; A.D. Ellerman, C. Marcantonini and A. Zaklan, ‘The European Union Emissions Trading System: Ten Years and Counting’ (2016) 10 *Review of Environmental Economics and Policy* 89.

69 See for example F. Parisi, V. Fon and N. Ghei, ‘The Value of Waiting in Lawmaking’ (2004) 18 *European Journal of Law & Economics* 131; J.E. Gersen and E.A. Posner, ‘Timing Rules and Legal Institutions’ (2007) 121 *Harvard Law Review* 544; B. Luppi and F. Parisi, ‘Optimal Timing of Legal Intervention. The Role of Timing Rules’ (2009) 122 *Harvard Law Review Forum* 18; J.E. Gersen and A. Joseph O’Connell, ‘Hiding in Plain Sight. Timing and Transparency in the Administrative State’ (2009) 76 *The University of Chicago Law Review* 1157.

70 N. Cortez, ‘Regulating Disruptive Innovation’ (2014) 29 *Berkeley Technology Law Journal* 175; H. Armstrong and J. Rae, ‘A Working Model for Anticipatory Regulation’ NESTA, 2017 at [https://media.nesta.org.uk/documents/working\\_model\\_for\\_anticipatory\\_regulation\\_0.pdf](https://media.nesta.org.uk/documents/working_model_for_anticipatory_regulation_0.pdf).

71 P.L. Farnese, ‘The Prevention Imperative: International Health and Environmental Governance Responses to Emerging Zoonotic Diseases’ (2014) 3 *Transnational Environmental Law* 285, 300.

species; and c) to the extent feasible and appropriate, *to prevent*, reduce or control factors that are endangering or are likely to further endanger the species, *including strictly controlling the introduction of*, or controlling or eliminating, already introduced exotic species.

The risks of disease transmission and mutation among intensely farmed cattle and poultry, in turn, could be managed in farming and animal welfare regulation, the latter of which tends to be overwhelmingly focused on animal husbandry rather than wildlife. Most obviously, we can conceive of minimum living space requirements and regular health checks for animals to reduce the risk of accelerating viral spread through farmed populations.

Further along the risk gestation chain, regulatory interventions could seek to manage the risk of zoonotic disease outbreaks at the stages of commercialisation, transport and trade. Hunting and poaching restrictions, for example, do little to reduce the risk that viruses migrate between non-human species, but may reduce the risk that, one step further down the chain, zoonosis materialises. As to trade regulation, we find an example in Article XX(b) of the General Agreement on Tariffs and Trade which allows WTO member countries to restrict trade where necessary to ‘protect human, animal or plant life or health’. This provision was designed with the risks of AIS and zoonotic diseases in mind and could constitute the basis for the adoption of zoonotic risk control measures. European Union Council Regulation 1/2005 offers an example of transport regulation with relevance for zoonotic disease risk control, as it sets minimum standards for the welfare of animals during transport, which include measures aimed to protect transported animals from disease.<sup>72</sup>

Finally, towards the end of the risk gestation chain, we find a variety of regulatory interventions that react to rather than prevent disease. These range from animal disease control measures, such as culling regulation,<sup>73</sup> to food hygiene standards<sup>74</sup> and, ultimately, human disease control measures, including the wealth of regulatory restrictions which have been issued since the spread of covid-19.<sup>75</sup> In most jurisdictions, the greatest density of zoonotic risk control

72 See also Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Art VIII(3): ‘The Parties shall ensure ... that all living specimens, during any period of transit, holding or shipment, are properly cared for so as to minimize the risk of injury, damage to health or cruel treatment’.

73 cf P. Farnese, ‘Will Nonhuman Rights Decrease Human Vulnerability to Zoonotic Diseases?’ (2015) 18 *Journal of International Wildlife Law and Policy* 199, 215, giving the example of Canadian animal health regulation according to which, when ‘a disease such as [avian influenza] is found, all animals at the “infected place” [must] be culled, regardless of whether the animal has contracted the disease or been known to have come in contact with an infected animal’. See also the Terrestrial Animal Health Code (TAHC) of the World Organization for Animal Health (OIE) which prescribes a ‘stamping out’ policy, which involves: ‘the killing of the animals which are affected and those suspected of being affected in the herd and, where appropriate, those in other herds which have been exposed to infection by direct animal to animal contact, or by indirect contact of a kind likely to cause the transmission of the causal pathogen’.

74 For example Regulation (EC) No 178/2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety (Arts 14, 15) and Regulation (EC) No 853/2004 of 29 April 2004 laying down specific hygiene rules for the hygiene of foodstuffs.

75 See for example the UK Coronavirus Act 2020 and The Health Protection (Coronavirus, International Travel) (England) Regulations 2020 (S.I. 2020/568); The Health

measures is located here, at the very end of the risk gestation chain. There is a comparatively thinner layer of regulatory provisions that targets the middle stages of commercialisation and transport of animal products. Restrictions that intervene at the start of the risk gestation chain, such as limitations on land use and habitats protection for the sake of zoonotic risk control, are positively scarce.

The sprawling field of climate change regulation, too, contains measures occurring along different stages of the risk gestation chain. Some provisions enable regulatory intervention at an early stage. For example, requirements to consider climate change in the context of environmental impact assessment (EIA) and planning decisions which mandate that climate change considerations must be taken into account prior to development consent, may result in a particular development being modified or pre-empted. Hence, the risk that the ensuing development causes increased GHG emissions is suppressed.<sup>76</sup> Regulation for the promotion and use of renewable energy, too, is an early-stage intervention as it seeks to displace and prevent our very reliance on the carbon-intensive processes that contribute to climate change risks.<sup>77</sup> Conceivably, regulation also could be introduced to restrict the volume of carbon-intensive processes (for instance, aviation) or products (say, laundry machines) that may be generated, although examples of such measures remain extremely rare.

