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The Physicist and The Sheep Farmer

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This Essay explores two historical events—the exposure of the Daigo Fukuryū Maru (Lucky Dragon #5) to nuclear fallout from a U.S. thermonuclear bomb test in the Pacific Ocean and the contamination of the Cumbrian Fells in the United Kingdom as a result of the nuclear explosion at the Chernobyl disaster—to better understand what, if anything, can the history of technoscientific advising in policymaking contexts teach scholars about technical expertise in policymaking today? The Essay then teases out three lessons. First, expertise in political contexts is never unmediated, meaning that technical expertise should be understood as filtered through social, political economic, and other kinds of biases. Second, informational technologies are multifaceted sociotechnical systems such that giving one form of expertise a privilege over decision-making is a recipe for skewed policymaking. Third, sociotechnical systems operating in the physical world are subject to acute and irresolvable indeterminacies that make the kind of reduction to numbers preferred by technical expertise inappropriate. Sociolegal scholars working in law and technology should consider these lessons in context.

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Introduction

Expertise is in crisis.[1] Faced with both legitimate and disingenuous critiques, technoscientific expert advice in policymaking is at risk of being replaced with epistemic relativism. It is not the case that "any idea or claim is just as good" or just as true as another merely because someone has made a claim to knowledge.[2] Although the danger has been brewing for some time,[3] it is a particularly acute problem today given the ascendance of demagogic regimes that engage in science denialism and spread misinformation.[4]

At the same time, a particular kind of expertise—namely, knowledge of and experience with building, designing, and coding advanced informational technologies—is being touted

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[1] *See generally* GIL EYAL, THE CRISIS OF EXPERTISE (2019).
[2] Vicki C. Jackson, *Knowledge Institutions in Constitutional Democracies: Preliminary Reflections*, 7 CAN. J. COMPAR. & CONTEMP. L. 156, 182, 216 (2021).
[3] *See, e.g.*, NAOMI ORESKES & ERIK M. CONWAY, MERCHANTS OF DOUBT: HOW A HANDFUL OF SCIENTISTS OBSCURED THE TRUTH ON ISSUES FROM TOBACCO SMOKE TO GLOBAL WARMING 8–9 (2010) (demonstrating the strategy to manipulate science expertise in bad faith to sow doubt about scientific consensus in order to achieve policy wins).
[4] *See, e.g.*, Madison Czopek & Katie Sanders, *Robert F. Kennedy Jr.'s Campaign of Conspiracy Theories: PolitiFact's 2023 Lie of the Year*, POLITIFACT (Dec. 21, 2023), https://www.politifact.com/article/2023/dec/21/robert-f-kennedy-jrs-campaign-of-conspiracy-theori/ [https://perma.cc/V2L7-MLE6]; Louis Jacobson, *RFK Jr. Exaggerates Share of Autistic Population with Severe Limitations*, POLITIFACT (Apr. 21, 2025), https://www.politifact.com/article/2025/apr/21/rfk-jr-exaggerates-share-of-autistic-population-wi/ [https://perma.cc/YX5B-7EQ2]; Jude Joffe-Black, Lisa Hagen & Audrey Nguyen, *How Kash Patel Has Used Children's Books and Podcasts to Promote Conspiracy Theories*, NPR (Dec. 10, 2024), https://www.npr.org/2024/12/09/nx-s1-5213692/kash-patel-conspiracy-theories-fbi [https://perma.cc/WZX9-SULU]; Brandy Zadrozny, *Big Lie 2.0: How Trump's False Claims About Noncitizens Voting Lay the Groundwork to Undermine the Election*, NBC NEWS (Oct. 25, 2024), https://www.nbcnews.com/politics/2024-election/trump-election-results-2024-noncitizens-voting-big-lie-rcna175552 [https://perma.cc/452L-R7UV]; Alexander Tin & Joe Walsh, *Dr. Casey Means, Trump's New Surgeon General Nominee, is RFK Jr. Ally and MAHA Advocate*, CBS NEWS (May 8, 2025), https://www.cbsnews.com/news/trump-casey-means-surgeon-general-nominee/ [https://perma.cc/FXR4-FTEV].

by technologists, partisans, and policymakers as necessary for making technology policy.[5] Technologists and their lobbyists have also been given broad power, resulting in indiscriminate slash-and-burn policies in the name of "efficiency" and unprecedented deregulation.[6] Expertise is being manipulated for political gain.

To address this manipulation, scholars must develop a theory of expertise in policy spaces that mediates between relativism and blind obedience and takes account of expertise's position within a hyper-partisan society rife with algorithmically mediated misinformation. Furthermore, this new theory must acknowledge how claims of expertise unduly augment the power of oligarchic and demagogic forces and must provide a path for rescuing legitimate expertise from political threats.

This Essay is part of an ongoing effort to develop such a theory. Elsewhere, I have explored how appeals courts validate specious claims of fact by leveraging false or misleading claims of expertise for conservative political gain.[7] I also conducted field work to understand how nonprofit advocacy groups involved in drafting privacy legislation at the federal level conceptualize their expertise and apply it in practice.[8] I then considered the mostly implicit rationales for privileging technical knowledge—particularly in computer engineering, software design, and artificial intelligence (AI)—during technology policymaking, and found many of the rationales incoherent or normatively biased.[9]

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[5] Ari Ezra Waldman, *Challenging Technology Expertise*, 105 B.U. L. REV. (forthcoming 2026) (manuscript at 11–15) [hereinafter *Challenging*].

[6] *See, e.g.*, Tara Suter, *Ramaswamy: "We Want to Go In and Slash and Burn that Bureaucracy*," THE HILL (Nov. 14, 2024), https://thehill.com/homenews/administration/4990434-ramaswamy-says-doge-will-slash-burn-bureaucracy/ [https://perma.cc/CRP5-LATX]; Matt Brown & Matt O'Brien, *House Republicans Include a 10-Year Ban on US States Regulating AI in "Big, Beautiful" Bill*, ASSOC. PRESS (May 16, 2025), https://apnews.com/article/ai-regulation-state-moratorium-congress-39d1c8a0758ffe0242283bb82f66d51a [https://perma.cc/SWS8-HHEE].

[7] *See* Ari Ezra Waldman, *Manufacturing Uncertainty in Constitutional Law*, 91 FORDHAM L. REV. 2249, 2252 (2023).

[8] Ari Ezra Waldman, *Civil Society and the Crisis of Privacy Law*, 74 EMORY L.J. 1079, 1097 (2025) [hereinafter Waldman, *Civil Society*].

[9] Waldman, *Challenging*, *supra* note 5.

