CHAPTER THREE

ON CLIMATE CHANGE AND CYBER ATTACKS: LEVERAGING POLYCENTRIC GOVERNANCE TO HELP HEAL THE PLANET AND PROMOTE CYBER PEACE

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INTRODUCTION

It is difficult to think of two issues with a greater potential to negatively impact both our natural environment and the global economy than climate change and cyber attacks. Though the long-term estimates on both threats are notoriously hard to pin down, contested assessments on the cost of cyber attacks range from approximately $400 billion in 2014 to more than $10 trillion by 2018 (a figure, if true, far larger than estimates for the global illegal drugs market).[1] Similarly, the cost of climate change has been assessed at some $1.2 trillion annually, which is roughly 1.6 percent of global gross domestic product (GDP).[2] The price tag of delaying action to stem climate change has been calculated at more than 3 percent of global GDP—which would come to more than $150 billion annually in the United States alone—while the least-developed nations face losing more than 10 percent of their GDP.[3] Looking ahead, the White House has noted that "net mitigation costs increase, on average, by approximately 40 percent for each decade of delay."[4] In other words, there is an urgent, global need to mitigate the risk of both cyber insecurity and a changing climate. The question is how—and, more broadly, whether—twentieth-century multilateral solutions used to address other global collective action problems still resonate in the twenty-first century.[5]

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*Special thanks to Professor Dan Cole for his helpful comments and critiques of this chapter.

1. *See, e.g.*, CTR. FOR STRATEGIC & INT'L STUDIES, NET LOSSES: ESTIMATING THE GLOBAL COST OF CYBERCRIME 2 (2014), http://www.mcafee.com/us/resources/reports/rp-economic-impact-cybercrime2.pdf [https://perma.cc/HA7T-Q4JW]; Brian Taylor, *Cyberattacks Fallout Could Cost the Global Economy $3 Trillion by 2020*, TECHREPUBLIC (Feb. 20, 2014, 10:38 AM), http://www.techrepublic.com/article/cyberattacks-fallout-could-cost-the-global-economy-3-trillion-by-2020/ [https://perma.cc/5VY3-Z7MG]; *On the Front Lines Against Cyber Hackers*, CBS News (Sept. 15, 2016), http://www.cbsnews.com/videos/on-the-front-lines-against-cyber-hackers/.

2. *See Climate Change Is Already Damaging Global Economy, Report Finds*, THE GUARDIAN (Sept. 15, 2012), http://www.theguardian.com/environment/2012/sep/26/climate-change-damaging-global-economy [https://perma.cc/BV9Y-K3RT].

3. *See id.*; EXEC. OFFICE OF THE PRESIDENT, THE COST OF DELAYING ACTION TO STEM CLIMATE CHANGE 2 (2014), https://www.whitehouse.gov/sites/default/files/docs/the_cost_of_delaying_action_to_stem_climate_change.pdf [https://perma.cc/89HP-5VL3].

4. *Id.*

5. *See* Elinor Ostrom, *A Polycentric Approach for Coping with Climate Change* 6 (World Bank Group, Policy Research Working Paper No. 5095, 2009), http://www.iadb.org/intal/intalcdi/pe/2009/04268.pdf [https://perma.cc/J7M8-7K5Z] (explaining that

The Internet has become a prolific tool for economic development and free expression, disproving early assertions such as those by Professor Paul Krugman that the Internet's impact would barely rival the fax machine.[6] Indeed, according to the consultancy McKinsey & Company, more than $8 trillion is processed annually through e-commerce alone. Current estimates also suggest that cyberspace contributes some $1.6 trillion to the global economy, a figure larger than the GDP of Canada.[7] Estimates on the economic benefit of a healthy, stable global ecosystem are even more complicated to calculate, but those that have tried, such as the World Bank, have placed the figure in the trillions.[8]

Thus, much is to be gained by ascertaining effective interventions to promote both sustainable development and sustainable cybersecurity.[9] Indeed, the potential for a cross-pollination of best practices between these regimes beckons. Although the atmosphere and cyberspace are distinct extraterritorial arenas, they share similar problems of overuse, difficulties of enforcement, and the associated challenges of collective inaction and free riders.[10] Moreover, billions of "actors affect the global atmosphere,"[11] just as they do the Internet.[12]

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there is "at least one outcome [that] yields higher returns for *all* who are involved, but participants posited as maximizing short-term benefits make independent decisions and are not predicated to achieve this outcome"). An earlier version of this chapter was published as Scott J. Shackelford, *On Climate Change and Cyber Attacks: Leveraging Polycentric Governance to Mitigate Global Collective Action Problems*, 18 VANDERBILT JOURNAL OF ENTERTAINMENT AND TECHNOLOGY LAW 653 (2016).

6. *See* Jay Yarow, *Paul Krugman Responds to All the People Throwing Around His Old Internet Quote*, BUS. INSIDER (Dec. 30, 2013, 9:06 AM), http://www.businessinsider.com/paul-krugman-responds-to-internet-quote-2013-12 [https://perma.cc/L5BC-C5BC].

7. *See* JAMES MANYIKA & CHARLES ROXBURGH, MCKINSEY GLOBAL INST., THE GREAT TRANSFORMER: THE IMPACT OF THE INTERNET ON ECONOMIC GROWTH AND PROSPERITY 1–2 (2011), http://www.mckinsey.com/insights/high_tech_telecoms_internet/the_great_transformer [https://perma.cc/R9RP-V4FU].

8. *See, e.g.*, *New Study Adds Up the Benefits of Climate-Smart Development in Lives, Jobs, and GDP*, WORLD BANK GROUP [WBG] (June 23, 2014), http://www.worldbank.org/en/news/feature/2014/06/23/study-adds-up-benefits-climate-smart-development-lives-jobs-gdp [https://perma.cc/A7Z7-URXD].

9. *See* Scott J. Shackelford & Timothy L. Fort, *Sustainable Cybersecurity: Applying Lessons from the Green Movement to Managing Cyber Attacks*, 2016 U. ILL. L. REV. 1995 (2016) (laying out the argument for applying concepts from the field of sustainable development to addressing an array of cybersecurity issues).

10. *See* Ostrom, *supra* note 5, at 8 ("[Free riders] enjoy the benefit of others' restraint in using shared resources or others' contribution to collective action.").

11. *Id*. at 6.

12. However, it should be noted that fewer actors utilize the Internet than the atmosphere, though more than three billion people were online as of March 2016. *Countries*, INTERNET WORLD STATS (Mar. 28, 2016), http://www.internetworldstats.com/list2.htm [https://perma.cc/CUZ4-3MC4].

With weather patterns shifting, global sea levels rising, and temperatures likely to exceed 1.5 degrees Celsius by 2100, climate change is a problem affecting the entire world, but it is a problem with dispersed economic benefits and often-concentrated environmental harms.[13] Similarly, much of the cost of cyber attacks is concentrated in a relatively small number of nations even as others are becoming havens for cybercriminals.[14]

Yet it is also true that actions taken by a multiplicity of actors on small and medium scales can impact both the global climate change problem and the cause of promoting a global culture of cybersecurity. This relationship is part and parcel of the literature on polycentric governance, which is quickly coming into vogue as the preferred model of tackling "new" global collective action problems, marking a shift from twentieth-century models of global commons governance.[15] As was discussed in Chapter One, a "commons" is a general term meaning "a resource shared by a group of people."[16] The notion of the global commons posits that there are limits to national sovereignty in certain parts of the world and that these areas should be "open to use by the [international] community but closed to exclusive appropriation" by treaty or custom.[17] At its height, the global commons comprised nearly 75

13. Ostrom, *supra* note 5, at 8; *see* JONATHAN M. HARRIS & BRIAN ROACH, THE ECONOMICS OF CLIMATE CHANGE 8 (2009); INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE [IPCC], CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS SUMMARY FOR POLICYMAKERS 18 (2013), https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf [https://perma.cc/3774-XRT9]; *Overview of Impact, Adaptation, and Vulnerability*, IPCC (Feb. 28, 2016), http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=55 [https://perma.cc/FK73-QEMM].

14. *See* Rachael King, *Countries with the Most Cybercrime*, BLOOMBERG BUS. (2012), http://www.bloomberg.com/ss/09/07/0707_ceo_guide_security/1.htm [https://perma.cc/4H75-5GJ9] (noting that the United States, China, and Germany together comprise nearly 40 percent of global cybercrime); *see also* INT'L TELECOMMS. UNION [ITU], GLOBAL CYBERSECURITY INDEX & CYBERWELLNESS PROFILES 1 (2015) (ranking nations in terms of their vulnerability to and mitigation strategies for cyber attacks).

15. *See* 1 ELINOR OSTROM & THE BLOOMINGTON SCH. OF POLITICAL ECON., POLYCENTRICITY IN PUBLIC ADMINISTRATION AND POLITICAL SCIENCE 118 (Michael D. McGinnis & Dan Cole eds., 2015).

16. Charlotte Hess & Elinor Ostrom, *Introduction: An Overview of the Knowledge Commons*, *in* UNDERSTANDING KNOWLEDGE AS A COMMONS: FROM THEORY TO PRACTICE 3, 3 (Charlotte Hess & Elinor Ostrom eds., 2006).

17. CHRISTOPHER C. JOYNER, GOVERNING THE FROZEN COMMONS: THE ANTARCTIC REGIME AND ENVIRONMENTAL PROTECTION 222 (1998) (defining a global commons and positing that Antarctica may qualify as a global commons suitable to the application of the CHM concept); Geert van Calster, *International Law and Sovereignty in the Age of Globalization*, *in* ENCYCLOPEDIA OF LIFE SUPPORT SYSTEMS 2–3 (2015), http://www.eolss.net/Sample-Chapters/C14/E1-36-01-04.pdf [https://perma.cc/664G-AM6L].

percent of the Earth's surface, including the high seas, Antarctica, and outer space as will be discussed in Chapters Four and Five, as well as the atmosphere, and (some argue) cyberspace, which are the extraterritorial topics for this chapter.[18] As has been explained, some of these regions—particularly the deep seabed and outer space—were gradually regulated to a greater or lesser extent not by individual countries, but by the international community through the vague Common Heritage of Mankind (CHM) concept that promotes the equitable distribution of scarce resources.[19] More recently, this trend has reversed itself with the rise of polycentric accords.[20]

Increasingly, leaders across an array of fields, from the former President of Estonia and the former Director of the Internet Corporation for Assigned Names and Numbers (ICANN) to Nobel Laureates, have proffered polycentric governance as the best path forward to addressing the global collective action problems of climate change and cyber attacks.[21] Surprisingly, there is a paucity of literature tracing the promise and pitfalls of polycentricity across both regimes.[22] It is the goal of this chapter to help begin

18. *See, e.g.*, Mark E. Redden & Michael P. Hughes, *Global Commons and Domain Interrelationships: Time for a New Conceptual Framework?*, 259 INST. ON NAT'L STRATEGIC STUDIES 1–3 (2010) (merging the traditional civilian definition of global commons, which includes Antarctica, and emphasizing the importance to the US military of operating throughout the global commons).