Most prominent in the area of climate change regulation are undoubtedly those regulatory conditions that operate one step further down the risk gestation chain and govern the actual emission of GHGs. They include emissions trading regimes, (industrial) maximum emission standards and (commercial) emission intensity levels, and carbon taxes. Finally, there are those climate change regulatory interventions which respond to the emission of GHGs *ex-post*. These include requirements for the creation, enhancement and maintenance of carbon sinks, or the introduction of carbon capture and storage technology, and the rapidly growing range of climate change resilience-building and adaptation requirements.

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Protection (Coronavirus, Restrictions) (No 3) (England) Regulations 2020 (S.I. 2020/750); The Health Protection (Coronavirus, Wearing of Face Coverings in a Relevant Place) (England) Regulations 2020 (S.I. 2020/791); The Health Protection (Coronavirus, Collection of Contact Details etc. and Related Requirements) Regulations 2020 (S.I. 2020/1005); The Health Protection (Coronavirus, Restrictions) (Self-Isolation) (England) Regulations 2020 (S.I. 2020/1045); The Health Protection (Coronavirus, Restrictions) (Local Authority Enforcement Powers) (England) Regulations 2020 (S.I. 2020/1375).

76 See for example the UK Town and Country Planning Environmental Impact Regulations (2017), Sched 4(5)(f).

77 For example the EU Renewable Energy Directive (EU) 2018/2001 establishes a binding EU target of at least 32 per cent for 2030. In accordance with the newly adopted European Climate Law, this target may be revised upwards to 40 per cent, as foreseen in the 2021 Commission proposal for a Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 COM(2021) 557 final. See also Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (European Climate Law) [2021] OJ L243/1.



## Prevent-act-harm

A strong line in regulation scholarship promotes the view that the effective governance of situations which display a high degree of complexity and dynamism – two qualities which indubitably apply to zoonotic disease and climate change risks – is more easily secured by pursuing a combination of regulatory approaches than by relying on a single strategy.<sup>78</sup> Given the variety in both zoonotic disease and climate change risk regulation, this is a reassuring message, however, it does not obviate the need carefully to examine the balance between different regulatory strategies and evaluate its likely effectiveness. Indeed, as illustrated above, a general overview of the range of existing zoonotic disease control measures affirms that the lion's share of measures is concentrated towards the end of the risk gestation chain, and consists of interventions that seek to intercept risk transmission at the point of, or after, non-human-to-human contagion. In the case of climate change, in turn, the bulk of regulatory interventions is situated in the middle of the risk gestation chain, between *ex-ante* emissions prevention and *ex-post* adaptation. The question therefore presents itself whether, in either scenario, the distribution of risk regulatory interventions presents the most effective balance, in particular in the light of the various risk characteristics that zoonotic disease and climate change risks display.

In order to assess the appropriateness of the balance between regulatory interventions to address, respectively, zoonotic disease and climate change risks, this article takes inspiration from Steven Shavell's influential 'prevent-act-harm' model. In 'The Optimal Structure of Law Enforcement',<sup>79</sup> Shavell distinguishes between mandatory interventions that effectively police risk taking (or, in his terminology, that prevent the manifestation of 'undesirable' or 'dangerous' acts); interventions that police the dangerous act itself; and interventions that police harmful acts. The difference between danger and harm, here, is the difference between potentiality and actuality – shooting a gun is a dangerous act; shooting and hitting someone is a harmful act. Correspondingly, a preventative intervention in this example would be a restriction on the purchase of guns; an act-based intervention would be a prohibition on firing guns; and a harm-based intervention a punishment for hitting people (or other targets) with gunshots. It should be acknowledged that, in drawing up this model, Shavell was not primarily pre-occupied with the choice between different forms of regulatory intervention. Instead, his argument was more broadly pitched and aimed to calibrate the balance between regulation, civil liability and criminal liability, whereby preventative action was most strongly associated with rules and regulations (for example gun control laws), act-based interventions with criminal liability (reckless endangerment), and harm-based actions with criminal and civil liability (tort).

78 N. Gunningham, P. Grabosky and D. Sinclair, *Smart Regulation. Designing Environmental Policy* (Oxford: OUP, 1998); J. Braithwaite, 'Rules and Principles: A Theory of Legal Certainty' (2002) at <https://doi.org/10.2139/ssrn.329400>; N. Gunningham and D. Sinclair, 'Regulatory Pluralism: Designing Policy Mixes for Environmental Protection' (1999) 21 *Law & Policy* 49; J. van Erp, M. Faure, A. Nollkaemper and N. Philipsen (eds), *Smart Mixes for Transboundary Environmental Harm* (Cambridge: Cambridge University Press, 2019); Steele, n 33 above, 139.

79 Shavell, n 3 above.

However, within the narrower zone of regulation itself, it is also possible to distinguish measures that are more preventative in scope from those that target dangerous acts or the commission of harm. Moreover, the criteria which Shavell proposes to steer the choice between prevent-, act- and harm-based interventions also lend themselves to application within the realm of regulation. For these reasons, it is an appropriate model within the context of this discussion, and it has indeed been used as such in mainstream regulation scholarship.<sup>80</sup>

Shavell argues that the balance between prevent-, act- and harm interventions should be guided by the following factors:

- (1) Uncertainty;
- (2) The likelihood that harm will have been prevented;
- (3) Opportunity costs;
- (4) Enforcement costs;
- (5) The amount of information available to the regulatory addressee;
- (6) The level of sanctions available.