In an ongoing research agenda, I ask: What, if anything, can the history of technoscientific advising in policymaking contexts teach scholars about technical expertise in policymaking today?[10] Specifically, I am interested in contexts in which technical and scientific knowledge is integrated into a political decision. Technoscientific input can also play a determinative role in specific political decision-making, as was the case with two nuclear disasters of the Twentieth Century: the Daigo Fukuryū Maru (Lucky Dragon #5) incident and the contamination of the Cumbrian Fells in the United Kingdom after the explosion at Chernobyl. Both are cautionary tales: Innocent people were harmed in part because of the pathologies of relying too much or improperly on one form of technical expertise in policymaking contexts.

Both narratives offer scholars and policymakers lessons for a more nuanced way of connecting technoscientific expertise to policymaking. Given space constraints, this Essay focuses on three related lessons: First, expertise in political contexts is never unmediated. That is not the same as saying there is no difference between expertise and power or that reality is whatever people with power says it is. Rather, the mediation of expertise means that technoscientific advice in policy is necessarily channeled through institutions, individuals, and mechanisms that affect how expertise is used to make decisions. Therefore, it is insufficient to simply "follow the science" when making technoscientific policy decisions.[11] Accordingly, one goal of institutional design should be to ensure that technoscientific expertise is mediated in the public interest.

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[10] Although there is a difference between science and technology, I follow the sociologists who argue that the social construction of technology can be understood along similar theoretical and methodological lines as the study of the sociology of science. This Essay also abstracts to a sufficiently high level to make the differences irrelevant. On the social construction of science and technology, please see, for example, Steve Woolgar, *The Turn to Technology in Social Studies of Science*, 16 SCI., TECH. & HUM. VALUES 20 (1991); THE SOCIAL SHAPING OF TECHNOLOGY (Donald MacKenzie & Judy Wajcman eds., 1985); Trevor Pinch & Wiebe Bijker, *The Social Construction of Facts and Artefacts*, 14 SOC. STUD. SCI. 399 (1984).

[11] Mark Tushnet, *Trust the Science But Do Your Research: A Comment on the Unfortunate Revival of the Progressive Case for the Administrative State*, 98 IND. L.J. 335, 354 (2023).

Second, informational technologies are multifaceted sociotechnical systems that require multifaceted expertise. Letting one group of experts set policy based on their expertise in one part of the underlying scientific or technical artefact is to grant a policymaking privilege to people whose expertise covers less—sometimes much less—than the sum total of issues comprising the policy problems. Furthermore, the experts with that policymaking privilege may not be the best equipped to set policy, especially not on their own. The only thing that is certain about them is that they are the ones who have won the "jurisdictional struggles" to be in the room where expert advice is given.[12] These struggles are matters of politics.[13] That politics must be capable of giving voice to diverse perspectives and sifting through legitimate and illegitimate claims to seats at the table if we are to achieve sound policy that serves the public rather than just wealthy interests.

Third, sociotechnical systems operating in the physical world are subject to acute and irresolvable indeterminacies. Therefore, contrary to politically motivated schemes of *de*regulation that are justified with claims about the benefits of innovation,[14] tech policy must not only acknowledge and account for omnipresent indeterminacy but err on the side of abundant precaution. Luckily, precautionary approaches have precedent, particularly in environmental policy, that can serve as models for tech policy.

This Essay proceeds as follows. After this Introduction, Part I details two historical case studies in which technoscientific advice was integrated into political decisions: the Lucky Dragon #5, whose crew experienced nuclear fallout

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[12] EYAL, *supra* note 1, at 22.

[13] It is, as the sociologist Ida Hoos argued, making technical experts and their constituencies the "beneficiaries of [supposedly] 'rationally devised' course[s] of action," thereby creating a "technico-corporate state." IDA R. HOOS, SYSTEMS ANALYSIS IN PUBLIC POLICY 13 (1972).

[14] *See* Matt Brown & Matt O'Brien, *House Republicans Include a 10-Year Ban on US States Regulating AI in "Big, Beautiful" Bill*, ASSOC. PRESS (May 16, 2025), https://apnews.com/article/ai-regulation-state-moratorium-congress-39d1c8a0758ffe0242283bb82f66d51a [https://perma.cc/ZML6-FNP3]. *See also* JULIE E. COHEN, BETWEEN TRUTH AND POWER 93 (2019) (discussing the "innovation-industrial complex" that sees technology development as an unmitigated good and regulation as anathematic to that good).

firsthand, and the Cumbrian Fells incident, where sheep farmers bore the brunt of harm after a rainstorm brought radioactive isotopes onto their sheep's grazing land. Although both incidents are sufficiently complex to warrant book manuscripts on their own, this Part focuses on the ways in which technoscientific advice affected particular policy decisions. Part II then teases out three lessons for scholars and policymakers, focusing on the mediation of expertise, the kind of expertise necessary for policymaking about sociotechnical systems, and the effect of indeterminacy on expert advice. The Essay concludes with avenues for future research.

I. Two Case Studies of Expertise

The Lucky Dragon sailed from Yaizu, Japan more than thirty years before the explosion at Chernobyl. The two stories are obviously different and multifaceted, but they both speak to the role of scientific and technical experts in making science and technology policy. This Part uses contemporaneous and secondary sources to describe the relevant parts of both narratives.

A. Fishing Amid a Nuclear Test

On March 1, 1954, the United States military and the Atomic Energy Commission (AEC) jointly tested a thermonuclear bomb, codenamed Bravo, over the Bikini Atoll in the Marshall Islands.[15] The explosion released energy equivalent to 15 million tons of TNT, 1000 times more powerful than the fission bomb dropped on Hiroshima nine years earlier.[16] It was the largest ever nuclear explosion at the time and it remains the largest nuclear test the United States has ever conducted.[17] The massive fire released into the sky made one eyewitness call it "the day the sun rose in the West."[18]

The test was technically a success, but it did not go as U.S. nuclear scientists expected. Bravo was a fission reaction that

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[15] OISHI MATASHICHI, THE DAY THE SUN ROSE IN THE WEST: BIKINI, THE LUCKY DRAGON, AND I 5–8 (Richard H. Minear trans. 2011).
[16] MORRIS LOW, VISUALIZING NUCLEAR POWER IN JAPAN 97 (2020).
[17] RICHARD RHODES, DARK SUN: THE MAKING OF THE HYDROGEN BOMB 541 (1995).
[18] MATASHICHI, *supra* note 15 (referring to the book's title).