19. *See* KEMAL BASLAR, THE CONCEPT OF THE COMMON HERITAGE OF MANKIND IN INTERNATIONAL LAW xix–xx (1998) (describing the history of international efforts to bring the seabed, ocean floor, and outer space resources, such as the moon, within the Common Heritage of Mankind (CHM)).

20. *See* Daniel H. Cole, *Advantages of a Polycentric Approach to Climate Change Policy*, 5 NATURE CLIMATE CHANGE 114, 114 (2015) (noting that the "need to pay more attention to existing and potential subglobal climate policies" be they under a heading of 'polycentric,' or "'building blocks,' 'regime complexes' or 'bottom-up systems.'").

21. *See* Nancy Scola, *ICANN Chief: "The Whole World Is Watching" the U.S.'s Net Neutrality Debate*, WASH. POST (Oct. 7, 2014), https://www.washingtonpost.com/blogs/the-switch/wp/2014/10/07/internet-operations-chief-snowden-disclosures-make-my-job-easier/ [https://perma.cc/YJ7B-C3YC].

22. *Cf.* Myanna Dellinger, *An Unstoppable Tide: Creating Environmental and Human Rights Law from the Bottom Up*, 15 OR. REV. INT'L L. 63 (2013) (analyzing the potential of polycentric governance to promote legal development in the fields of human rights and environmental law). For background on the application of polycentric principles to the cause of climate governance generally, see Cinnamon P. Carlarne, *Rethinking a Failing Framework: Adaptation and Institutional Rebirth for the Global Climate Change Regime*, 25 GEO. INT'L ENVTL. L. REV. 1 (2012); Jeffrey L. Dunoff, *From Green to Global: Toward the Transformation of International Environmental Law*, 19 HARV. ENVTL. L. REV. 241 (1995); Celeste Hammond, *The Evolving Role for Transactional Attorneys Responding to Client Needs in Adapting to Climate Change*, 47 J. MARSHALL L. REV. 543 (2013); Stephen Kim Park & Gerlinde Berger-Walliser, *A Firm-Driven Approach to Global Governance and Sustainability*, 52 AM. BUS. L.J. 255 (2015); Josephine van Zeben, *Subsidiarity in European Environmental Law: A Competence Allocation Approach*, 38 HARV. ENVTL. L. REV. 415 (2014). For a more general background on the application of polycentric governance to addressing legal

such a conversation about the cross-pollination of governance best practices between these arenas while offering a framework for how and why governance of both the Internet and the atmosphere is changing to get a better sense of where we are heading and what we all can do to help ensure a more sustainable future.

This chapter investigates the extent to which the atmosphere and cyberspace are reminiscent of other parts of the global commons,[23] such as the deep seabed and outer space analyzed in Chapters Four and Five,[24] in that they are transitioning from a multilateral to a polycentric governance ecosystem. It also analyzes both the policy and practical implications of this transition. Part I examines the forces shaping climate change policies and Internet governance by focusing on technological advancement, resource scarcity, and multipolar politics. Part II then applies lessons from the history of cyberspace to contemporary issues in atmospheric governance. To this end, Part III traces the evolution of the climate change regime focusing both on the top-down UN Framework Convention on Climate Change and bottom-up bilateral and regional efforts. Part IV then compares and contrasts this history with that of Internet

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challenges from reconceptualizing property rights to enhancing cybersecurity, see Amanda Craig, Scott J. Shackelford, & Janine Hiller, *Proactive Cybersecurity: A Comparative Industry and Regulatory Analysis*, 52 AM. BUS. L.J. 721 (2015); Jamie Prenkert & Scott J. Shackelford, *Business, Human Rights, and the Promise of Polycentricity*, 47 VAND. J. TRANSNAT'L. L. 451 (2014); Scott J. Shackelford, Timothy L. Fort, & Jamie Prenkert, *How Businesses Can Promote Cyber Peace*, 36 U. PA. J. INT'L L. 353 (2015); Scott J. Shackelford & Andraz Kastelic, *A State-Centric Cyber Peace? Analyzing the Current State and Impact of National Cybersecurity Strategies on Enhancing Global Cybersecurity*, N.Y.U. J. LEG. & PUB. POL'Y (forthcoming 2016); Scott J. Shackelford et al., *Using BITs to Protect Bytes: Promoting Cyber Peace and Safeguarding Trade Secrets through Bilateral Investment Treaties*, 52 AM. BUS. L.J. 1 (2015); Scott J. Shackelford, *Neither Magic Bullet Nor Lost Cause: Land Titling and the Wealth of Nations*, 21 N.Y.U. ENVTL. L.J. 272 (2014).

23. Robert O. Keohane & David G. Victor, *The Regime Complex for Climate Change* (Harvard Kennedy Sch., Discussion Paper 10-33, 2009), http://belfercenter.ksg.harvard.edu/files/Keohane_Victor_Final_2.pdf [https://perma.cc/HZ88-NUZD] (arguing that a "global commons" is a descriptive term referring to "a resource that it is difficult or impossible to exclude others from enjoying but that is degraded by use") (later published as Robert O. Keohane & David G. Victor, *The Regime Complex for Climate Change*, 9 PERSPECTIVES ON POLITICS 7 (2009)); *see also* CHRISTOPHER C. JOYNER, GOVERNING THE FROZEN COMMONS: THE ANTARCTIC REGIME AND ENVIRONMENTAL PROTECTION 221, 255 (1998) (discussing the global commons in the context of Antarctic governance).

24. *See* Scott J. Shackelford, *Was Selden Right? The Expansion of Closed Seas and Its Consequences*, 47 STAN. J. INT'L L. 1, 2, 22 (2011) (taking a similar approach analyzing the expansion of closed seas and its consequences); *see also* Scott J. Shackelford, *Governing the Final Frontier: A Polycentric Approach to Managing Space Weaponization and Debris*, 51 AM. BUS. L.J. 429, 430–33 (2014) (analyzing the extent to which polycentric governance may help mitigate the dual issues of orbital debris and space weaponization).

governance. The potential of polycentric governance to mitigate the two global collective action problems of climate change and cyber attacks is assessed in Part V along with a study of regime effectiveness.

II. THE INFLUENCE OF TECHNOLOGY, RESOURCE SCARCITY, AND MULTIPOLAR POLITICS ON CLIMATE CHANGE AND CYBER ATTACKS

Three variables provide a useful analytical framework for investigating the evolution of both climate and Internet governance. First, the technological advancements that gave birth to cyberspace are also shaping both the pace of climate change and the manner in which it may be addressed.[25] Second, growing resource scarcity is influencing governance decisions in both domains, as it exists across the global commons.[26] Third, the structural variable of multipolar politics that has evolved subsequent to the end of the Cold War and the United States' "unipolar moment" is fracturing multilateral forums and has made reaching consensus on governance questions increasingly difficult. Each variable is introduced and analyzed in the context of the tragedy of the atmospheric and cyber pseudo commons.[27]

A. Technological Advancements

In many ways, the history of the Internet can be read as a story highlighting the triumph of technology and group

25. *See* Adnan Z. Amin, *The Economics of Renewable Energy: Falling Costs and Rising Employment*, HUFFINGTON POST (May 27, 2015, 1:21 PM), http://www.huffingtonpost.com/adnan-z-amin/the-economics-of-renewabl_b_7452996.html [https://perma.cc/82M9-VK3H].

26. *See, e.g.*, Shane Streifel, John Baffes, & Betty Dow, *Global Commodity Watch*, WORLD BANK (Sept. 21, 2010), http://blogs.worldbank.org/prospects/global-commodity-watch-0 [https://perma.cc/47JK-A5YC] (reporting changes in commodity prices from 1980 to 2010); *see* Patrick M. Cronin, *Foreword* to SECURING FREEDOM IN THE GLOBAL COMMONS ix (Scott Jasper ed., 2010).

27. As was introduced in Part I, the pseudo commons represents a compromise position between competing models of cyber regulation, namely those espousing Internet sovereignty and Internet freedom. *See* JOSEPH S. NYE, JR., CYBER POWER15 (May 2010), http://belfercenter.ksg.harvard.edu/files/cyber-power.pdf (referring to cyberspace as an "imperfect commons"); Press Release, Ind. Univ., London Conference Reveals 'Fault Lines' in Global Cyberspace and Cybersecurity Governance (Nov. 7, 2011), http://newsinfo.iu.edu/news/page/normal/20236.html [https://perma.cc/CEB2-CPXC]; SCOTT J. SHACKELFORD, MANAGING CYBER ATTACKS IN INTERNATIONAL LAW, BUSINESS, AND RELATIONS: IN SEARCH OF CYBER PEACE 54 (2014). It should also be noted that other variables doubtless also play an important role in shaping how and why these regimes have evolved in the ways in which they have, such as implicit national security concerns, but have been factored to the extent possible within these three meta variables.

innovation.[28] Cyberspace is a unique in that it is artificial. As such, technological improvement not only helps scale functionality in cyberspace, but technology also introduces technical vulnerabilities that threaten to undermine public trust in the system. For example, modern smartphones can be used as microphones even when they are turned off,[29] and Microsoft found that malware installation was part of the personal computer production process in East Asian factories.[30] The explosion in Internet usage enabled by technological advancements has also put a strain on existing Internet governance structures, pushing ICANN, for example, to expand the number of Top-Level Domains it offers even as some nations seek to strengthen their "cyber sovereignty."[31] Such developments help illustrate the extent to which technological advancement is intimately intertwined with Internet governance even if there is no single magic bullet to neutralize these threats.