Uncertainty is determined by the availability of reliable information on the relation between choices, decisions and activities on the one hand, and harm on the other.<sup>81</sup> Uncertainty is therefore a function of the reliability of risk data. The higher the degree of uncertainty, the weaker the case for intervention. Here, Shavell posits that, since the adverse impacts of choices and activities are usually less well understood when they are planned and initially undertaken than later, when initiatives result in the development of dangerous behaviour and, even more so, when negative impacts actually materialise, the presence of uncertainty would typically argue in favour of intervention towards the ‘harm’ end of the chain.<sup>82</sup>

The second determinant is the expected change in the probability of harm ratio: out of all children who have been stopped from boarding rollercoasters because they did not meet the height prescription, how many have been safeguarded from accidents? The greater the expected change, the stronger the case for early intervention. Opportunity costs, in turn, typically are higher for preventative than for act- or harm-based measures as the former restrict a broader range of choice – staying at home limits our choices more than being required to wear a mask when out and about. Conversely, observance of a stay-at-home order may be easier to police than diligent mask-wearing, so strong variation in enforcement costs may steer the needle of intervention towards a different point along the risk gestation chain. The two final criteria regard the capacity of the (potential) regulatory addressee and the level of sanctions available. The better informed the target audience, and the tougher the penalties for engaging

80 See for example references in R. Baldwin, M. Lodge and M. Cave, *Understanding Regulation* (Oxford: OUP, 2<sup>nd</sup> ed, 2012) 244–248; A. Ogus, *Regulation: Legal Form and Economic Theory* (Oxford: Hart Publishing, 2004) 215; M. Cohen, *Monitoring and Enforcement of Environmental Policy* August 1998) at <https://doi.org/10.2139/ssrn.1201081> K. Yeung, *Securing Compliance. A Principled Approach* (Oxford: Hart Publishing, 2004).

81 Shavell, n 3 above, 263–264.

82 *ibid*, 263.

in either dangerous or harmful behaviour, the weaker the case for preventative action.<sup>83</sup> Arguably, the level of sanctions criterion is qualitatively different from the five others, since punishment is a matter of legislative or regulatory choice rather than an exogenous factor that regulators need to account for. However, as asserted by Shavell, sanctions need to be socially acceptable to be workable, which does constrain the range of regulatory discretion.<sup>84</sup>

An alternative, more pared down framing of the model, as presented by Robert Baldwin, engages chiefly with Shavell's second criterion and advises regulators to look at the rate of progression between the prevent, act, and harm stages.<sup>85</sup> If the introduction of the risk is highly likely to trigger dangerous behaviour or situations, but the relation between danger and harm is less secure, this should steer the regulator towards preventative intervention. For example, fireworks are typically bought with the intention of setting them off, which constitutes a dangerous act. The rate of progression from risk to act, therefore, is high. Yet only a small minority of people enjoying fireworks are harmed. The rate of progression from act to harm, therefore, is low. Following Baldwin, this risk profile should steer regulators towards intervening at the prevention stage, for example by limiting the calibre of fireworks that can be sold for individual consumption. Conversely, the rate of progression between the prevent and act stages may be low – mountain hikers who stick to publicly accessible and maintained paths rarely run into trouble. However, there is a comparatively high incidence of accidents among those who seek out uncharted slopes. Here, regulatory interventions would more effectively target and police off-track activities than restrict access to hiking trails altogether. Instances with a high rate of progression between both the prevent and act, and the act and harm stages, warrant a more even spread of regulatory measures (although certain US-readers might disagree, the gun example springs to mind). If both rates of progression are low (the run-of-the-mill dog owner is unlikely to set their dog onto vulnerable people, and in any event the average domesticated dog is unlikely to cause harm), the case for regulation is weak and any 'freak' accident is better addressed through liability.<sup>86</sup>

### APPLYING THE 'PREVENT-ACT-HARM' MODEL TO CLIMATE CHANGE AND ZONOTIC DISEASE RISKS

The lion's share of existing climate change regulation engages with what in Shavell's model corresponds to the 'act' stage of the risk gestation chain: measures that target and curb the dangerous act of emitting GHGs into the atmosphere. In the case of zoonotic disease risk, regulatory intervention chiefly

83 *ibid.*, 261. cf R. Baldwin and J. Black, 'Really Responsive Regulation' (2008) 71 MLR 59.

84 Shavell, n 3 above, 262.

85 R. Baldwin and M. Cave, *Taming the Corporation. How to Regulate for Success* (Oxford: OUP 2021) 71–74.

86 cf N. Komesar, *Imperfect Alternatives: Choosing institutions in Law, Economics and Public Policy* (Chicago, IL: University of Chicago Press, 1994).

consists of a combination of act and harm-focused measures. In both cases, we find the sparsest regulatory coverage at the 'prevent' end of the regulatory chain.

Prima facie, this distribution of regulatory attention could be viewed as in line with the dictates of the Shavell model. As is the case for most health and environmental risks, climate change and zoonotic disease risks operate in a context of uncertainty.<sup>87</sup> Indeed, recalling their systemic dimension, uncertainty is not only present but constitutes a core attribute of both risks. Following Shavell, the presence of uncertainty in principle should steer regulators towards the later stages of intervention. Uncertainty also impairs our ability to gauge the rate of progression between risks, dangerous acts, and harm, which again discourages regulatory intervention. Opportunity costs, too, would appear to be much greater for preventative climate change and zoonotic disease control measures than for act- or harm-based intervention. For example, the opportunity costs of refusing consent for industrial farming (a preventative measure) are likely to be significantly higher than the costs of mandating regular health checks for farmed animals that are transported across borders (an act-based measure). Hence, an initial assessment suggests that, when applied to climate change and zoonotic disease spread, at least three of Shavell's six criteria point away from preventative action and towards the later 'act' or 'harm-based' stages, which validates the existing spread of interventions along the risk gestation chain. Incidentally, this conclusion would not surprise Shavell since, as his article confirms, the 'prevent-act-harm' model tends to work in a justificatory rather than a critical manner and reveal the rationality behind policing arrangements which, from an alternative vantage point, might appear unfair or inefficient.<sup>88</sup>