triggered a larger fusion reaction, so scientists knew the explosion would be big. It turned out to be twice as powerful than any of them predicted.[19] President Dwight Eisenhower later said that the size of the explosion "must have surprised and astonished the scientists."[20] There were several factors that contributed to the inaccurate predictions. Bravo was the first test of a bomb in Operation Castle, the project to build the so-called "super," or hydrogen bomb.[21] Therefore, the work was somewhat new to everyone. This unfamiliarity led to scientists overlooking a key part of the chain reaction,[22] committing a "theoretical error" in their understanding of what would happen at the nuclear level.[23] One Western historian called this oversight a "chance event."[24]

Another variable was the weather. According to testimonials, the U.S. ignored notices of "unfavorable winds" that could affect the Bravo test.[25] The AEC went ahead with the test anyway. Together with the scientists' errors, weather changes made nuclear fallout reach beyond the previously announced danger zone, the range of which was calculated by nuclear physicists on the Bravo project but changed several times after the Lucky Dragon had left port.[26]

The fallout from the explosion fell on inhabited islands and onto a small Japanese tuna trawler, the Lucky Dragon #5, which was fishing outside of the danger zone.[27] The crew likely

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[19] RHODES, *supra* note 17 at 542; ROBERT GILPIN, AMERICAN SCIENTISTS AND NUCLEAR WEAPONS POLICY 138 (1962).
[20] GREG HERKEN, THE BROTHERHOOD OF THE BOMB 285 (2002).
[21] *Id*. at 284–285.
[22] John Swenson-Wright, *The Lucky Dragon Incident of 1954: A Failure of Crisis Management*, *in* JAPANESE DIPLOMACY IN THE 1950S: FROM ISOLATION TO INTEGRATION 141 (Iokibe Makoto, Caroline Rose, Tomaru Junko, & John Weste eds. 2008); *see also id*. at 143 (referring to a "miscalculation" being a more likely explanation than malice given the presence of U.S. vessels outside the danger zone).
[23] Mark Schreiber, *Lucky Dragon's Lethal Catch*, JAPAN TIMES (Mar. 18, 2012), https://www.japantimes.co.jp/life/2012/03/18/general/lucky-dragons-lethal-catch/ [https://perma.cc/VYC6-LYJ8].
[24] Swenson-Wright, *supra* note 22, at 141.
[25] MATASHICHI, *supra* note 15, at 50.
[26] HERKEN, BROTHERHOOD, *supra* note 20, at 285; MATASHICHI, *supra* note 15, at 18.
[27] *Id*. There is some disagreement in the historical literature about exactly how far away the Lucky Dragon was from the test site. Sources written by

knew that Bikini had been a nuclear testing site before; as recently as 1952, Japan's Maritime Safety Board warned ships to stay away[28] However, they did not know the U.S. was going to conduct nuclear tests at Bikini on March 1;[29] publication of that information came after the Lucky Dragon had left port.[30] Nor could they have known that being outside the danger zone would still be dangerous.

When they noticed the explosion and fine ash falling from the sky, the twenty-three members of the Lucky Dragon crew attempted to escape, but it took them six hours to retrieve their fishing gear and nets from the ocean.[31] They gathered the radioactive dust with their hands; one "took a lick" of the dust and compared it to falling snow.[32] It collected all over the boat, on their bodies, and in the fishing haul.[33] Japanese media described the Bravo fallout as "ash of death."[34] The dust stuck to their skin and clothes and entered their bodies through nasal passages, eyes, and ears. Later that day, all started to feel sick

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Western scholars tend to put the boat closer, one as close as 82 miles east of Bikini. *E.g.*, RHODES, *supra* note 17, at 542. Other Western scholars cite these estimates. *E.g.*, Swenson-Wright, *supra* note 22, at 140. One placed the boat only 14 miles outside the restricted area. Martha Smith-Norris, *"Only as Dust in the Face of the Wind": An Analysis of the BRAVO Nuclear Incident in the Pacific, 1954*, 6 J. AM.-EAST ASIAN RELATIONS 1, 4 (1997). Japanese sources place it farther away at nearly 100 miles from Bikini. *E.g.*, Aya Homei, *The Contentious Death of Mr. Kuboyama: Science as Politics in the 1954 Lucky Dragon Incident*, 25 JAPAN F. 212, 213 (2013). *See also* LOW, *supra* note 16, at 96 (collectively relying on both Japanese and Western sources and placing the boat "70-100 miles away from Bikini Atoll," but not citing a source for the distance). Oishi Matashichi, a fisherman on the Lucky Dragon #5 at the time of the Bravo test who wrote a memoir about the experience, stated that the "area off-limits was ninety miles due west from where we'd be fishing." MATASHICHI, *supra* note 15, at 17. In any case, the Lucky Dragon was outside the danger zone.

[28] RALPH LAPP, THE VOYAGE OF THE LUCKY DRAGON 24 (1958).

[29] Schreiber, *supra* note 23.

[30] The English-language version of the *Nippon Times* reported on it on March 1. *See* Kyodo-UP, *H-Bomb Test Observers to Leave Next Weekend*, Nippon Times (Mar. 1, 1954), at 1 (cited in LOW, *supra* note 16, at 96).

[31] MATASHICHI, *supra* note 15, at 20.

[32] *Id*. at 20.

[33] *Id*.

[34] Homei, *supra* note 27, at 215 (citing the original newspaper report on the incident in Japan in the March 16 issue of *Yomiuri shinbun*). Matashichi called it "death ash". MATASHICHI, *supra* note 15, at 5.

with classic symptoms of acute radiation syndrome—itching, swelling, diarrhea, and pigmentation of the skin.[35] The crew headed home as fast as they could.

Within three days, they developed skin blisters.[36] Their faces turned black, and their hair began to fall out.[37] High levels of radiation were detected near and on the ship, in the hospital rooms, and at the fisherman's houses after they returned home days later.[38] Weeks later, dangerous levels were found in the fishermen's hair and nails.[39]

The U.S. government said the danger to humans and fish would be minimal. On March 18, a team of U.S. physicians, including a hematologist and the chief of the Atomic Bomb Casualty Commission, concluded that the fishermen would recover in a few weeks, a month at most."[40] Japanese physicians—along with all the evidence from the fishermen themselves once they were hospitalized—cast doubt on that prediction.[41]

Some of the statements from U.S. officials, particularly from AEC Chairman Lewis Strauss, were dismissive of Japanese concerns. At a news conference on March 31, 1954, Strauss stated that, based on the calculations of nuclear scientists advising the AEC, radioactivity in short- and long-range fallout would "decrease rapidly after the tests until the radiation level has returned approximately to the normal background."[42] But such statements came at a time when researchers in Japan and the U.S. still knew relatively little about living in environments with background radiation.[43] For obvious reasons, scientists knew even less about the effects of a fusion bomb releasing radioactive material in areas already