Similar to cyberspace, technological advancements played an important role in the rate of global climate change; the atmospheric concentration of greenhouse gases rose dramatically during the industrial revolution, and the greenhouse gas production rate accelerated after World War II.[32] Technology is also part of

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28. *See generally* WALTER ISAACSON, THE INNOVATORS: HOW A GROUP OF HACKERS, GENIUSES, AND GEEKS CRATED THE DIGITAL REVOLUTION (2014).

29. *See* Christopher Bucktin, *Spies Can Listen to Your iPhone Microphone Even If It Is Switched OFF, Experts Reveal*, DAILY MIRROR (June 10, 2014, 3:29 PM), http://www.mirror.co.uk/news/technology-science/technology/spies-can-listen-your-iphone-3670347 [https://perma.cc/GQD2-AA6U].

30. *Malware Inserted on PC Production Lines, Says Study*, BBC NEWS (Sept. 13, 2012), http://www.bbc.com/news/technology-19585433 [https://perma.cc/FZT5-F2UE].

31. *China Internet: Xi Jinping Calls for 'Cyber Sovereignty,'* BBC NEWS (Dec. 16, 2015), http://www.bbc.com/news/world-asia-china-35109453 [https://perma.cc/9NK2-R683]. For more on this topic, see Scott J. Shackelford et al., *Back to the Future of Internet Governance?*, GEO. J. INT'L AFF. (June 25, 2015), http://journal.georgetown.edu/back-to-the-future-of-internet-governance [https://perma.cc/CWS3-DURQ]. The end of each domain name (i.e., "dot-org" or "dot-com") indicates the top-level domain (TLD). *First New Generic Top-Level Domains Delegated*, INTERNET CORP. FOR ASSIGNED NAMES & NOS. [ICANN] (Oct. 23, 2013), http://www.icann.org/en/news/press/releases/release-23oct13-en [https://perma.cc/P4RW-8EW3]; *New Generic Top-Level Domains*, ICANN (Feb. 28, 2016), http://newgtlds.icann.org/en/announcements-and-media/video/overview-en [https://perma.cc/N2ZB-7BWF]. There are more country codes than countries because country-code TLDs are sometimes given to disputed territories. For a list of current TLDs, see *Root Zone Database*, INTERNET ASSIGNED NOS. AUTH. [IANA] (Feb. 28, 2016), http://www.iana.org/domains/root/db/ [https://perma.cc/DL3R-25UV].

32. *What Are the Greenhouse Gas Changes Since the Industrial Revolution?*, AM. CONST. SOC'Y (Feb. 28, 2016), http://www.acs.org/content/acs/en/climatescience/greenhousegases/industrialrevolution.html [https://perma.cc/D5V4-V3YG].

the solution to climate change, from energy efficiency innovations, such as breakthroughs in battery technologies, to the rise in alternative energy vehicles and distributed power generation.[33] However, as President Obama has stated, there is not one solution to the problem of global climate change.[34] Instead, an all-of-the-above approach is needed to meet global renewable energy targets,[35] as is also true in the cybersecurity context.

B. Demand for Services and Resource Scarcity

Although few might realize it given the rate at which the Internet has successfully scaled,[36] some aspects of cyberspace are increasingly scarce, including Internet Protocol (IP) address space. IP addresses are made up of 32-bit binary strings. "Bits" are the 1s and 0s (electronic pulses and non-pulses) of computer-speak. An IP version 4 (IPv4) address is the equivalent representation of a 32-bit binary string, which is split into four eight-bit sequences known as "bytes" that also correspond to one of the decimal strings.[37] Created in 1981, IPv4 allowed the creation of more than four billion IP addresses, which early Internet architects thought would be sufficient for expansion.[38] They were wrong. Europe started rationing IPv4 addresses in September 2012.[39]

33. *See, e.g.*, *The Clean Energy Economy in Three Charts*, U.S. DEP'T OF ENERGY (Jan. 6, 2014, 5:55 PM), http://energy.gov/articles/clean-energy-economy-three-charts [https://perma.cc/9E8K-ALXV].

34. *See* Jason Furman & Jim Stock, *New Report: The All-of-the-Above Energy Strategy as a Path to Sustainable Economic Growth*, COUNCIL OF ECON. ADVISERS, EXEC. OFFICE OF THE PRESIDENT (May 29, 2014, 11:30 AM), https://www.whitehouse.gov/blog/2014/05/29/new-report-all-above-energy-strategy-path-sustainable-economic-growth [https://perma.cc/8KKA-M8NT].

35. *Id*.

36. *See DNSSEC—The Path to a Secure Domain*, INT'L INFRASTRUCTURE FOUND. (Feb. 28, 2016), https://www.iis.se/english/domains/tech/dnssec/ [https://perma.cc/T7ZS-YQBB].

37. George Ou, *IP Subnetting Made Easy*, TECHREPUBLIC (Feb. 25, 1016, 4:25 AM), http://www.techrepublic.com/blog/data-center/ip-subnetting-made-easy-125343/ [https://perma.cc/MM6V-C2EL].

38. *See, e.g.*, Robert McMillan, *Coming This Summer: U.S. Will Run Out of Internet Addresses*, WALL ST. J. (May 13, 2015), http://www.wsj.com/articles/coming-this-summer-u-s-will-run-out-of-internet-addresses-1431479401; John Brzozowski, *IPv4 Depletion Not the Beginning of the End, it's Just the End of the Beginning*, COMCAST (Sept. 24, 2015), http://corporate.comcast.com/comcast-voices/ipv4-depletion-not-the-beginning-of-the-end-its-just-the-end-of-the-beginning.

39. *See* Mark Ward, *Europe Hits Old Internet Address Limits*, BBC NEWS (Sept. 14, 2012), http://www.bbc.com/news/technology-19600718 [https://perma.cc/Q9EH-LW4C]. Many countries have complained that IANA's IPv4 allocation unfairly favored the United States. *See* Yang Jingde & Liu Yang, *Interview: Internet IP Addresses Not Exhausted: ITU Official*, XINHUA (Feb. 14, 2011), http://news.xinhuanet.com/english2010/business/2011-02/14/c_13730415.htm [https://perma.cc/ET24-T69D]. There has been a movement to ensure that IPv6 allocations are more equitable. *See ITU and IPv6*, ITU (Feb. 28, 2016), http://www.itu.int/net/ITU-T/ipv6/ [https://perma.cc/X922-X2QJ].

Since 1992, engineers have been designing and attempting to implement a new system called IP version 6 (IPv6), which features a larger address space—on the order of billions of IP addresses for each person alive in 2013. Architects again imagine this scale to be inexhaustible.[40] Time will tell whether this view is accurate. As with IP address scarcity, there are also issues of overuse that can occur in cyberspace. For example, spam messages consume limited bandwidth, which have been called a form of "information pollution,"[41] and distributed denial of service attacks can cause targeted websites to crash because of too many requests for site access.[42]

As with cyberspace, there are many ways to conceptualize scarcity in terms of the climate. One is, simply put, the limited amount of clean air. Numerous authors, including Professor Peter Barnes, have analyzed the tragedy of the atmospheric commons, which predicts the gradual overexploitation of all common pool resources—including oceans and the atmosphere.[43] The atmosphere has a limited storage capacity, meaning that property rights must be defined so as to curtail the open access nature of the climate as well as mitigate the destructive behavior of free riders, such as through mechanisms like cap and trade systems.[44] This process, in essence, can turn a medium as amorphous as the atmosphere into something as definite as a parking garage; as Professor Barnes explains, "Whoever gets the [parking] spaces can use them, trade them, or sell them, but once the garage is full, that's it."[45] Much of the difficulty in the ongoing climate

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40. *See* Kaushik Das, *Top 10 Features That Make IPv6 'Greater' than IPv4*, IPV6 (Feb. 28, 2016), http://ipv6.com/articles/general/Top-10-Features-that-make-IPv6-greater-than-IPv4.htm [https://perma.cc/8V6L-G8XS].

41. David A. Bray, *Information Pollution, Knowledge Overload, Limited Attention Spans, and Our Responsibilities as IS Professionals* 1 (Glob. Info. Tech. Mgmt. Ass'n World Conference, 2008), http://ssrn.com/abstract=962732 [https://perma.cc/9526-GYNP]; *see also* Roger Hurwitz, *The Prospects for Regulating Cyberspace: A Schematic Analysis on the Basis of Elinor Ostrom,"General Framework for Analyzing Sustainability of Social Ecological Systems,"* 325 SCI. 419, 419–22 (2009) (arguing that aside from bandwidth, "the more important common pool resource is public or shared trust" that may be breached through cyber insecurities).

42. *See, e.g.*, Jonathan A. Ophardt, *Cyber Warfare and the Crime of Aggression: The Need for Individual Accountability on Tomorrow's Battlefield*, 2010 DUKE L. & TECH. REV. 1, 2–6, 10 n.35.

43. *See* PETER BARNES, WHO OWNS THE SKY? OUR COMMON ASSETS AND THE FUTURE OF CAPITALISM 34–35 (2003); David Feeny et al., *The Tragedy of the Commons: Twenty-Two Years Later*, 18 HUM. ECOLOGY 1, 1 (1990).

44. *See* BARNES, *supra* note 43, at 36.

45. *See id.*

negotiations discussed below turns on this question of which nations can pollute and to what degree. More explicitly, the question is how should property rights to clean air be distributed—how much clean air should go to developed nations that have enjoyed the status quo open access system and how much should go to less-developed nations. This debate over common but differentiated responsibilities in the atmosphere is similar to that which is occurring now with regard to allocating IPv6 address space.[46]

C. Multipolar Politics

The rise of multipolar politics has made it increasingly difficult to reach consensus through multilateral forums, including the United Nations itself in part because the higher number of interested parties increases the transaction costs of collective action.[47] The UK Ministry of Defense sums up the situation succinctly: "Out to 2040, the locus of global power *will* move away from the United States . . . and Europe towards Asia, as the global system shifts from a uni-polar towards a multi-polar distribution of power."[48] With the rise of multipolar (multiple power center) politics and the "Rest,"[49] distinctions between the West and the East, developing and developed countries, and the North and the South are impacting the development of international law generally[50] and both climate and cyber law specifically.[51] Indeed, the rise of new public and private cyber powers underscores this shift in international relations,[52]

46. *See, e.g.*, *ITU and IPv6*, ITU, http://www.itu.int/net/ITU-T/ipv6/ [https://perma.cc/GA3S-XDQX].