However, first impressions can be misleading. Indeed, this article argues that this prima facie validation of the regulatory status quo should be challenged on two grounds. First, a more considered application of the 'prevent-act-harm' model, which fully engages with the distinctive risk profiles of both the spread of zoonotic disease and climate change, would not confirm the existing spread of regulatory interventions as adequate and would instead urge a recalibration. Taken on its own terms, a thoughtful application of Shavell's model to intersystemic systemic risks produces a critical rather than a justificatory result. Secondly, it is argued that while Shavell's model still has much to contribute to the regulatory debate, it does not account for or respond to the full complexity of contemporary health and environmental risk governance. The 'prevent-act-harm' model, as currently construed, offers a linear solution to a compound problem. It overlooks the impact of globalisation and of intra- and intersystemic interdependencies on, particularly, rate of progression and on the opportunity costs of intervention at various stages of the risk gestation chain. Accounting for

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87 M. Mesa-Frias, Z. Chalabi, T. Vanni and A. Foss, 'Uncertainty in environmental health impact assessment: Quantitative methods and perspectives' (2013) 23 *International Journal of Environmental Health Research* 16; J. Reis and P. Spencer, 'Decision-making under uncertainty in environmental health policy: new approaches' (2019) 57 *Environmental Health and Preventive Medicine* 24; A. Stewart and A. Hursthouse, 'Environment and Human Health: the Challenge of Uncertainty in Risk Assessment' (2019) 8 *Geosciences* 24.

88 Shavell, n 3 above, 270–271.

such interdependencies within the model would generate different results, and would augment the model's value as a benchmark for regulatory effectiveness.

### **Uncertainty and rate of progression assessments for intersystemic systemic risks**

In the Shavell model, the presence of uncertainty functions as a caution against preventative action. However, as established earlier, intersystemic systemic risks such as climate change and zoonotic disease risks contend with various and distinctive forms of uncertainty, including cause-effect uncertainty, impact uncertainty, and distribution uncertainty. This begs the question whether each of these dimensions of uncertainty is considered in the Shavell model, and whether each ought to steer in the same direction, namely, away from preventative action.

The uncertainty dimension which features most prominently in Shavell's thinking is cause-effect uncertainty – uncertainty about non-ionising radiation causing leukaemia,<sup>89</sup> or about dietary habits impacting fertility. Cause-effect uncertainty should warn regulators away from early intervention. After all, if it ultimately transpires that electric cables do not jeopardise children's health, then any preventative action taken to keep children away from electric cables would have been as wasteful as it was ineffective.

As asserted in the risk profiles of climate change and zoonotic disease risks (see the section above headed 'Intersystemic systemic risks'), our knowledge about the cause-effect relationships between man-made GHG emissions and global heating, or between global heating and disruptive health and environmental impacts, is scientifically robust. The connections between the drivers of zoonosis and disease outbreaks, too, are widely recognised. This low level of cause-effect uncertainty in the fields of climate change and zoonotic disease should attenuate the bias against preventative action. Indeed, the risk that such preventative action would curtail activities that ultimately prove to be unconnected to harmful impacts, is negligible. Hence, it does not appear warranted to backload regulatory intervention for climate change or zoonotic disease risk control out of a concern for cause-effect uncertainty.

Impact uncertainty, too, plays an important role in Shavell's 'prevent-act-harm' model. The greater the uncertainty about the frequency with which risks convert into adverse impacts, and the greater the unpredictability regarding the magnitude of harm that will ensue, the more difficult it is to determine the rate of progression between risk, danger, and harm. Impact uncertainty makes it harder to claim with confidence a high rate of progression between risk and danger, or between danger and harm. Thus, like cause-effect uncertainty, impact uncertainty beckons the regulator towards the later stages of the regulatory intervention chain.

Both climate change and zoonotic disease risk are fields that undeniably contend with impact uncertainty. Moreover, given the complexity of both systems, full predictability of either the frequency or intensity of harm is likely

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<sup>89</sup> n 50 above.

to remain beyond our grasp.<sup>90</sup> Yet at the same time, it would be fallacious to cling onto an outdated image of climate change and zoonotic disease impacts as exceptional, erratic and, ultimately, unforeseeable. Climate change risks and zoonotic disease risks are fading swans; they are persistent and ubiquitous, and cause harm with increasing regularity and severity. Full predictability may continue to elude us, yet we are now undoubtedly much better informed about the rate of progression – about the likelihood that added risk will trigger danger, and that danger will convert into harm. Hence, a thoughtful application of Shavell's second benchmark no longer unequivocally points towards the 'harm' stage of regulatory intervention.

Finally, it should be acknowledged that, although cause-effect uncertainty is negligible and impact uncertainty is on the wane, both the fields of climate change and zoonotic disease risk still face high levels of distribution uncertainty. It remains extremely difficult to forecast precisely when and where harm will occur, and whom will be most affected.<sup>91</sup> However, in contrast to cause-effect uncertainty and impact uncertainty, the presence of distribution uncertainty does not impair the case for early intervention. In fact, rationalist models such as the Coase theorem<sup>92</sup> and Shavell's prevent-act-harm model consciously – and controversially<sup>93</sup> – disregard distributional impacts in decision making on the optimisation of rules and regulation, favouring overall welfare maximisation over equitable distribution of wins and losses. In any event, whereas cause-effect and impact uncertainty primarily erode confidence in the effectiveness of regulatory interventions at the 'prevent' and 'act' stages, distribution uncertainty in the first place complicates assessments of the likely success of interventions at the 'harm' stage. Hence, the persistence of distribution uncertainty should steer towards, rather than away from preventative regulation.