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[35] MATASHICHI, *supra* note 15, at 22.
[36] Homei, *supra* note 27, at 215.
[37] *Id.* at 213 (citing Japanese scholarship and reports); MATASHICHI, *supra* note 15, at 23.
[38] MATASHICHI, *supra* note 15, at 27.
[39] *Id.* at 29.
[40] *Id.*
[41] Carolyn Kopp, *The Origins of the American Scientific Debate Over Fallout Hazards*, 9 SOC. STUD. Sci. 403, 405 (1979); MATASHICHI, *supra* note 15, at 32–36.
[42] GILPIN, *supra* note 19, at 139.
[43] Swenson-Wright, *supra* note 22, at 151–52.

plagued by high levels of radiation from previous bombs. The AEC was only just beginning to study these questions.[44]

It turns out that the U.S. either ignorantly or maliciously dismissed Japanese concerns too soon. On March 16, fish at the Osaka Fish Market showed high levels of radiation.[45] Eleven days later, other fishing vessels returned to port with radioactive tuna.[46] Tests on the radioactive ash itself found Strontium-90, which has a half-life of nearly twenty years and increases the risk of cancer and leukemia, among other radioactive isotopes.[47] On March 19, eighteen days after the test, the U.S. made the danger zone eight times larger than it was originally set for the Bravo test.[48] Six months later, on September 23, 1954, the first crew member died; his name was Kuboyama Aikichi.[49] One headline read: "First victim of a hydrogen bomb".[50] His death was followed by others, as well as numerous cases of radiation-induced cancer and liver cirrhosis.[51]

B. The Worst Nuclear Accident Since the Last One

Almost thirty-two years later, on April 26, 1986, the No. 4 reactor at the Chernobyl Nuclear Power Plant exploded. On May 2, a radioactive cloud passed over the United Kingdom, which rained down deposits of radioactive cesium on Northern England and Wales.[52] After the cesium seeped into the groundwater and soil, sheep grazing in the mountains of

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[44] *See* SUE RABBITT ROFF, HOTSPOTS: THE LEGACY OF HIROSHIMA AND NAGASAKI 44–47 (1995).
[45] LOW, *supra* note 16, at 97.
[46] *Id*.
[47] Homei, *supra* note 27, at 218.
[48] MATASHICHI, *supra* note 15, at 30.
[49] Homei, *supra* note 27, at 221.
[50] *Id*.
[51] MATASHICHI, *supra* note 15, at 82.
[52] Brian Wynne, *Sheepfarming After Chernobyl: A Case Study in Communicating Scientific Information*, 31 SCI. & POL'Y SUSTAINABLE DEV. 10, 12 (1989) [hereinafter Wynne, *Sheepfarming After Chernobyl*]. Much of the work in sociology on the Cumbrian Fells sheep comes from Brian Wynne, and his work is cited extensively throughout this Essay.

Cumbria showed dangerously elevated levels of cesium isotopes.[53]

The government initially dismissed any concerns.[54] On May 6, 1986, four days after the upland thunderstorms, Secretary of State for the Environment, Kenneth Baker, told Parliament that "the effects of the cloud have already been assessed," which wasn't true, "and none represents a risk to health in the United Kingdom," which, it turned out, was also not true.[55] Seven days later, Minister Baker announced that "the incident may be regarded as over" by the end of the week.[56] That was also off the mark. The head of the National Radiological Protection Board conceded that the Chernobyl explosion could lead to a "a few tens" of extra cases of cancer in the U.K. over the following fifty years.[57] By May 16, the government ended its daily briefings on cesium levels in Cumbria, reasoning that all had returned to normal.[58] This mirrored the government's behavior during its alleged cover-up of nuclear contamination from the Sellafield nuclear reprocessing complex in the nearby Lake District of Cumbria.[59] Sellafield was the site of the worst nuclear facility incident before Chernobyl, and many hill sheep farmers lost faith in government after Sellafield due to its failure to fully explore and be transparent about any nearby contamination and its accompanying health effects.[60]

By the end of May, the Conservative Party-led government was backpedaling. The Ministry of Agriculture, Fisheries and Food (MAFF) found lamb meat samples recording dangerously high levels of cesium, far higher than the levels set by the European Economic Community as requiring

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[53] Brian Wynne, *Misunderstood Misunderstanding: Social Identities and Public Uptake of Science*, 1 PUB. UNDERSTANDING SCI. 281, 285 (1992) [hereinafter Wynne, *Misunderstood*].
[54] *Id*.
[55] Wynne, *Sheepfarming After Chernobyl*, *supra* note 52, at 13.
[56] *Id*.
[57] *Id*.
[58] *Id*. at 14.
[59] Brian Wynne, *Social Identities and the Public Uptake of Science*, *in* SOCIAL AND ETHICAL ASPECTS OF RADIATION RISK MANAGEMENT 283–288 (Deborah Oughton & Sven Hansson eds., 2013) [hereinafter *Social Identities*].
[60] *Id*.

government intervention.[61] Nearly a month later, on June 20, the government made an announcement that surprised everyone: The movement and slaughter of sheep in Cumbria and North Wales would be banned.[62]

MAFF said the ban would last three weeks.[63] This assessment was based on advice from nuclear physicists tasked by the government to investigate the Cumbrian sheep. They recognized the problem—radioactive cesium from Chernobyl showing up in soil in the Cumbrian Fells—as fitting neatly into their expertise. They knew the half-life of cesium isotopes in soil (about 20 days).[64] They also knew of studies demonstrating that cesium would be "locked up" or immobilized in soil and, after about a week, would no longer affect any grass growing out of the soil.[65] With that information, they believed they could predict with some level of mathematical certainty how long it would take for cesium levels to fall in the sheep.