47. *See* EVERETT C. DOLMAN, ASTROPOLITIK: CLASSICAL GEOPOLITICS IN THE SPACE AGE 13–15 (2002).

48. DEV., CONCEPTS & DOCTRINE CTR., MINISTRY OF DEFENCE, STRATEGIC TRENDS PROGRAMME: GLOBAL STRATEGIC TRENDS—OUT TO 2040, 2010, at 10 (UK), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/33717/GST4_v9_Feb10.pdf [https://perma.cc/C38S-XNQG] [hereinafter DCDC].

49. *The Rise of the Rest*, FAREED ZAKARIA (May 3, 2008), http://fareedzakaria.com/2008/05/12/the-rise-of-the-rest/ [https://perma.cc/G4KU-5XVJ]. *But see* Richard N. Haass, *The Age of Nonpolarity: What Will Follow U.S. Dominance*, FOREIGN AFFAIRS, May–June, 2008, at 45.

50. *See* Matthew Happold, *Introduction* to INTERNATIONAL LAW IN A MULTIPOLAR WORLD 2 (Matthew Happold ed., 2012).

51. *See* OSCAR SCHACHTER, INTERNATIONAL LAW IN THEORY AND PRACTICE 9 (1991) (discussing the importance of power distribution among states in forming international law).

52. *See, e.g.*, Fareed Zakaria, *Excerpt: Zakaria's 'The Post-American World,'* NEWSWEEK (May 3, 2008), http://www.newsweek.com/excerpt-zakarias-post-american-world-89645 [https://perma.cc/6VFP-TDBJ]. *But see* Haass, *supra* note 52 (arguing for the emergence of "a nonpolar international system . . . characterized by numerous centers with meaningful power").

complicating international efforts to reach consensus on improving cybersecurity through multilateral organizations[53] even as the political and economic costs of the cyber threat mount.[54] Similarly, the difficulty faced by the international community in reaching a binding climate accord from the Kyoto Protocol to the 2015 Paris Agreement showcases both the difficulty of relying exclusively on the UN Framework Convention on Climate Change process and the promise of a polycentric approach. After all, even the Paris Agreement itself relies heavily on voluntary national reduction pledges to meet its greenhouse gas reduction goals.[55] This situation stands in marked contrast to other regimes, such as the law of the sea and outer space, that were largely negotiated during the Cold War at a time when agreement among the few principal powers—particularly the two superpowers—meant relatively quick regulatory advances when interests converged, as is discussed further below.[56]

D. Summary

Technological progress, resource scarcity, and the rise of multipolar politics are all exerting pressure on the form of both climate and Internet governance. Regulatory change must keep pace with technical, political, and economic change if the tragedies of the atmospheric and cyber pseudo commons are to be mitigated.[57] In order to determine whether such regulatory change is occurring with sufficient speed, the evolution of climate law and

53. *See* COMM'N ON GLOB. GOVERNANCE, OUR GLOBAL NEIGHBOURHOOD 10 (1995); Danielle Kelh & Tim Maurer, *Did the U.N. Internet Governance Summit Actually Accomplish Anything?*, SLATE (Dec. 14, 2012, 4:43 PM),http://www.slate.com/blogs/future_tense/2012/12/14/wcit_2012_has_ended_did_the_u_n_internet_governance_summit_accomplish_anything.html [https://perma.cc/H6RP-HFCQ].

54. *See* REIN MÜLLERSON, INTERNATIONAL LAW, RIGHTS AND POLITICS: DEVELOPMENTS IN EASTERN EUROPE AND THE CIS 38–40 (1994) (discussing the shifting character of international relations after the end of the Cold War); Mark MacCarthy, *What Payment Intermediaries Are Doing About Online Liability and Why It Matters*, 25 BERKELEY TECH. L.J. 1037, 1114 (2010) (analyzing the potential for a tragedy of the cyber commons); Elisabeth Bumiller & Thom Shanker, *Panetta Warns of Dire Threat of Cyberattack on U.S.*, N.Y. TIMES, Oct. 11, 2012, at A1.

55. *See, e.g.*, Coral Davenport, *Nations Approve Landmark Climate Accord in Paris*, N.Y. Times (Dec. 12, 2015), http://www.nytimes.com/2015/12/13/world/europe/climate-change-accord-paris.html?emc=edit_na_20151212&nlid=52536178&ref=cta&_r=0 [https://perma.cc/TJ5B-AG6P].

56. *See infra* Part III.A.

57. Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243, 1245 (1968) (discussing the causes of the classic tragedy of the commons).

policy as well as Internet governance must be reviewed to provide a foundation for analysis.

III. AN INTRODUCTION TO GLOBAL CLIMATE CHANGE LAW AND POLICY

It is beyond the scope of this chapter to provide a comprehensive grounding in the history of climate law and policy. Numerous helpful and up-to-date volumes are already available on that topic.[58] Rather, the goal here is to briefly survey the literature with a special emphasis on the role played by technological advancement, scarcity, and multipolar politics on driving the type and pace of regulatory change before comparing these developments with the field of Internet governance. Special attention is paid to the post-Kyoto Protocol timeframe starting with the 2009 Copenhagen Accord. What has come since then is the most relevant for discussions of the 2015 UN Conference of the Parties in Paris (COP21). Increasingly polycentric regulatory structures are being favored by environmental stakeholders, as has long been the case in cyberspace, setting up a comparative analysis of governance best practices undertaken in Part V.

A. Early History: 1972 Stockholm Conference to the 1992 Earth Summit

The birth of the modern international environmental law movement may be traced in many ways to Rachel Carson's 1962 book, *Silent Spring*, which documented the effects of widespread pesticide use in the United States.[59] The public outcry following its publication was intense and grew over time, touching off an array of environmental movements focusing on issues ranging from toxic waste to air and water pollution. These efforts culminated in the first Earth Day on April 22, 1970, which remains the largest public demonstration in US history with more than twenty million Americans participating.[60] Such a groundswell of support laid the foundation for a slew of environmental legislation in the United States, from the 1970 Clean Air Act to the 1973

58. *See, e.g.*, JOYEETA GUPTA, THE HISTORY OF GLOBAL CLIMATE GOVERNANCE (2014).

59. *See, e.g.*, *DDT: A Brief History and Status*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/pesticides/factsheets/chemicals/ddt-brief-history-status.htm [https://perma.cc/JLC6-ESJS].

60. *See Earth Day: The History of a Movement*, EARTH DAY NETWORK, http://www.earthday.org/about/the-history-of-earth-day/ [https://perma.cc/F564-Q3PV].

Endangered Species Act and the 1977 Clean Water Act.[61] Indeed, this mass movement was so successful that it spread beyond US shores to an array of nations that similarly passed groundbreaking environmental legislation in the 1960s and 1970s. The 1972 Stockholm Declaration, arguably the first major modern global environmental conference, gave voice to this movement and helped further awaken stakeholders around the world as to the importance of environmental protection. The Declaration's first principle states in part that humans have the right to "an environment of a quality that permits a life of dignity and well-being[.]"[62] The role of scientists was central throughout this period, even more so when it came time to address the problem of ozone depletion through what came to be known as the Montreal Protocol.[63]

Much like Rachel Carson's *Silent Spring* helped jumpstart a global conversation about the state of environmental protection, an article by three British scientists helped precipitate arguably the most successful international treaty in history—the Montreal Protocol—which in 2009 became the first UN treaty to achieve universal ratification.[64] The story of the Montreal Protocol began in 1984 when Joseph Farman, Brian Gardiner, and Jonathan Shanklin discovered a long-hypothesized springtime hole in the ozone layer over Antarctica and published their findings in *Nature* one year later.[65] This revelation touched off a sequence of events that culminated just two years later with the Montreal Protocol on

61. *See generally U.S. Laws & Regulations*, U.S. ENVTL. PROT. AGENCY, http://www2.epa.gov/laws-regulations [https://perma.cc/BLC9-UMUE].

62. U.N. Conference on the Human Environment, *Declaration of the United Nations Conference on the Human Environment*, § II, ¶ 1, U.N. Doc. A/CONF.48/14/Rev.1 (June 5–6, 1972), http://www.unep.org/Documents.Multilingual/Default.asp?documentid=97&articleid=1503 [https://perma.cc/98VH-5YPE]; *see also* G.A. Res. 2994 (XXVII) Declaration of the United Nations Conference on the Human Environment (Dec. 15, 1972).

63. *See* Richard E. Benedick, *Science, Diplomacy, and the Montreal Protocol*, EARTH ENCYCLOPEDIA (June 12, 2007), http://www.eoearth.org/view/article/155895/ [https://perma.cc/5ZG9-LB4A].

64. *See* U.N. Conference on Environment and Development, Key Achievements of the Montreal Protocol to Date (July 3, 2009), http://ozone.unep.org/Publications/MP_Key_Achievements-E.pdf [https://perma.cc/TF6N-A742] [hereinafter Key Achievements].

65. THE OZONE HOLE, http://www.theozonehole.com/ [https://perma.cc/B2MC-R95K]; *see* J.C Farman, B.G. Gardiner & J.D. Shanklin, *Large Losses of Total Ozone in Antarctica Reveal Seasonal $C1O_x/NO_x$ Interaction*, NATURE (May 16, 1985), http://www.nature.com/nature/journal/v315/n6016/abs/315207a0.html.