### **Linear models for compound problems: the need to adapt the prevent-act-harm model to globalised intersystemic systemic risks**

Shavell's model presents risk creation, dangerous acts and harm as singular and linear events: a risk can trigger a dangerous act and a dangerous act can trigger harm. Obviously, reality is more complex; risks may not be created by a single, clearly identifiable decision but may result from a combination of choices and circumstances. Risk creation may enable more than one dangerous act, and dangerous acts may cause a range of harmful impacts. This is not necessarily problematic; models are deliberately designed as pared down and

90 cf C. Zanocco et al, 'Place, Proximity, and Perceived Harm: Extreme Weather Events and Views about Climate Change' (2018) 149 *Climatic Change* 349, 350.

91 M.L. Weitzman, 'Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change' (2011) 5 *Review of Environmental Economics and Policy* 275; Morse et al, n 83 above; Yang Chen et al, 'Recent Progress and Emerging Topics on Weather and Climate Extremes Since the Fifth Assessment Report of the Intergovernmental Panel on Climate Change' (2018) 43 *Annual Review of Environment and Resources* 35.

92 R. Coase, 'The Problem of Social Cost' (1960) 3 *The Journal of Law & Economics* 1.

93 A. Volokh, 'Rationality of Rationalism – The Positive and Normative Flaws of Cost-Benefit Analysis' (2011) 48 *Houston Law Review* 79, 91.

simplified representations of complex events. Indeed, it is their very parsimony that helps the user to understand complex events as problems that are capable of being solved. However, if the mismatch between the complexity of events and the parsimony of the model becomes too great, the model's problem-solving effectiveness may be compromised. I argue that, if left unaltered, the complexity that the globalised and intersystemic systemic dimensions of both zoonotic disease and climate change risks inject into the Shavell model impair its effectiveness as a mechanism to determine the appropriate timing of regulatory interventions.

First, the intersystemic systemic character of climate change and zoonotic disease risks radically alters the structure of the risk gestation chain. Systemic risks not only trigger dangerous acts which in turn trigger harm; they trigger additional, cascading risks within the system, which all entail distinctive sets of potential dangers and harmful effects. In a systemic risk structure, danger and harm do not build in a linear,<sup>94</sup> but in an exponential way. The scope for exponential growth is further widened when factoring in the intersystemic dimension of climate change and zoonotic disease risks. To mention but the most obvious interlinkages, climate change risks not only trigger other climate change risks; they also trigger biodiversity risks (which in turn foster zoonotic disease risks), financial and investment risks and risks to the economy overall. Zoonotic disease risks trigger other health risks, but they also foster further biodiversity depletion risks and economic risks.

The mismatch between the linearity of the Shavell model and the multi-dimensional nature of complex risks is thrown into further relief when we recall the globalisation dimension of risks such as climate change and zoonotic disease spread. Globalisation fosters a multiplication of dangerous acts along the risk gestation chain and, hence, intensifies the likelihood of harmful effects.<sup>95</sup> This is particularly prominent in the context of zoonotic disease risks. Consider, for example, the proliferation of different dangerous situations in the globalised food production chain. Pigs reared for human consumption are often bred in one country, fattened in another, and finally transported again to a third distant location for slaughter. The journey of the pork from slaughterhouse to consumer is likely to be equally lengthy and convoluted. Thus, in its short life span, a mass-produced pig is exposed to a far greater viral load, encountered in a succession of different settings, than its locally sourced counterpart.<sup>96</sup> This multiplication of dangerous acts needs to be accounted for if the model is still to deliver a reliable steer towards the optimal point of intervention.

The distance between Shavell's model and the complexity of the situations it seeks to capture is such that the model's ability to generate rational decisions is impaired. Most obviously, the mismatch affects the functionality of

94 M.A. Centeno et al, 'The Emergence of Global Systemic Risk' (2015) 41 *Annual Review of Sociology* 65, 68.

95 *ibid.*

96 B.K. Manuja, A. Manuja and R. Kumar Singh, 'Globalization and Livestock Biosecurity' (2014) 3 *Agricultural Research* 22.

the ‘rate of progression’ tenet: a responsive decision-making model ought to take into account not only risk’s capacity for fostering dangerous acts, but also the multiplication of dangerous acts and risk’s capacity to create additional, cascading risks within and across systems. Secondly, the intersystemic systemic and globalised dimensions of risk can and should affect how opportunity costs are factored into risk decision making. We recall that, as a rule, the earlier an intervention is staged along the risk gestation chain, the higher the opportunity costs: a greater number of potentially beneficial activities is foreclosed if a park is sealed off, than if the park remains open but the playground and cafeteria are shut. Concerns about opportunity costs have long been a powerful deterrent to early intervention in health and environment regulation, particularly when such intervention would stand in the way of land development. Even within regulatory regimes that are specifically designed for the protection of wildlife and its habitats, such as the EU Habitats Directive, a door is left ajar to override protective arrangements for ‘imperative’ economic reasons,<sup>97</sup> such is the lure of land development and the fear of losing out on opportunities for economic growth.

The regulatory weight attached to opportunity costs could arguably be challenged on its own terms, but it becomes all the more problematic when the risks at issue have a strong systemic and intersystemic dimension. Within the Shavell model – and indeed within regulatory decision making generally – the opportunity costs of preventative action are, explicitly or implicitly, traded off against likely averted harm. However, the harm is considered exclusively with reference to individualised risks. There is no provision within the Shavell model to factor in, for example, financial market instability which may be triggered indirectly by changes in land use, given the increased likelihood that such changes result in increased risk of zoonotic mutation or a rise in GHG emissions which, in turn, could produce health and environmental calamities with grave and systemic financial consequences. Conversely, when the costs of early intervention on climate change are weighed against climate change impacts averted, there is no established practice equally to consider the beneficial impact which these same measures may have on zoonotic risk management.<sup>98</sup> Intersystemic dependence alters both the costs and the benefits of intervention, and it needs to be taken into account in order to make optimal determinations about the timing of regulation and enforcement.