They were wrong. Cesium levels rose in some areas. They stayed the same in others. Nowhere did the levels drop.[66] Despite this, government scientific advisers urged all Cumbrian sheep farmers to hang on to their contaminated sheep just a few more weeks.[67] They remained certain that cesium levels would soon drop.[68] That didn't happen, either. Despite the physicists' claims, a three-week moratorium on the sale and slaughter of sheep grazing in the now-contaminated Cumbrian Fells became an indefinite ban.[69] The last restrictions on sheep farming in Cumbria were removed not in

[61] Wynne, *Sheepfarming After Chernobyl*, *supra* note 52, at 13–14.
[62] Wynne, *Social Identities*, *supra* note 59, at 288.
[63] *Id*.
[64] Brian Wynne, *May the Sheep Safely Graze: A Reflexive View of the Expert-Lay Knowledge Divide*, *in* RISK, ENVIRONMENT AND MODERNITY: TOWARDS A NEW ECOLOGY 63 (Scot Lash et al. eds., 2012) [hereinafter Wynne, *May the Sheep Safely Graze*].
[65] Wynne, *Social Identities*, *supra* note 59, at 289.
[66] Wynne, *Sheepfarming After Chernobyl*, *supra* note 52, at 15.
[67] Wynne, *Social Identities*, *supra* note 59, at 289.
[68] Wynne, *Sheepfarming After Chernobyl*, *supra* note 52, at 15, 34.
[69] Wynne, *Social Identities*, *supra* note 59, at 288.

June 1986, when the three-week ban would have ended, but in July 2012, twenty-six years later.[70]

II. Lessons for Technology Expertise

Both the Lucky Dragon and the Cumbrian Fells are generative case studies about the production, performance, and use of expert knowledge.[71] They show how technoscientific expertise is mediated through nonexpert institutions. The case studies illustrate that claims of expertise in a new technology are really demands for privileged status for one type of knowledge among multiple sources of expertise about multifaceted, sociotechnical problems. They also show the risks of failing to account for indeterminacies when making tech policy. As this Part explores, optimism about the capacity of one form of expertise to solve social problems can be corrosive.

A. Mediating Expertise

Both incidents speak to the complex dynamics of technoscientific expertise in making policy decisions. For the Lucky Dragon, those who knew how to build a thermonuclear bomb made fallout calculations and assessed risks based on their expertise and knowledge. They then advised their superiors about the extent of a containment zone.[72] Ultimate decisions were made by the military and political leaders in charge. For the Cumbrian Fells, there were two types of experts with different bases of knowledge: the physicist and the sheep

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[70] *Post-Chernobyl Disaster Sheep Controls Lifted on Last UK Farms*, BBC NEWS (June 1, 2012), https://www.bbc.com/news/uk-england-cumbria-18299228 [https://perma.cc/7YYS-P6AC].

[71] They are also about a lot of other things. The Lucky Dragon incident can teach us much about US-Japanese relations after World War II, the ongoing debate among scientists about the hydrogen bomb, and the growth of post-War Japanese media. The Cumbrian Fells is a story about government transparency, the growing cultural divide between old and new in Thatcherite Britain, and the political economy of precarious industries like sheep farming. Each of these narratives is beyond the scope of this Essay, but each is discussed in the literature cited throughout.

[72] This is not the only possible chronology in technoscientific expertise influencing political decisions, but it is a common one described in the historical literature of technoscientific advice to presidents. *See* ZUOYUE WANG, IN SPUTNIK'S SHADOW: THE PRESIDENT'S SCIENCE ADVISORY COMMITTEE AND COLD WAR AMERICA 71–179 (2008).

farmer.[73] Each shared and performed their expertise using different strategies and customs. The former knew much about cesium, its half-life, and radioactive isotopes; the latter relied on generations of experience with Cumbrian soil, sheep, and grazing. The former spoke with the certainties offered by numbers and standardized experiments; the latter lived with the indeterminate interactions among weather, livestock, and plant life. Ultimately, when developing policies on sheep farming bans and containment zones, the government listened only to the physicists' advice.

These case studies highlight the fact that technoscientific expertise in policymaking contexts is mediated through political institutions.[74] Within the field of science and technology studies, to say expertise is mediated is to acknowledge that specialized knowledge is filtered, shared, interpreted, and applied through institutional and social processes.[75] Sometimes those processes are formal, such as a

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[73] Hence the title of this Essay. The title also alludes to the title of a book by Langdon Winner. LANGDON WINNER, THE WHALE AND THE REACTOR (2d ed. 2020).

[74] This is canon in Science and Technology Studies. *See, e.g.*, BRUNO LATOUR, THE PASTEURIZATION OF FRANCE (Alan Sheridan & John Law trans. 1988) (arguing that the institutional adoption of Louis Pasteur's discoveries depended on the aims, incentives, and positionality of social and political actors beyond the laboratory); BRUNO LATOUR, REASSEMBLING THE SOCIAL: AN INTRODUCTION TO ACTOR-NETWORK THEORY 5 (2005) (understanding "social" to mean the "trail of associations between heterogeneous elements," which includes expertise and political processes).

[75] LATOUR, PASTEURIZATION, *supra* note 74. The notion dates back to the pragmatists, who argued that all knowledge is mediated through experience. *See, e.g.*, Ruth Anna Putnam, *Dewey's Epistemology*, *in* THE CAMBRIDGE COMPANION TO DEWEY 39 (Molly Cochran ed., 2010); Kenneth W. Stikkers, *Dialogue Between Pragmatism and Constructivism in Historical Perspective*, *in* JOHN DEWEY BETWEEN PRAGMATISM AND CONSTRUCTIVISM 67, 77 (Larry A. Hickman et al. eds., 2009) (noting William James's conception of knowledge as "a function of our dynamic, creative interaction with the world"); Mark Johnson, *Cognitive Science and Dewey's Theory of the Mind, Thought, and Language*, *in* JOHN DEWEY BETWEEN PRAGMATISM AND CONSTRUCTIVISM 123, 136. The STS version is more social; it argues that knowledge and science are mediated through individuals and institutions. A related canon in law and technology scholarship is that networked information technologies mediate users' relationships to and experience with the world. *See* Julie E. Cohen, *What Privacy is For*, 126 HARV. L. REV. 1904, 1912–1913 (2013).

Daubert hearing in court,[76] or a consensus report written by a technoscientific advisory committee and shared with political staff and decisionmakers. Other times the mediation is informal, with technoscientific experts providing ad hoc advice to decisionmakers on specific questions.[77] Setting containment zones and banning the sale of sheep are political decisions informed by technoscientific advice. Technoscientific knowledge (along with its embedded assumptions) had to pass through military and political leaders.

This has several implications. The mediation of expertise necessarily means the translation of expertise. Technoscientific experts may adapt their advice to make their recommendations more palatable to political decisionmakers. They may minimize the uncertainties that come with any scientific prediction when faced with nonexperts who demand definite answers. Experts may emphasize some data and minimize others to maintain credibility and maintain their positions at the decision-making table.[78] Experts may engage in any number of other communication and performance strategies to share their expertise. Experts also have their own incentives and goals. Policymakers and the public should understand expert knowledge as filtered through the ordinary social systems that affect us all.[79]

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[76] *See, e.g.*, WANG, *supra* note 72; SHEILA JASANOFF, SCIENCE AT THE BAR: LAW, SCIENCE, AND TECHNOLOGY IN AMERICA (1995).