Substances that Deplete the Ozone Layer.[66] A prime example of a successful targeted treaty in the climate-change context, an initially small group of nations worked to ban the use of chlorofluorocarbons (CFCs) that destroy ozone under this agreement.[67] As of 2009, the myriad benefits of the Montreal Protocol include a 98 percent reduction in CFCs, more than twenty million cataract cases avoided in the United States alone, and a reduction of twenty-five billion tons of greenhouse gas (GHG) emissions—more than the Kyoto Protocol.[68] It has also provided a blueprint for the phase out of other harmful gases such as hydrofluorocarbons (HFCs).[69]

Why has the Montreal Protocol been so successful, and what lessons does it hold for climate change and, for that matter, cybersecurity? In short, the science was clear once the large hole in the ozone layer above Antarctica was discovered, scarcity was plain, reliable and cost-effective alternatives were available, and geopolitics was simpler. Taking each factor in turn, the science linking CFCs and the hole in the ozone was well established and apparent, whereas in the climate-change context, atmospheric transition is gradual and is not always as straightforward or attention grabbing as a massive and expanding hole over Antarctica.[70] In other words, the dangers from excessive greenhouse gas emissions can be more indirect, and occur on a longer timescale, than the destruction of the ozone layer. Similarly, in the cybersecurity context, how many and what type of cyber attacks will it take to reach a tipping point pushing the world into collective action? Former George W. Bush Administration Cybersecurity Advisor Richard Clarke, for example, envisions a scenario in which the tipping point is never reached, but instead

66. *See* The Montreal Protocol on Substances That Deplete the Ozone Layer, Annex III, Art. 1(I), 1522 U.N.T.S. 3 (1987); S. Exec. Res. No. 100-10 (1987).

67. *See* Daniel Bodansky, *The History of the Global Climate Change Regime*, *in* INTERNATIONAL RELATIONS AND GLOBAL CLIMATE CHANGE 23, 29–35 (Urs Luterbacher & Detlef F. Sprinz eds., 2001) (noting that the Montreal Protocol was precipitated by national regulation).

68. *See* Key Achievements, *supra* note 64.

69. *See, e.g.*, *Nearly 200 Nations Reach Agreement to Phase out HFC Greenhouse Gases*, DW (Oct. 15, 2016), http://www.dw.com/en/nearly-200-nations-reach-agreement-to-phase-out-hfc-greenhouse-gases/a-36049841.

70. *See* Pamela S. Chasek et al., *Ozone Depletion*, *in* THE GLOBALIZATION READER 526, 526–30 (Frank J. Lechner & John Boli eds., 2014).

small-scale losses in IP mount to result in a "death of a thousand cuts."[71]

Second, the scarcity and fragility of ozone was made clear by the scientists' findings, while CFCs were traced to a relatively small number of manufacturing sectors in a handful of nations. Instead of a multi-billion-dollar CFC industry in a minority of countries, global climate change impacts multi-trillion dollar industries across myriad sectors and economies. The scale of the problem thus makes climate change exceedingly more difficult to manage than the ozone hole—similar to the multifaceted cyber threat.

Moreover, the ozone layer heals itself. So too does the climate, but on a much longer timescale.[72] The distributed nature of cyberspace similarly means that it is robust; indeed, it could theoretically survive a nuclear war. Though, like the climate, nothing can protect it from geopolitics.[73] Third, a clear substitute to CFCs was also available,[74] unlike for all carbon emissions, or the Internet.[75] It was just a matter of incentivizing the switch to the substitute, which required payments. However, these payments were small relative to the problem of climate change—the US government has paid out roughly $21 billion over the life of the Montreal Protocol,[76] which can be compared to the more than $100 billion annual fund envisioned under many climate policy

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71. Ron Rosenbaum, *Richard Clarke on Who Was Behind the Stuxnet Attack*, SMITHSONIAN (Apr. 2012), http://www.smithsonianmag.com/history-archaeology/Richard-Clarke-on-Who-Was-Behind-the-Stuxnet-Attack.html?c=y&story=fullstory.

72. James Samenow, *Ozone Layer is Healing, Expected to Recover by Around 2050, Major Report Finds*, WASH. POST (Sept. 11, 2014), https://www.washingtonpost.com/news/capital-weather-gang/wp/2014/09/11/ozone-layer-is-healing-expected-to-recover-by-around-2050-major-report-finds/ [https://perma.cc/7JQC-ASK3]. *But see* Richard Harris, *Global Warming Is Irreversible, Study Says*, NAT'L PUB. RADIO (Jan. 26, 2009 8:34 PM), http://www.npr.org/templates/story/story.php?storyId=99888903 [https://perma.cc/ZH2C-ULSE] (noting certain exceptions).

73. ANDREW W. MURRAY, THE REGULATION OF CYBERSPACE: CONTROL IN THE ONLINE ENVIRONMENT 63 (2006).

74. *See* Kal Raustiala, *Nonstate Actors in the Global Climate Regime*, *in* INTERNATIONAL RELATIONS AND GLOBAL CLIMATE CHANGE, at 95, 102.

75. *See* Michael V. Copeland, *The Internet Needs a Plan B*, WIRED (Feb. 27, 2013, 3:16 PM), http://www.wired.com/business/2013/02/the-internet-needs-a-plan-b/ [https://perma.cc/WT7H-NP89].

76. Cass R. Sunstein, *Montreal vs. Kyoto: A Tale of Two Protocols* 15 (Univ. of Chi. Law Sch. John M. Olin L. & Econ. Working Paper Series, Paper No. 302, 2006), www.law.uchicago.edu/files/files/302.pdf [https://perma.cc/MN2D-VLEL].

scenarios.[77] Third, the Montreal Protocol was agreed as the Cold War was ending, at a time in which superpower collaboration helped engender global agreement, such as may be seen during the so-called "golden age" of space law discussed in Chapter Five.[78] International relations had transformed by the time of the 1992 Earth Summit that gave birth to the UN Framework Convention on Climate Change (UNFCCC), complicating the playing field with an array of public and private power centers that helped to lay the groundwork for the polycentric ecosystem of the present.[79]

Twenty years after the 1972 Stockholm Declaration, another major UN conference was held. It drew together 172 nations, hundreds of thousands of people (including nearly ten thousand journalists alone), and some 2,400 nongovernmental organizations (NGOs).[80] Despite the slew of participants, the Earth Summit, also known as the Rio Summit, had a lofty purpose and was actually productive (in contrast to later gatherings, such as Copenhagen, discussed below)—producing the Declaration on Environment and Development, the UN Convention on Biological Diversity, and the UN Framework Convention on Climate Change itself.[81] The objective of the UNFCCC is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[82] The much broader scope of these negotiations as compared to those surrounding the Montreal Protocol is immediately apparent, covering everything from public transportation and clean water to

77. *See Financial, Technology and Capacity-Building Support*, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://cancun.unfccc.int/financial-technology-and-capacity-building-support/new-long-term-funding-arrangements/ [https://perma.cc/454U-MYKS].

78. *See* FRANK LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 37 (2009). However, it should be noted that the Montreal Protocol was instigated by the U.S. and European officials. *See* Daniel H. Cole, *Climate Change and Collective Action*, *in* 61 Current Legal Problems 2008 229, 237 (Colm O'Cinneide & Jane Holder eds., 2008).

79. *See, e.g.*, Christopher Joyce, *Climate Strategists: To Cut Emissions, Focus On Forests*, NAT'L PUB. RADIO (Dec. 10, 2011), http://www.npr.org/2011/12/10/143454111/climate-activists-to-cut-emissions-focus-on-forests?sc=17&f=1001 [https://perma.cc/LV9U-XJSA] (reporting that some nations, such as Norway, are looking outside the UN framework for action on climate change).

80. *See* U.N. Conference on Environment and Development, Rio Declaration on Environment and Development, U.N. Doc. A/CONF.151/26/Rev.1 (Aug. 12, 1992), http://www.un.org/geninfo/bp/enviro.html [https://perma.cc/NCB4-NS3R].

81. *Id*.; United Nations Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 79; United Nations Conference on Environment and Development, Framework Convention on Climate Change, June 4, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC]; S. TREATY DOC NO. 103-20 (1993).

82. UNFCCC, *supra* note 81, at art. 2; *see* DONALD A. BROWN, CLIMATE CHANGE ETHICS: NAVIGATING THE PERFECT MORAL STORM 138 (2013).

fossil fuel alternatives.[83] Because of the broad ambit of covered activities, the 154 nations that originally signed onto the UNFCCC only agreed to a voluntary, non-binding aim of reducing atmospheric GHG concentrations to 1990 levels by 2000, a goal that many countries did not meet.[84] In other words, it was an agreement to agree, which would be filled out through annual conference of the parties (COP) gatherings that have taken place since the 1995 COP1 in Berlin, as shown in Figure 1.

The responsibilities of developed and developing nations under the UNFCCC process highlight the tidal changes underway in both geopolitics and the global economy in the early 1990s with the end of the Cold War and the beginning of the United States' so-called "unipolar moment" that corresponded with the rise of emerging markets.[85] Developed states, known as Annex I countries in the UNFCCC universe, are required to "adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of GHG and protecting and enhancing its GHG sinks and reservoirs."[86] Annex II nations, then, are leading developed nations (OECD countries) which pay mitigation costs for developing nations, known as non-Annex I nations, reflecting the notion of common but differentiated responsibilities to manage the problem of scarcity. Thus, the emphasis for developing states remained economic development, highlighting the continuing difficulty of defining "sustainable development."[87] These differences—including such contentious topics as the amount of adaptation funding and technology transfer schemes—were brought to the

83. STEPHANIE MEAKIN, THE RIO EARTH SUMMIT: SUMMARY OF THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (1992), http://publications.gc.ca/Collection-R/LoPBdP/BP/bp317-e.htm [https://perma.cc/SZQ8-D7C2].

84. UNFCCC, *supra* note 81, at art. 2; *History of Kyoto Protocol*, CTR. FOR CLIMATE & ENERGY SOLUTIONS, http://www.c2es.org/international/negotiations/kyoto-protocol/history [https://perma.cc/B4DV-22MJ].

85. *See* Charles Krauthammer, *The Unipolar Moment*, FOREIGN AFFAIRS (Nov. 1990), https://www.foreignaffairs.com/articles/1991-02-01/unipolar-moment [https://perma.cc/3YZB-5JNS].

86. UNFCCC, *supra* note 81, at art. 3.

87. Sustainable development is defined in the Brundtland Report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Rep. of the World Comm'n on Env't and Dev.: Our Common Future (1987), transmitted to the General Assembly as an Annex, 37, U.N. Doc. A/42/427; *see also* Gabcikovo-Nagymaros Project (Hung. v. Slovk.), 1997 I.C.J. 7, 78 (Sept. 25) (defining sustainable development as the "need to reconcile economic development with protection of the environment").

forefront when it came time to fill in the UNFCCC with particulars through the guise of a protocol negotiated in Kyoto, Japan.