### **Enforcement costs, information, and sanctions**

This discussion has focused chiefly on the first three tenets of the ‘prevent-act-harm’ decision-making model. This is because uncertainty, rate of progression, and opportunity costs are the factors which, at first glance, are hardest

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97 Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora [1992] OJ L206/7 (as amended), Art 6(4).

98 S. Harrop, ‘Holistic and Leadership Approaches to International Regulation: Confronting Nature Conservation and Developmental Challenges. A Reply to Farnese’ (2014) 3 *Transnational Environmental Law* 311, 312.



to reconcile with the ‘prevent’ side of regulatory intervention. As the preceding paragraphs have sought to demonstrate, such reconciliation is however possible if we take full account of the intersystemic systemic risk profiles of climate change and zoonotic disease.

A consideration of the three remaining criteria – enforcement costs, information availability and sanctions – does not change this assessment. There is no reliable data to suggest that the enforcement of harm-based climate change or zoonotic disease control measures is less costly than enforcing preventative measures. In fact, research on zoonotic diseases indicates that the effectiveness of culling, which is both the most widely enforced control measure and the last available opportunity to break the chain of zoonotic contagion, performs unevenly as a disease control strategy, and there are indications that its effectiveness may reduce over time.<sup>99</sup> As the effectiveness of culling as a late-stage intervention is called into question, the corresponding enforcement costs rise. As to the fifth criterion of information availability, the huge information discrepancies between special interests and the public,<sup>100</sup> on the subject of climate change as well as zoonotic disease risks, only serve further to strengthen the case for preventative action since, following Shavell, lack of public information reduces the effectiveness of harm-based interventions. Sanctions, finally, do not offer a clear steer towards either early or late intervention. Generally, there appears to be limited public support for tough sanctions, regardless of whether these sanctions relate to preventative, act-based or harm-based interventions. Take, for example, the enforcement of poaching laws, which is an act-based intervention.<sup>101</sup> Public support for repressive action on poaching tends to be precarious, particularly in countries where significant segments of the population rely on an informal economy for subsistence.<sup>102</sup> Similar constraints apply with regard to harm-based interventions that seek to suppress the spread of a disease after the threshold of human contagion has been breached. As we have experienced repeatedly in the past year, there are sharp limits to the effectiveness of threats and punishment as a way of enforcing, for example, social distancing rules.<sup>103</sup> Hence, while credible sanctions for preventative interventions may be hard to come by, the picture is not necessarily rosier on the act- and harm-based side of the equation.

99 J.C. Prentice, N.J. Fox, M.R. Hutchings, P.C.L. White, R.S. Davidson and G. Marion, ‘When to Kill a Cull: Factors Affecting the Success of Culling Wildlife for Disease Control’ (2019) 16 *Journal of the Royal Society Interface* 1; S. Walker, ‘Planned wild boar cull in Poland angers conservationists’ *The Guardian* 11 January 2019 at <https://www.theguardian.com/environment/2019/jan/11/planned-wild-boar-cull-in-poland-angers-conservationists>. See also Farnese, n 93 above, 199–200: ‘delaying action to address the root causes of disease emergence may no longer be justified by the false confidence that infectious diseases can be controlled through culling’.

100 cf C. Tilly, ‘Unequal Access to Scientific Knowledge’ (2007) 8 *Journal of Human Development* 245.

101 As explained above, apprehending poachers has a limited impact on the spread of disease among wildlife, but it lowers the likelihood of diseased animals coming into contact with human populations.

102 Barber, n 44 above, 315.

103 C. Murphy, H. Williamson, E. Sargeant and M. McCarthy, ‘Why People Comply with Covid-19 Social Distancing Restrictions: Self-Interest or Duty?’ (2020) 53 *Australian & New Zealand Journal of Criminology* 477, 479.

## ONLY CONNECT: THE RATIONALIST CASE FOR PREVENTATIVE REGULATORY INTERVENTION

Once we fully engage with the intersystemic systemic nature of climate change and zoonotic disease risks, two major consequences become inescapable. First, current regulatory regimes are too weak on early stage, prevent-based intervention to be effective. There is a pressing need for more regulation that curbs additional risk creation rather than regulation that manages extant risk. This conclusion should not be interpreted as a call to abandon consideration of further act- or harm-based interventions, let alone to jettison resilience strategies such as building flood defences to cope with extreme weather, or culling in the case of zoonotic disease spread. Such measures remain necessary, all the more so since both climate change and zoonotic disease risks are locked in and additional adverse impacts are already unavoidable.<sup>104</sup> However, in the face of rapidly approaching climatological and ecological tipping points, the most urgent action point is to ramp up regulation that seeks to prevent further catastrophe rather than regulation that seeks to deal with the fall-out. It might be easily assumed that, since climate change and zoonotic disease impacts are already inevitable, it is now ‘too late’ for mitigation and society should instead channel its energy into adaptation. Yet this assumption rests on the fallacious premise that, after the deluge, we will have ‘weathered the storm’ and be able to resume life as before. For intersystemic systemic risks, the opposite is true: the unfolding of a health or environmental catastrophe does not inoculate us against repeat events; it compounds the risk of further instability. In practical terms, a 2°C warmer world will not be one that is less vulnerable to continued GHG emissions; it will be more so.<sup>105</sup>

Secondly, the discussion of opportunity costs and benefits of early intervention for intersystemic systemic risks underscores the need for integrated and joined-up decision making in risk governance. Building responsiveness to the intersystemic and globalised dimensions of risk is a challenge for risk regulation. Notwithstanding the thriving debate and rapidly expanding literature on systemic risk in the financial sector and beyond,<sup>106</sup> strategies of compartmentalisation and incrementalism are deeply engrained in risk regulation,<sup>107</sup> whereas joined-up thinking remains exceptional and hard to operationalise.<sup>108</sup> Moreover, the scale of the challenge should be acknowledged: even where willingness abounds, there is no ready formula to account for the multiplication of dangerous acts within global supply chains, or to integrate potential intersystemic fall-out from zoonotic disease or climate risks into strategic determinations about the scope and timing of regulatory intervention. Yet the absence of easy fixes should neither explain nor justify failure to attempt change. As a

104 cf E. Boyd, B. Nykvist, S. Borgström and I.A. Stacewicz, ‘Anticipatory Governance for Socio-ecological Resilience’ (2015) 44 *AMBIO* S149, S151.