[77] There are many mediating processes outside of politics, as well. Journalists mediate expertise when integrating that expertise into pieces for consumption by lay publics. Bloggers and so-called influencers on social media are now mediators of expertise, as well. Technologies can also mediate expertise, as when experts disseminate their knowledge via television, streaming, or social media services. Their expertise is subject to technical constraints and distributed algorithmically, filtering both what and how information is communicated and affecting who gets to see it.

[78] *See, e.g.*, Wynne, *Misunderstood*, *supra* note 53; Steven Shapin, *Cordelia's Love: Credibility and the Social Studies of Science*, 3 PERSPECTIVES ON SCI. 255 (1995); THOMAS GIERYN, CULTURAL BOUNDARIES OF SCIENCE (1999).

[79] To be clear, that is not the same as saying expert knowledge is pure politics. Rather, it suggests that when understanding expert knowledge, policymakers and scholars must acknowledge the social processes that filter it as it moves from the laboratory and into the political space. Plus, the argument, often repeated in the administrative law literature, that agency experts are influenced by their own self-interest may be overstated; the argument ignores the institutional structures that channel agency work

One response might be to insulate technoscientific expertise from politics. However, that is not possible when the expertise is used to inform what are inherently political decisions.[80] Rather, our goal should be to ensure that expert advice is channeled through social and political systems that are designed to advance the public interest. The historian Zuoyue Wang has argued that during the height of scientific advising to U.S. presidents in the post-World War II era, the mediation of scientific expertise in the public interest was often achieved because of a rough consensus among scientists and politicians across the political spectrum about the goals of American nuclear policy.[81] Achieving that kind of consensus may be difficult in today's polarized politics, but government can, at a minimum, certainly do a better job of looking beyond profit-seeking industries for their technoscientific experts.

This hints at another lesson of the Lucky Dragon and the Cumbrian Fells. As the next section illustrates, both incidents—like all policy decisions involving technology and science—involve more than just technology and science. Policymakers must widen their aperture when thinking about what kinds of expertise are relevant.

B. Expertise in Sociotechnical Systems

Both the Lucky Dragon and Cumbrian Fells incidents centered the expertise of physicists and other scientists with knowledge and experience in nuclear power and weaponry. For the Lucky Dragon, the scientists involved in the Bravo bomb test used their expertise to set a fallout zone based on their assessment of the likely strength of the nuclear explosion. For the Cumbrian Fells, government nuclear scientists used their knowledge of cesium isotopes and the current literature in their field to make conclusions about the effects of cesium in the soil.

But both policies were about more than just physics. Weather, topography, and medical conditions of victims play important roles in determining risk from nuclear fallout. Those

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toward the public interest. *See, e.g.*, Sidney Shapiro, *The Failure to Understand Expertise in Administrative Law*, 50 WAKE FOREST L. REV. 1097, 1130-34 (2015).

[80] Waldman, *Civil Society*, *supra* note 8, at 1113–14.

[81] Wang, *supra* note 72, at 5–6.

who set the no-go zone near Bikini failed to properly account for wind blowing ash and rain across the Pacific. They had little knowledge about the effect of the Marshall Islands' climate on radioactive fallout. They knew even less about how exposure to a new thermonuclear device would affect those who had already been exposed to nuclear radiation. They never considered—or perhaps, never cared about—the possibility that fishing vessels may not have learned about the Bravo test before leaving port.

Meanwhile, those who told the U.K. government to set a three-week ban on Cumbrian sheep knew almost nothing about Cumbrian soil, the region's wet weather, and the daily activities of upland mountain sheep.[82] Nor did they account for local farmers' deep distrust of and skepticism about government science policy since the alleged cover-up of the Sellafield leak. Government scientists conducted tests on the sheep but ignored sheep farmers' warning that their methods, which included fencing in sheep that were normally accustomed to open roaming, would ruin the experiments.[83] Experts also recommended moving affected sheep down the mountainside where the cesium levels were lower, but they had no idea that moving sheep was not practically possible.[84]

The lack of multidomain expertise about multifaceted problems affected scientists' policy recommendations. The Lucky Dragon danger zone was publicized late and expanded months after the Bravo test.[85] In Cumbria, scientists based their projections on tests showing that cesium would not spread through soil that were conducted on alkaline clay soil, not on the acidic, peaty soils of the Cumbrian uplands.[86] That difference proved important. In peaty soils that get a lot of rain, as Cumbria does, cesium is not immobilized; it spreads and recycles.[87] Given this, the three-week ban and expert recommendations to keep contaminated sheep for a short time seems absurd.

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[82] Wynne, *May the Sheep Safely Graze*, *supra* note 64, at 63–64.
[83] Wynne, *Misunderstood*, *supra* note 53, at 287.
[84] *Id*.
[85] Matashichi, *supra* note 15, at 30.
[86] Wynne, *Misunderstood*, *supra* note 53, at 286.
[87] Wynne, *May the Sheep Safely Graze*, *supra* note 64, at 64.

Therefore, these incidents highlight the fact that expertise is almost always limited. The social theorist Niklas Luhmann argues that, at its core, expertise is just a promise of knowledge about a new or future problem that one person can rarely fulfill: "an expert is a specialist to whom one can put questions that he is unable to answer."[88] Reporters ask privacy lawyers to comment on new data-extractive products not because they know everything about those products, but because lawyers have knowledge and experience about one relevant area. Good reporters would also want to speak to technologists to learn how the artefacts work, to sociologists to understand the forces affecting its construction and use, to political scientists to see where the product fits into larger political debates, and to community members likely affected by the product as well. They not only have different perspectives; they bring different forms of expertise to different parts of the problem.

This is particularly true for policy about technology. Technologies—from nuclear power in our case studies to machine learning and AI today—are multidimensional and embedded within social systems.[89] Victims of the Lucky Dragon incident faced not only radiation poisoning, but cultural memories of Hiroshima and Nagasaki, a sharpening cold war, rising tensions with the U.S. amid the need for a strong alliance, and professional conflicts between Japanese and U.S. experts. Cumbrian sheep farmers faced the potential extinction of their industry but resisted too much reliance on

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[88] GOTTHARD BECHMANN, THE RISE AND CRISIS OF SCIENTIFIC EXPERTISE, IN EXPERTISE AND ITS INTERFACES 23 (Niklas Luhmann & Imre Hronzsky eds., 2003) (quoting Luhmann) (gendered pronouns in original).