B. Kyoto to Copenhagen: The Unipolar Moment Wanes

By 1995, it became evident to many stakeholders that voluntary emission reductions envisioned under the 1992 UNFCCC were inadequate to mitigate the threat of global climate change. Thus, negotiations began at COP1 to strengthen the global response, eventually resulting two years later in the Kyoto Protocol.[88] This binding agreement, the first treaty to mandate GHG reductions, required developed nations to reduce their emissions by an average of 5.2 percent below 1990 levels by 2012 (although enforcement was left unspecified). Among other things, the Kyoto Protocol included four different trading offsets including the Clean Development Mechanism that permitted countries to earn credits and purchase offsets to be put toward their emission targets, which has faced criticism even as the agreement has grown in importance.[89] The Protocol entered into legal force on February 16, 2005, when fifty-five nations had ratified it.[90] Ultimately, the Kyoto Protocol has been successful in terms of participation; 191 nations have ratified the agreement since 1997, but several large emitters, including Australia, Canada (which ratified the agreement but subsequently pulled out), and most notably the United States, remain outside the system.[91] Kyoto's firm commitment period, which began in 2008, was scheduled to end in 2012 but was subsequently extended beyond 2012 by the Doha Agreement to provide a bridge toward a more inclusive and comprehensive global climate treaty discussed below in the context of COP21.[92]

Even with the Kyoto Protocol, the agreement was still insufficient to codify sustainable development in international law. Some commentators criticized the agreement as not being

88. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 11, 1997, 2303 U.N.T.S. 162 [hereinafter Kyoto Protocol].

89. *See, e.g.*, Michael W. Wara, *Measuring the Clean Development Mechanism's Performance and Potential*, 55 UCLA L. REV. 1759, 1761–63 (2008). A fifth offset mechanism was added when the REDD+ program was negotiated. *See* REDD: Protecting Climate, Forests and Livelihoods, Int'l Inst. for Env't & Dev., http://www.iied.org/redd-protecting-climate-forests-livelihoods (last visited Dec. 12, 2016).

90. *See Kyoto Protocol Fast Facts*, CNN, http://www.cnn.com/2013/07/26/world/kyoto-protocol-fast-facts/ [https://perma.cc/K3W8-PFTA].

91. *Id*.

92. *See, e.g.*, Karl Ritter & Michael Casey, *UN Climate Conference: Kyoto Protocol Extended at Doha, Qatar Talks*, ASSOC. PRESS (Dec. 8, 2012, 4:33 AM), http://www.huffingtonpost.com/2012/12/08/un-climate-conference-kyoto-doha-qatar_n_2262371.html [https://perma.cc/U7DV-7GPE].

ambitious enough, while others focused on the fact that it only bound developed nations, though most of the growth in emissions was already coming from emerging markets.[93] This argument highlights the fact that, even though the United States remained the only economic, political, and military superpower in the late 1990s, the rise of other stakeholders was already affecting climate negotiations. Moreover, the pace of both technological change and economic growth quickened, particularly in the 2000s with China overtaking the United States in nominal GHG emissions by 2006 (though the U.S. still leads China on a per capita basis),[94] and it soon became clear the notion of leaving developing countries out of a final climate agreement was untenable even as it was necessary to build support for a climate treaty at the time Kyoto was negotiated.[95] Yet, despite rising urgency from Intergovernmental Panel on Climate Change (IPCC) reports, a push for a new treaty to replace the Kyoto Protocol happened only gradually, coming to a head more than a decade later in 2009 during the fifteenth Conference of the Parties (COP15).[96] This process is in contrast to the two years it took to negotiate and ratify the Montreal Protocol under the Vienna Convention, which, along with the relative success of that instrument as compared to Kyoto, demonstrates that in an era increasingly defined by multipolar politics and rising scarcity, scientific consensus had become a necessary but insufficient criterion of success.

C. COP15 Forward: Enter the Multipolar Status Quo

COP15 underscored the changing role of the United Nations, the rise of multipolar politics and its effect on commons governance, and rapid technological advancements alongside growing scarcity. These issues are not limited to the atmosphere, but also apply to cyberspace. For example, COP15 and the annual climate negotiations that followed demonstrate the difficulty of

93. *See, e.g.*, Helen Dewar & Kevin Sullivan, *Senate Republicans Call Kyoto Pact Dead*, WASH. POST, Dec. 11, 1997, at A37.

94. *See China Overtakes U.S. in Greenhouse Gas Emissions*, N.Y. TIMES (June 20, 2007), http://www.nytimes.com/2007/06/20/business/worldbusiness/20iht-emit.1.6227564.html?_r=0 [https://perma.cc/8AUU-LFW5].

95. *See* SEBASTIAN OBERTHÜR & HERMANN E. OTT, THE KYOTO PROTOCOL: INTERNATIONAL CLIMATE POLICY FOR THE 21ST CENTURY 9, 60 (2013).

96. *See* David Adam, *From Kyoto to Copenhagen*, WASH. MONTHLY (2009), http://www.washingtonmonthly.com/features/2009/0907.adam.html [https://perma.cc/CH7U-QTTQ].

reaching consensus between major emerging markets, like the BASIC group (Brazil, South Africa, India, and China)[97] and other power centers, including the United States, the European Union, and the G77.[98] The struggle to reach agreement across such an array of stakeholders and interests has led to the development of more targeted forums, both in terms of membership and subject matter, in what could be considered a shift toward a polycentric approach to atmospheric management.[99]

Moreover, COP15 illustrated the extent to which negotiations over implementing legal instruments that became part and parcel of "old commons" regimes such as the deep seabed and outer space have—like the CHM concept itself—changed over time.[100] COP15 is thus a microcosm both of what is at stake in the "new commons" of the atmosphere and cyberspace going forward and how politically, economically, and legally difficult it is to create new, inclusive governance structures to address global collective action problems.

During COP15, held in Copenhagen in December 2009, delegations from 192 nations came together to address the mounting problem of global climate change.[101] Yet by this point, and in part because of the rise of multipolar politics in an arena designed for consensus, the actions of a few nations were able to block progress for several critical days.[102] At the heart of the debate was how the atmosphere should be governed: what form should regulation take, what is the most appropriate level for

97. Also known as the BRICS, this group is not only "an economic concept but increasingly . . . is also taking the form of a political entity." Haibin Niu, *A Chinese Perspective on the BRICS in 2015*, COUNCIL OF COUNCILS, COUNCIL ON FOREIGN RELATIONS (Feb. 6, 2015), http://www.cfr.org/councilofcouncils/global_memos/p36088%20?cid=nlc-npbnews-2015_national_conference_confirmation_and_background--link48-20150602&sp_mid=48790069&sp_rid=a3plZ3VyYUBjZnIub3JnS0 [https://perma.cc/EH5N-7424].

98. *See Key Powers Reach Compromise at Climate Summit*, BBC NEWS (Dec. 19, 2009), http://news.bbc.co.uk/2/hi/europe/8421935.stm [https://perma.cc/RV8Q-V2GU]; *see also About the Group of 77*, THE GROUP OF 77 AT THE UNITED NATIONS, http://www.g77.org/doc/ [https://perma.cc/37AZ-P9JZ].

99. *See* Daniel H. Cole, *From Global to Polycentric Climate Governance*, 2 CLIMATE L. 395, 395 (2011) (discussing the potential of polycentric governance to better address climate change given the failures of multilateral efforts); *see also* Dave Keating, *Climate Action Goes National*, EUR. VOICE (Nov. 28, 2013), http://www.europeanvoice.com/article/imported/climate-action-goes-national/78871.aspx [https://perma.cc/3UDM-Q49E].

100. *See generally* Christopher C. Joyner, *Legal Implications of the Concept of the Common Heritage of Mankind*, 35 INT'L & COMP. L.Q. 190 (1986) (laying out the five contested elements of the CHM concept).

101. *See* Emma Duncan, *Getting Warmer*, THE ECONOMIST (Dec. 3, 2009), http://www.economist.com/node/14994872 [https://perma.cc/XU94-2YFB].

102. *See Key Powers Reach Compromise at Climate Summit*, *supra* note 99.

regulation, and how can compliance be enforced? In the end, COP15 proved unable to answer these questions, resulting in a last-minute, "lackluster" Copenhagen Accord featuring voluntary emissions pledges that neither replaced the Kyoto Protocol as was the goal, nor really satisfy anyone.[103] As a result, the struggle to reach agreement across such an array of interests has led to the development of more targeted forums since COP15, both in terms of membership and subject matter, in what could be considered a shift toward a polycentric approach to atmospheric management.[104] For example, the US Conference of Mayors climate protection efforts are an example of this movement, with more than five hundred mayors signing on to voluntary efforts aimed at reducing emissions from their cities.[105] Such efforts have been met with some success, which is why Professor Ostrom argued that polycentric regulation is the best way to ensure that multilateral treaties are reinforced by regional, bilateral, national, and sub-national actors so as to help ensure that sufficient progress is being made.[106] This was the state of affairs heading into Paris in December 2015.[107]

Figure 1: Key Dates in Global Climate Law and Policy[108]

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103. *See* Rhys Gerholdt, *Copenhagen Accord Weekly Roundup: April 28*, CLIMATE ACTION (Apr. 28, 2010), http://blog.usclimatenetwork.org/climate-negotiations/copenhagen-accord-weekly-roundup-april-28/ [https://perma.cc/CEW2-PE4A]; *see also* Roger Harrabin, *UN Climate Talks Extend Kyoto Protocol, Promise Compensation*, BBC NEWS (Dec. 8, 2012), http://www.bbc.co.uk/news/science-environment-20653018 [https://perma.cc/E97R-9QM9] (noting that the Russian delegation tried to slow progress at COP18 but ultimately their objections were put down by the Chairman); Matt McGrath, *Last-Minute Deal Saves Fractious UN Climate Talks*, BBC NEWS (Nov. 23, 2013), http://www.bbc.co.uk/news/science-environment-25067180 [https://perma.cc/3SBN-Z6B5].

104. *See* Cole, *supra* note 99, at 395.

105. *See About the Mayors' Climate Protection Center*, U.S. CONFERENCE OF MAYORS, http://usmayors.org/climateprotection/about.htm [https://perma.cc/8DEU-VB3D].