105 cf L. Alfieri et al, ‘Global Projections of River Flood Risk in a Warmer World’ (2017) 5 *Earth’s Future* 171.

106 n 1 and nn 18–26 above.

107 Heyvaert, n 6 above.

108 cf Farnese, n 71 above, 302–303 (referring to the narrow framing that tends to characterise environmental regulation, even at the transboundary level).

minimum, the globalised and intersystemic character of contemporary health and environmental risks, such as climate change and zoonotic disease, should alert regulators to the possibility that the rate of progression is underrated and, conversely, opportunity costs are overestimated relative to the range and diversity of risk management opportunities in the wake of early regulatory intervention.

The legal and regulatory implications of both lessons are far-reaching. Prevention and joined-up thinking in the first place call for serious investment in improved impact assessment practices, so that intersystemic systemic risks are no longer considered in isolation and their potential for cascading within and across sectors is accounted for in decision making.<sup>109</sup> There is a growing body of literature on how to perform such assessment,<sup>110</sup> yet there is at present no legal expectation to consider systemic and cross-sectoral impacts of plans, projects or policies.

Better information about the systemic and intersystemic dimensions of risk creation should, in turn, give a strong steer in the context of development consent, permitting processes and other decisions regarding land and marine use. To date, notwithstanding a basis of support in international biodiversity law for the adoption of protective measures to prevent exposure to AIS and the spread of disease among wildlife,<sup>111</sup> zoonotic disease risk is barely factored into conservation law, zoning law, planning law and land law.<sup>112</sup> Work by commentators such as Farnese and Harrop forcefully argues that, both at the international and domestic level, regulatory arrangements that contribute to the protection of habitats and wildlife are far too weak to control the spread of zoonotic disease.<sup>113</sup> Similar deficiencies plague the regulatory frameworks that govern animal husbandry. Even in countries with expansive animal welfare provisions, such as the UK, animal welfare regulation does not contain specific measures to manage the risk of viral contagion.<sup>114</sup> The most targeted information available is a few short paragraphs on biosecurity in a non-binding Code of Recommendations for the Welfare of Livestock, which suggest good hygiene and stress reduction, thorough cleaning of transportation equipment, and the use of isolation facilities for new livestock.<sup>115</sup>

By comparison, many countries do have legal requirements for public authorities to consider climate change impacts in planning, zoning and habitats decision making, but such requirements are often of a purely procedural nature. The recent string of English court decisions on the validity of

109 Renn et al, n 1 above, 12.

110 *ibid*; Schweizer, n 1 above, 86–90.

111 To varying degrees, zoonotic disease risks have been considered in the context of the Convention on Biological Diversity the Ramsar Convention on the conservation of wetlands, and the Convention on the Conservation of Migratory Species of Wild Animals (CMS). See Farnese, n 71 above.

112 Cromie, n 43 above, 224.

113 Farnese, n 71 above; Harrop, n 98 above.

114 The most pertinent measures are contained in the Animal Welfare Act, s 9 which in general terms affirms a duty to ensure that the needs of the animal are met, including (a) the need for a suitable environment, and (c) any need to be housed with, or apart from, other animals.

115 [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/69368/pb7949-cattle-code-030407.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69368/pb7949-cattle-code-030407.pdf).

government approval to build a third runway at Heathrow airport, a development which will indisputably result in an increase in GHG emissions as aviation traffic intensifies further, offers a good illustration of the current weakness of preventative climate change regulation.<sup>116</sup> As affirmed throughout the various stages of litigation, the responsibility to take into account climate change law and policy in decision making on planning is exhausted as soon as governmental authorities can show that the issue has been given consideration. If in their opinion – an opinion which is given a wide berth of deference – overall long-term climate targets remain theoretically achievable, authorisations for new carbon-intensive projects remain perfectly compatible with climate change commitments. Notwithstanding the locked-in nature of climate change risk, which implies that even under idealised conditions the world would face a minimum 0.6°C temperature rise, UK law at present offers not even a rebuttable presumption that carbon-intensive projects will cause harm.

Legal reform to require integrated impact assessment, and to increase the weight attached to assessment results in consent and authorisation processes, would constitute a vital first step in the recalibration of risk regulation towards early-stage intervention. However, to take the preventative agenda seriously, it is also necessary to countenance restrictions on ongoing activities that contribute to intersystemic systemic risk creation. In the context of climate change, this would imply adopting strategies to phase out fossil fuel production itself, rather than only capping GHG emissions.<sup>117</sup> With regard to zoonotic disease risk, preventative action would include the pursuit of public policies to de-intensify and downscale poultry and cattle farming, and a reconfiguration of global supply chains to constrain the multiplication of dangerous acts such as mass transportation.