[89] This insight is indebted to Science and Technology Studies (STS) scholars. *See, e.g.*, LANGDON WINNER, THE WHALE AND THE REACTOR ix (2d ed. 2020); Trevor J. Pinch & Wiebe E. Bijker, *The Social Construction of Facts and Artifacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other*, 14 SOCIAL STUDS. SCI. 399 (1984); Maranke Wieringa, *What to Account for When Accounting for Algorithms*, FAT*'20: PROC. OF THE 2020 CONF. ON FAIRNESS, ACCOUNTABILITY, AND TRANSPARENCY, Jan. 27, 2020, at 1, 10, https://doi.org/10.1145/3351095.3372833 [https://perma.cc/WXE5-3TNR]; Andrew Selbst, danah boyd, Sorelle Friedler, Suresh Venkatasubramanian & Janet Vertesi, *Fairness and Abstraction in Sociotechnical Systems*, FAT*'19: PROC. OF THE 2019 CONF. ON FAIRNESS, ACCOUNTABILITY, AND TRANSPARENCY, Jan. 29, 2019, at 59, 60, 63.

the government's nuclear experts after the lack of transparency after the Sellafield disaster. Both incidents provoked anti-government sentiment.[90] Both involved the revictimization of groups previously targeted or harmed by nuclear power. At the same time, both narratives involved highly technical details that members of the public wanted to understand; expertise can play important roles in the production and dissemination of that knowledge.

However, no one person or even one entire field of expertise has the precise and multidomain knowledge needed to fully understand a new and multifaceted technology.[91] Some expertise does not exist yet. Some people may be experts in some part of a problem, but they may only see and understand the risks that fall within their field, leading to skewed and incomplete policy proposals.[92] Worse yet, policy dominated by experts in one field may fall victim to domain-specific bias and conceptualize all problems as one that falls neatly within their bailiwick of experience and methodologies.[93] To be clear, that is not to suggest that just anyone should set no-go zones for nuclear bomb tests. Expertise in nuclear physics is necessary to do that. But it is also true that expertise in nuclear physics is not the only necessary piece of the puzzle.

Learning this lesson today might mean first asking why certain groups of experts are automatically given policymaking privilege on certain topics. Does knowledge of coding or a degree in computer science entitle a person to priority when making policy on AI? Does knowledge of molecular biology and experience with the chemical makeup of vaccines mean that person should set public health vaccine policy? Does experience selling credit default swaps give a person expertise to advise on financial policy? The answers to these questions depend on context but it seems clear that there can be a disconnect between someone's admitted expertise in the underlying artefact and the tools necessary to make good policymaking about that artefact.

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[90] *See* Wynne, *Misunderstood*, *supra* note 53, at 285.
[91] EYAL, *supra* note 1, at 66.
[92] *Id*.
[93] ABRAHAM MASLOW, THE PSYCHOLOGY OF SCIENCE: A RECONNAISSANCE 15 (1966).

Policymakers might also want to hear from a variety of experts when making policy on complex, sociotechnical matters. In her study of privacy policymaking, the political scientist Priscilla Regan identified no less than seven groups that could claim some expertise in policy discussions about protecting privacy on mobile applications.[94] With respect to AI, "[u]nderstanding algorithmic harms requires a broader community of experts: community advocates, labor organizers, critical scholars, public interest technologists, policy makers, and the third-party auditors who have been slowly developing the tools for anticipating algorithmic harms."[95] Lay expertise, which figures prominently in abolitionist critiques of carceral systems,[96] should also be included.

C. The Problem of Indeterminacy

In our case studies, scientific and technical expertise accompanied a professional commitment to quantification, a methodology of problem solving based on the reduction of uncertainties to numbers.[97] In the Lucky Dragon incident, scientists determined the bomb's fallout zone by creating a

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[94] Priscilla Regan, *Pathways to Information Privacy Policy: Pluralist or Expert?*, 25 BERKELEY TECH. L.J. 717, 739 (2020).

[95] Emanuel Moss et al., *Assembling Accountability: Algorithmic Impact Assessment for the Public Interest*, DATA & SOC'Y 6–7 (2021), https://datasociety.net/wp-content/uploads/2021/06/Assembling-Accountability.pdf [https://perma.cc/LU9V-NBGJ].

[96] *See, e.g.*, Ngozi Okidegbe, *To Democratize Algorithms*, 69 UCLA L. REV. 1688, 1732–34, 1737–40 (2023) (arguing that representatives from communities subject to police surveillance should sit on local commissions that could critically assess and resist police use of algorithmic surveillance); Jocelyn Simonson, *Democratizing Criminal Justice Through Contestation and Resistance*, 111 NW. L. REV. 1609, 1612 (2017) (calling for "adversarial, contestatory forms of [lay] participation and resistance" in criminal justice to "build power and push for transformation" of a biased system); Jessica Eaglin, *The Categorical Imperative as a Decarceral Agenda*, 104 MINN. L. REV. 2715, 2739 (2020) (arguing that reliance on elite experts to achieve significant decarceration is misguided and recommending that laypersons be involved in shaping criminal justice agendas); Seda Gürses, Arun Kundnani & Joris van Hoboken, *Crypto and Empire: The Contradictions of Counter-Surveillance Advocacy*, 38 MEDIA, CULTURE & SOC'Y 576, 587 (2016) (calling for the inclusion of "those whose lives are supposed to be improved by the deployment of counter-surveillance technologies" in the design process).

[97] HOOS, *supra* note 13, at 125–27.

radius around the test site and calculating the likely extent of any fallout based on the bomb's expected strength, the altitude at which the bomb was to be detonated, and other quantifiable metrics. In the Cumbrian Fells case, the government's nuclear experts initially set a short window of contamination based on the half-life of cesium isotopes and testing showing the levels of cesium in the soil. Both cases reflected "normal science,"[98] or attempts to predict "the behavior of an agent," either cesium or bomb fallout, "by extrapolating from" what scientists knew about the agent, making assumptions along the way to come up with a quantified result.[99]

Quantification reduces uncertainties to numbers and works best on quantifiable problems.[100] However, that is easier said than done. Making policy involving "unknown unknowns" like the behavior of people and weather often means that tangible metrics fall away, the problem becomes less defined, and myriad nonquantifiable aspects arise.[101] As Sally Engle Merry argued, few problems in the real world are purely quantifiable; trying to force the square peg of reality into the round hole of numbers erases meaningful context necessary for thinking through problems.[102] "Soft" but crucial information is ignored, only "hard" data remains.[103]