106. *See* Pedro Fidelman, *Elinor Ostrom's Research Can Inspire Rio+20*, EARTH GOVERNANCE (Nov. 7, 2010), http://earthgovernance.org/tag/elinor-ostrom/ [https://perma.cc/SW5V-4538].

107. There was action between COP15 and COP21, but these have been changes in degrees that have reinforced the polycentric status quo rather than a dramatic shift in approach. For more on this topic, see Figure 1 and Shackelford, *surpa* note 5, at 673-77.

108. *Climate Change in Context*, UNFCCC, http://unfccc.int/essential_background/items/6031.php [https://perma.cc/GVB9-DLLY]. For a more comprehensive timeline of the development of global climate change law and policy, see GUPTA, *supra* note 58, at 41–43.

Year	**Event**
1972	**Stockholm Declaration**, First Global Environmental Conference
1979	First World Climate Conference
1988	Intergovernmental Panel on Climate Change created
1989	**Montreal Protocol** signed.
1990	IPCC's first assessment report released. IPCC and second World Climate Conference call for a global treaty on climate change. UN General Assembly negotiations on a framework convention begin.
1992	**Earth Summit**—the UNFCCC is opened for signature along with its sister Rio Conventions.
1995	The first Conference of the Parties (COP1) takes place in Berlin.
1996	The **UNFCCC Secretariat** is set up to support action under the Convention.
1997	Kyoto Protocol formally adopted in December at COP3.
2001	**IPCC's Third Assessment Report** released. Bonn Agreements adopted, based on the Buenos Aires Plan of Action of 1998. Marrakesh Accords adopted at COP7, detailing rules for implementation of Kyoto Protocol, setting up new funding and planning instruments for adaptation, and establishing a technology transfer framework.
2005	Entry into force of the **Kyoto Protocol**. The first Meeting of the Parties to the Kyoto Protocol (MOP1) takes place in Montreal.
2007	**IPCC's Fourth Assessment Report** released. Climate science entered into popular consciousness. At COP13, Parties agreed on the Bali Road Map, which charted the way towards a post-2012 outcome.
2009	**Copenhagen Accord** drafted at COP15 in Copenhagen. Countries later submitted emissions reductions pledges or mitigation action pledges, all non-binding.
2010	**Cancun Agreements** drafted and largely accepted by the COP, at COP16.
2011	The **Durban Platform** for Enhanced Action drafted and accepted by the COP, at COP17.
2012	The **Doha Amendment** to the Kyoto Protocol adopted.
2013	Key decisions adopted at COP19 include decisions on further advancing the Durban Platform, the Green Climate Fund and Long-Term Finance, the Warsaw Framework for REDD Plus, and the Warsaw International Mechanism for

Loss and Damage.

2014 COP20 witnessed new pledges for the Green Climate Fund as well as the "'multilateral assessment' of emission-cutting efforts by developed countries."

2015 COP21 with the goal of finalizing a global, binding climate treaty.

D. The Promise of Paris

At no time in the six years since the buildup to the Copenhagen meeting in 2009 have international expectations been so high for a binding climate deal "with legal force" detailing the rights and responsibilities for developed and developing nations alike.[109] In support of pledges made at COP19 in Warsaw, individual and small groups of nations have already begun announcing GHG reduction pledges to help build momentum. The first and most significant of these was the US-China climate pact, comprising the G2 leading economic powers and polluters (China was responsible for 28 percent of global GHG emissions, while the United States was responsible for 14.5 percent, as of March 2015).[110] The new joint US targets are "to cut net greenhouse gas emissions 26[–]28 percent below 2005 levels by 2025[,]" while China has pledged to hit peak "CO_2 emissions around 2030, with the intention to try to peak early, and to increase the non-fossil fuel share of all energy to around 20 percent by 2030."[111] Subsequently, China announced, in partnership with France, that it was upping the ante still further by offering "to reduce its carbon dioxide emissions per unit of GDP by 60[–]65% by 2030, from 2005 levels" along with getting 20 percent of its

109. *See, e.g.*, Elliot Diringer, *The Core Issues in the Paris Climate Talks*, CTR. CLIMATE & ENERGY SOLUTIONS (Feb. 11, 2015), http://www.c2es.org/blog/diringere/core-issues-paris-climate-talks [https://perma.cc/DFX7-3TGJ]; Nell Greenfieldboyce, *U.N. Holds Climate Talks in New York Ahead of Paris Meeting*, NAT'L PUB. RADIO (June 29, 2015), http://www.npr.org/2015/06/29/418641168/u-n-holds-climate-talks-in-new-york-ahead-of-paris-meeting?sc=17&f=2&utm_source=iosnewsapp&utm_medium=Email&utm_campaign=app [https://perma.cc/66XP-3Z9Y].

110. Jeff Tollefson, *UN Gets First Pledges on Road to Paris Climate Talks*, NATURE (Mar. 31, 2015), http://www.nature.com/news/un-gets-first-pledges-on-road-to-paris-climate-talks-1.17247 [https://perma.cc/8K3X-QZ3K]; Kyoto Protocol Fast Facts, *supra* note 90.

111. Press Release, White House Office of the Press Sec'y, Fact Sheet: U.S.-China Joint Announcement on Climate Change and Clean Energy Cooperation (Nov. 11, 2014), https://www.whitehouse.gov/the-press-office/2014/11/11/fact-sheet-us-china-joint-announcement-climate-change-and-clean-energy-c [https://perma.cc/AY3M-X6WR].

energy from renewable sources also by 2030.[112] Russia also committed to a 25–30 percent reduction in its GHG emissions below 1990 levels by 2030 (though if the carbon-absorbing capacity of its forests are taken into account, that figure could climb to as high as 75 percent).[113] The European Union has similarly pledged to reduce emissions 40 percent below 1990 levels by 2030, a figure that Norway is matching, while Switzerland has pledged a 50 percent reduction. Emerging markets are also acting, with Mexico pledging to hit its peak carbon emissions by 2026. Developed-developing nation blocks have also made joint pledges, demonstrating that a new era of North-South partnership may be dawning. The United States and Brazil, for example, have jointly pledged to attain 20 percent of their power from renewable sources by 2030, which represents a tripling by the United States and a doubling for Brazil from 2015 levels.[114] In total, more than a dozen nations and the European Union have made climate pledges as of July 2015, with many more to come.[115]

As impressive as these pledges are, Climate Action Tracker, a Berlin-based consortium of researchers that tracks national commitments, has stated that "[i]f all pending submissions receive a similar rank, the world will [still] be on track to breach the 2 °C target."[116] Yet hope remains—after all, having the United States, China, and the European Union on board comprises more than 50 percent of global emissions.[117] And this hope came to fruition at COP21 with the successful negotiation of the Paris Agreement, which is notable for at least three facts, including that: (1) it was the product of the collective efforts of 195 nations; (2) unlike Kyoto, it requires actions on the part of all nations, developed and developing alike; and (3) above all, it provides a framework for global collective action to mitigate the risk of global climate change.[118] For example, the Paris Agreement includes a mechanism, which takes effect in 2012, by which nations are supposed to increase their emission reduction targets every five

112. *See* Helen Briggs, *China Climate Plan Unveiled*, BBC NEWS (June 30, 2015), http://www.bbc.com/news/science-environment-33317451 [https://perma.cc/EEX9-Y2PJ].

113. Tollefson, *supra* note 110.

114. *See US and Brazil Set Energy Goals in Sign of Improving Ties*, BBC NEWS (June 30, 2015), http://www.bbc.com/news/world-us-canada-33333795 [https://perma.cc/3D7J-MEUF].

115. *See* Greenfieldboyce, *supra* note 109.

116. Tollefson, *supra* note 110.

117. *See id.*

118. *See* Davenport, *supra* note 55.

years.[119] Perhaps of greatest importance is the fact that the United States and China—the two largest greenhouse gas polluters—were instrumental in achieving global consensus, demonstrating the critical role played by minilateralism in furthering multilateral ends.[120]

This is the hope of polycentric governance. As noted by Michael Levi of the Council on Foreign Relations, for example, in commenting on the United States-China Climate Pact:

> Supporters have wrongly obsessed with achieving a comprehensive global climate treaty, and their opponents have gloated when attempts to negotiate such an agreement have inevitably failed. (A corollary: Those who welcomed the U.S.-China announcement primarily as a sign that a big global treaty might be possible next year are missing its main point.).[121]

Indeed, the point is that a comprehensive, global, and binding action may or may not follow through from the Paris Agreement, but such steps regardless constitute important progress. Already, China, India, and the European Parliament have ratified the accord along with 72 other nations as of October 2016,[122] meaning that the accord entered into force in November 2016, making the agreement among the fastest to enter into force as is explored further in Part V.[123] And there is a case to be made that even under

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119. *Cf.* Barbara Lewis, *EU Not Seen Increasing Emissions Targets Despite Paris Deal: Draft*, REUTERS (Feb. 29, 2016), http://www.reuters.com/article/us-climatechange-eu-idUSKCN0W21SR.

120. William Mauldin & Colleen McCain Nelson, *Obama, Xi Advance Climate Deal*, WALL ST. J**.,** Sept. 16, 2015, at A10 ("The U.S. pledged last year to reduce carbon-dioxide emissions by between 26% and 28% by 2025, compared with 2005 levels, while China said it would make sure its emissions peak by 2030 or earlier."). The US-China Climate Change Working Group was invaluable toward building support for the US-China climate pledge, which in turn catalyzed global action. *See, e.g.*, REPORT OF THE U.S.-CHINA CLIMATE CHANGE WORKING GROUP TO THE 7TH ROUND OF THE STRATEGIC AND ECONOMIC DIALOGUE, U.S. DEP'T ST. (June 24, 2015), http://www.state.gov/e/oes/rls/rpts/244467.htm; Cole, *supra* note 20, at 116-17 (arguing that when "the world's two largest emitters of carbon, and two of the existing global climate regime's greatest belligerents, entered into a bilateral agreement with the aim of improving global negotiations amounts to an implicit endorsement of the polycentric approach to climate governance.").

121. Michael Levi, *The Obama-China Climate Deal Can't Save the World. So What?*, WASH. POST (Nov. 21, 2014), http://www.washingtonpost.com/posteverything/wp/2014/11/21/the-obama-china-climate-deal-cant-save-the-world-so-what/ [https://perma.cc/XED8-LFJE].