It should be readily acknowledged that the changes proposed are extensive and come with a potential for disruption. Unquestionably, they would be ferociously contested by powerful actors with vested interests in the globalised, fossil fuel-dependent and agro-industrial economy. It should equally be conceded that they would require a more muscular, interventionist approach to regulatory authority than we have come to expect in the era of flexible governance.<sup>118</sup> Furthermore, recalling that climate change and zoonotic disease risks are globalisation risks, legal and regulatory reform must be carried out across different scales of governance and orchestrated. Yet however daunting the objections, they do not diminish the case for more early-stage intervention as a matter of economic rationality. Moreover, notwithstanding the scale and depth of proposed changes, existing legal principles, rules and decisions do provide anchoring points for reform. Impact assessment laws can be amended in the

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116 *R (on the application of Friends of the Earth Ltd and others) (Respondents) v Heathrow Airport Ltd (Appellant)* [2020] UKSC 52.

117 D. Carrington, 'Fossil fuel production on track for double the safe climate limit' *The Guardian* 20 November 2019 at <https://www.theguardian.com/environment/2019/nov/20/fossil-fuel-production-on-track-for-double-the-safe-climate-limit>.

118 cf N. Gunningham and C. Holley, 'Next-Generation Environmental Regulation: Law, Regulation, and Governance' (2016) 12 *Annual Review of Law and Social Science* 273.

light of the prevention principle to require consideration of the systemic and intersystemic spill-over potential of identified risks. In various jurisdictions, such as the EU, nature conservation law already incorporates a precautionary approach which in principle disallows development that poses a risk to the integrity of the site. Legal provisions are currently narrowly framed as they only consider risks to designated, protected areas, and a presumption against development is relatively easily rebutted by invoking imperative reasons of public interest, which may be economic considerations. However, these provisions could constitute a blueprint for a more expansive and less compromising approach to development consent, within and beyond the field of nature conservation. Finally, the greatest obstacles to reform would undoubtedly materialise around attempts to introduce early-stage intervention in ongoing global production and supply systems, for example, by capping fossil fuel production. Earlier initiatives such as the Montreal Protocol on Ozone-depleting Substances<sup>119</sup> offer some experience of globally orchestrated phase-outs, but the scale and complexity of decarbonisation, or of a transformation of the global meat production and supply sector, admittedly dwarfs that of any phase-outs attempted so far. Yet before dismissing the challenge as too difficult to face, we should at least make a sincere attempt to imagine the difficulties, the misery and, as this article has argued, the greater cost of living in a world that saw oncoming catastrophe and chose to look away.

## CONCLUSION

This article is, mercifully, by no means the first to emphasise the severity of the health and environmental governance challenges we face. By the same token, the interconnected nature of major contemporary health and environmental risks, such as global heating, collapsing global biodiversity<sup>120</sup> and zoonotic disease, is – finally – receiving a good deal of attention in scientific, scholarly and more generalist publications. In recent months, British newspapers reported Prince Charles's championing of Terra Carta, an intended eco-equivalent of Magna Carta targeted primarily at the private sector, which aims to have CEOs sign up to the mission of 'supporting and rapidly accelerating the world's transition towards a sustainable future'. As is typical for this kind of grand (and certainly grandly titled) initiative, the commitments listed in the documents are overwhelmingly broad, vaguely formulated and aspirational, and rely heavily on sweeping statements of purpose such as '[m]aking a sustainable future the growth story of our time'. The initiative is notable, however, for its acknowledgement of the deep interdependencies between climate change, biodiversity protection, and global health, and its repeated insistence that averting climate catastrophe and mass extinction is a health

119 Montreal (Canada), 16 September 1987, in force 1 January 1989 at <https://ozone.unep.org/treaties/montreal-protocol/montreal-protocol-substances-deplete-ozone-layer>.

120 S. Diaz et al, *Global Assessment Report on Biodiversity and Ecosystem Services: Summary for Policy Makers* IPBES, 2019, 12–15 at <https://ipbes.net/news/ipbes-global-assessment-summary-policy-makers-pdf>.

mission, and by inference a business mission, as much as it is an environmental mandate.

What this article aims to contribute to this burgeoning discussion is, first of all, a productive characterisation of contemporary risks as ‘intersystemic systemic risks’. This characterisation highlights a number of risk attributes which should be accounted for in the design of regulatory responses in order to optimise their chance of effectiveness. The article makes the case that this risk characterisation applies to climate change and zoonotic disease risks – two defining challenges of the era. Even on their own terms, the size and scale of both challenges warrants the conceptualisation of a new risk profile that optimally reflects their distinctive features. However, the concept of intersystemic systemic risk could also be helpful to enhance our understanding of a number of major risks outside the climate change and zoonotic disease risk sphere. Cybersecurity risks, for example, *prima facie* display similar intersystemic systemic dynamics. Additionally, they could also be understood as globalisation risks, fading swans, and also contend with a certain degree of ‘locked in’ risk. The concept of intersystemic systemic risk could therefore open the door to a broader reconsideration of the appropriateness of contemporary risk regulation strategies.

The second contribution is based on the premise that, in order to cope with the daunting range of health and environmental challenges we face today, it is not enough to clamour for more action and more regulation. We also need to think carefully about how to structure intervention and, particularly, how best to calibrate regulatory interventions along risk gestation chains. On this key question, the article argues that if the specifics of intersystemic systemic risks are fully accounted for, the application of Shavell’s ‘prevent-act-harm’ model would result in robust support for early-stage intervention. In the case of climate change and zoonotic disease risks, such early-stage intervention calls for significant investment in enhanced impact assessment requirements, for tighter restrictions on land and marine development, and for downscaling and even phasing out activities that currently expose global society to spiralling levels of intersystemic systemic risk, including intensive high-volume animal farming and fossil fuel production.

The significance of this finding is all the stronger when we recall that, as an example a rationalist approach, the Shavell model represents a ‘hard case’ for proponents of health and environmental regulation. Even in the face of catastrophe, advocates for preventative action are easily dismissed as well-intentioned idealists who have little conception of the cost of their proposals. Yet they are, on reflection, the only economic rationalists in the room.