This may have happened in both case studies. There is no way to quantify unexpected and repeatedly unexpected changes in weather. Had the scientists running the Bravo test considered the presence of unknown unknowns and appreciated their indeterminacy, the Bravo test may have looked different: The test may have been done at a lower altitude to reduce the fallout range; the danger zone could have been expanded to enhance safety; warnings would have been

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[98] THOMAS KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTIONS 5 (1962).
[99] Brian Wynne, *Uncertainty and Environmental Learning: Reconceiving Science and Policy in the Preventive Paradigm*, 2 GLOB. ENVT'L CHANGE 111, 115 (1992) [hereinafter Wynne, *Uncertainty*].
[100] Margot Kaminski, *Regulating the Risks of AI*, 103 B.U. L. REV. 1347, 1378 (2023); Lauren Willis, *Performance-Based Consumer Law*, 82 U. CHI. L. REV. 1309, 1373–74 (2015).
[101] Kaminski, *Risks*, *supra* note 100, at 1397.
[102] SALLY ENGLE MERRY, THE SEDUCTION OF QUANTIFICATION 1–2 (2016). *See also* HOOS, *supra* note 13, at 127.
[103] Laurence Tribe, *Technology Assessment and the Fourth Discontinuity: The Limits of Instrumental Rationality*, 46 S. CAL. L. REV. 617, 627 (1973).

publicized earlier. As it was, American scientists' confidence in their ability to reduce uncertainty to definite metrics contributed to significant harm to innocent Japanese fishermen.

Indeterminacies are even more pronounced in the Cumbrian Fells incident. There, sheep farmers warned government scientists that their proposal for a three-week restriction did not account for the indeterminate behavior of grazing sheep or the unique soil of the Fells.[104] Scientists could not "decide where and how to take samples," and when they did take samples, they found "variability in readings over small distances."[105] They found inconsistent background levels of cesium, and only gradually became "aware of the sheer number and variety of less controlled assumptions" that go into sheep farming.[106] As one farmer described, the scientists thought "a farm is a farm and a ewe is a ewe."[107] The reality is quite different. But the messiness of reality is washed away in a sea of quantifiable metrics. The scientists spoke with the kind of certainty and definiteness that comes from faith that the numbers tell the whole story. That should surprise no one: Quantification erases anything that isn't quantifiable.

Sociotechnical systems are replete with indeterminacy and unknown unknowns. That technologies with indeterminate outputs will interact with and, importantly, change society in indeterminate ways means that the tendency of certain types of expertise to try to reduce uncertainty to numbers is ill-suited to certain contexts.[108] Sociologists Michel Callon, Pierre Lascoumes, and Yannick Barthe called risk a "false friend" for this reason: Risk assessment attempts to quantify uncertainties, but in doing so, it implies that dangers are well identified and that whoever is doing the risk assessment knows how to calculate the odds of danger, that there exists some list of alternative actions, that the risks of those alternatives are also

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[104] Wynne, *May the Sheep Safely Graze*, *supra* note 64, at 64.
[105] Wynne, *Misunderstood*, *supra* note 53, at 293.
[106] *Id.*
[107] *Id.* at 297.
[108] Tribe, *supra* note 103, at 649–50 ("pursuing the technologies in question, for better or for worse, will profoundly alter what it means to be a human being. . . . At stake are . . . alterations in the very structures of human thought and reality on which all value premises and the choices that embody them . . . must be based.").

calculable, and that the risks and benefits are sufficiently fungible to place on alternate sides of a ledger.[109] That may work when modeling outcomes in the lab. But it is less likely to be true in practice.

In short, scientific and technical expertise accepts a "restricted agenda of defined uncertainties," particularly ones that are reduceable to numbers.[110] But social behavior, like other elements of the physical world, are contingent. A social, professional, or political commitment to quantification elides this.

This is not to say that all hope is lost or that omnipresent indeterminacy and the multifaceted nature of sociotechnical systems mean that policy should reflect whatever the people in power want. That misses the point of the Lucky Dragon and Cumbrian Fells incidents. These tragedies demand that policymakers embrace ignorance and indeterminacy as indispensable parts of the decision-making process. Policymakers need to know that their scientific advisers cannot fully model the world, only a slice of it. Scientists and technical experts need to know that their corner of expertise is not always suited to solve every social problem regardless of their faith in technical ways of thinking and quantification.

Of course, if the only thing policymakers care about is to achieve certain political ends regardless of reality or truth, then expertise does not matter. But the reality of ignorance and indeterminacy has direct policy implications. In environmental policy, respect for indeterminacy lends itself to more precautionary approaches, whereby preventative actions are taken without full and complete data based on the significant likely danger.[111] Precautionary principles may have saved lives on the Lucky Dragon #5 by having an expanded the danger zone. Embracing the uncertainties associated with cesium uptake in Cumbrian soil might have given sheep farmers a more predictable path forward, allowing them to adjust to new environmental realities before their industry was devastated.

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[109] MICHEL CALLON, PIERRE LASCOUMES & YANNICK BARTHE, ACTING IN AN UNCERTAIN WORLD 19, 20–21 (2009).
[110] Wynne, *Uncertainty*, *supra* note 99, at 115.
[111] *See generally* William Boyd, *With Regard for Persons*, 86 LAW & CONTEMP. PROBS. 101 (2023) (discussing precautionary approaches adopted by OSHA with respect to benzene).

The concepts of skepticism, ignorance, and indeterminacy will be explored in more depth in future work. For now, the Lucky Dragon and the Cumbrian Fells ask technoscientific policy and technoscientific experts to become more welcoming of indeterminacy and the added expertise needed to account for it.

Conclusion

This Essay asks scholars to consider lessons from the role of technoscientific expertise in two nuclear incidents of the last: the Lucky Dragon #5 and the Cumbrian Fells. Neither incident has received much attention in the legal literature.[112] Both involved technoscientific expertise mediated through social systems, featured complex sociotechnical systems, and were characterized by indeterminacies. The failure of decision-makers to take adequate account of all three of those features caused harm—and in the case of the Lucky Dragon #5, even death—to innocent bystanders. I have not made a complete effort to answer all the questions raised by these case studies. I do not have all of those answers. Although legal scholars have written extensively about technoscientific advice in courtrooms, the field of law and technology should pay greater attention to technoscientific expertise in policy contexts. This Essay is an initial attempt to look to history and to see what, if anything, scholars and policymakers can learn from the integration of scientific knowledge into political decision-making for making policy in today's highly technical world.

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[112] A Westlaw secondary source search revealed sixteen articles that mention the "Lucky Dragon." The phrase "Cumbrian Fells" does not appear at all. Nor does "Cumbria /s sheep."