122. Paris Agreement, Status of Ratification, UNFCCC, http://unfccc.int/paris_agreement/items/9444.php (last visited Oct. 6, 2016).

123. *See* Justin Worland, *Paris Climate Change Agreement Set to Take Effect After Quick Ratification Process*, TIME (Oct. 5, 2016), http://time.com/4519895/paris-agreement-ratification-european-union/.

a Trump administration, progress may not, in fact, significantly stall, though it may well be curtailed.[124] In other words, the great should not be the enemy of the good. Polycentric regulation has its faults, but so too does waiting consensus that may come too late—if at all. It would be better, one might think, to begin the process of legal clarification and norm building now—a process strikingly similar to that underway in the Internet governance context.

IV. THE POLYCENTRIC INTERNET GOVERNANCE ECOSYSTEM

As with the climate, Internet governance is fracturing, which makes addressing cybersecurity challenges more difficult.[125] Early theorists viewed cyberspace as either an "environment without borders and free from state control,"[126] or a space where regulation is possible.[127] This conceptualization may be compared to the atmosphere, wherein debates still rage over delineations between national and international airspace under the Chicago Convention,[128] considerations of the atmosphere as the "common concern of mankind" under the Convention on Biological Diversity,[129] and where airspace ends and the space law regime begins. More recent scholarship has recognized the complexity inherent in cyber regulation and the necessity of a dynamic model of Internet governance, as was introduced in Chapter One.[130] As a prerequisite to analyzing whether polycentric governance can

124. *See* Mark Muro, *Climate, Energy, and Trump: Progress is Still Possible*, BROOKINGS INST. (Nov. 15, 2016), https://www.brookings.edu/blog/the-avenue/2016/11/15/climate-energy-and-trump-progress-is-still-possible/.

125. *See* JONAH FORCE HILL, INTERNET FRAGMENTATION: HIGHLIGHTING THE MAJOR TECHNICAL, GOVERNANCE AND DIPLOMATIC CHALLENGES FOR U.S. POLICY MAKERS 31 (2012), http://belfercenter.hks.harvard.edu/files/internet_fragmentation_jonah_hill.pdf [https://perma.cc/VHU3-U3Q8].

126. MURRAY, *supra* note 73, at 250; *see* David R. Johnson & David G. Post, *Law and Borders—The Rise of Law in Cyberspace*, 48 STAN. L. REV. 1367, 1370–72 (1996) (noting that cyberspace, unlike physical space, does not lend itself to "territorially defined rules").

127. *See* Lawrence Lessig, *The Law of the Horse: What Cyberlaw Might Teach*, 113 HARV. L. REV. 501, 502, 533 (1999) ("I have argued that cyberspace is not inherently unregulable; that its [r]egulability is a function of its design.").

128. Convention on International Civil Aviation art. 89, Dec. 7, 1944, 61 Stat. 1180, 15 U.N.T.S. 295 [hereinafter Chicago Convention].

129. BASLAR, *supra* note 19, at 360 (noting that the reason that the phrase "common concern of mankind" was used instead in the 1988 UN General Assembly Declaration was to avoid the politically treacherous debate over full implementation of the CHM); IUCN Commission of Environmental Law, *Draft Covenant on Environmental Conservation and Sustainable Use of Natural Resources*, 87th PROC. AM. SOC. INT'L L. 519 (1993); A. Boyle, *International Law and the Protection of the Global Atmosphere*, *in* D. FREESTONE AND R. CHURCHILL, INTERNATIONAL LAW AND GLOBAL CLIMATE CHANGE 1, 1–3 (1992).

130. *See* MURRAY, *supra* note 73, at xii, 250.

promote a global culture of cybersecurity, this Part begins by offering a brief analysis of the evolution of Internet governance juxtaposed against the climate regime. Particular attention is paid to the forces of technological advancement, resource scarcity, and politics as applied to the formation and evolution of the Internet address and communications systems.

A. A (Very) Brief History of Internet Governance

The story of Internet governance may be broken down into at least three phases, during each of which the three identified variables—technology, scarcity, and multipolar politics—each played a significant part in shaping the evolution of the Internet.[131] Phase One spanned from roughly 1969 to the birth of ICANN in 1998 and encompassed cutting-edge work by network engineers and the ad hoc organizations that they developed, such as the Internet Engineering Task Force (IETF).[132] Phase Two coincided with the commercial success of the Internet and the rise of ICANN and other organizations seeking to address the first global "digital divide" represented by the divergence of information and communication technology resources between developed and developing nations, culminating with the creation of the Internet Governance Forum (IGF) in 2006.[133] Finally, Phase Three has been defined to date by the extent to which nations have begun to assert a greater role in Internet governance with the rise of multipolar politics and, correspondingly, polycentric governance, potentially causing a "new 'digital divide'" to emerge not between the "haves and have-nots," but between "the open and the closed."[134] This Section explores these phases, which are

131. For more in-depth discussion on the history of Internet governance through a polycentric lens, see Scott J. Shackelford, *Toward Cyberpeace: Managing Cyber Attacks through Polycentric Governance*, 62 AM. UNIV. L. REV. 1273 (2013); Scott J. Shackelford & Amanda N. Craig, *Beyond the New 'Digital Divide': Analyzing the Evolving Role of Governments in Internet Governance and Enhancing Cybersecurity*, 50 STAN. J. INT'L L. 119, 121–44 (2014); Shackelford, *supra* note 30, at 49–52.

132. The IETF continues to function as the leading Internet standards body today, and it has a reputation for being an open, relatively flat organization, adopting ideas when justified by results instead of according to rank. *See* KATHY BOWREY, LAW AND INTERNET CULTURES 56 (2005).

133. *See* Shackelford & Craig, *supra* note 131, at 129–43.

134. Larry Downes, *Requiem for Failed UN Telecom Treaty: No One Mourns the WCIT*, FORBES (Dec. 17, 2012), http://www.forbes.com/sites/larrydownes/2012/12/17/no-one-mourns-the-wcit/ [https://perma.cc/U3CU-QWBF].

summarized in Figure 3, before discussing the implications on addressing the global collective action problem of cyber attacks.

Technological advancement and a scarcity of formalized governance structures helped to catalyze innovation during Phase One of Internet governance that helped, in turn, give birth to the Internet as we know it today. The technological heart of the Internet is packet switching, which consists of transmitting information between linked computers and lays the groundwork for networking. Early in the predawn of the Information Age, routes between computers were frequently jammed. So engineers allowed messages to be divided into many smaller "packets" and sent along multiple paths to a destination, resulting in our ability to move information being multiplied by millions of times over.[135] Many networks, such as the Advanced Research Projects Agency Network (ARPANET), the International Telecommunication Union's Open Systems Interconnection (OSI),[136] and eventually the Transmission Control Protocol/Internet Protocol (TCP/IP) itself, were created throughout the 1970s and 1980s by adapting this packet-switching technology. TCP/IP boasted the efficiency, interoperability, and flexibility to permit diverse networks to talk to one another—giving rise to many security implications, as we will see—becoming *the* Internet.[137] By the early 1990s, all the ingredients were in place for explosive growth thanks to these technological advancements: a robust and open network, a free and user-friendly protocol in the form of TCP/IP, and an increase in the number of personal computers underscoring strong demand.[138] The amount of servers grew quickly, from one based out of the Stanford Linear Accelerator Center in 1990 to more than 250 in 1993. After a series of technical milestones, by 1995, the "World

135. For a detailed discussion of early Internet history, see KATIE HAFNER & MATTHEW LYON, WHERE WIZARDS STAY UP LATE: THE ORIGINS OF THE INTERNET (1996); *Brief History of the Internet*, INTERNET SOC'Y, www.isoc.org/internet/history/brief.shtml [https://perma.cc/58R2-R33J].

136. *See* DAVID G. POST, IN SEARCH OF JEFFERSON'S MOOSE: NOTES ON THE STATE OF CYBERSPACE 140 (2009) (noting that as late as the early 1990s, OSI networks practically were "the Internet"; in fact, until 1994, much of the US government used OSI); MURRAY, *supra* note 73, at 68–69; John R. Aschenbrenner, *Open Systems Interconnection*, 25(3) IBM SYS. J. 369, 369 (1986). For background on the history of ARPANET, see *History*, COMPUT. HISTORY MUSEUM, http://www.computerhistory.org/internet_history/ [https://perma.cc/F8KS-M95L].

137. *See* MURRAY, *supra* note 73, at 61 (arguing that the Advanced Research Projects Agency was created by President Eisenhower to maintain US technological superiority over the Soviet Union).

138. *See id.* at 72.

Wide Web" became equated with the Internet, boasting more than 73,500 servers.[139] You can now order a pizza online.[140]

Throughout Phase One, though, governance remained largely ad hoc and composed mostly of graduate students waiting for authority figures to show up.[141] The thing is, they never really did—at least not until 1998. Instead, an array of organic, technical organizations like the IETF emerged to handle communications systems as well as what was to become known as the Domain Name System (DNS), which matches IP addresses with website names.[142] In many ways, science and technical innovation became the currency of public diplomacy online, much as it long has been in other international spaces, such as the Poles.[143] This development is one reason why IETF has continued to enjoy more legitimacy in certain circles than other more top-down organizations, such as ICANN,[144] Neither politics nor scarcity played significant roles during Phase One, especially once TCP/IP was widely implemented. That was to change in the 1990s during the "DNS Wars" when the US government struck back.

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139. *See* Robert Cailliau, Speech Delivered at the Launching of European Branch of the W3 Consortium (Nov. 2, 1995), http://www.netvalley.com/archives/mirrors/robert_cailliau_speech.htm [https://perma.cc/DGK7-F5AZ].

140. *See Pizza Hut Tells Twitter It Made the First Online Sale in 1994*, HUFFINGTON POST (Sept. 9, 2013), http://www.huffingtonpost.com/2013/09/09/pizza-hut_n_3894981.html [https://perma.cc/2PYS-DWQA].

141. *See, e.g.*, Hans Klein, *ICANN and Internet Governance: Leveraging Technical Coordination To Realize Global Public Policy*, 18 INFO. SOC'Y 193, 198 (2002); *see* JOYCE REYNOLDS & JON POSTEL, NETWORK WORKING GROUP, IETF RFC 1000, (1987), http://www.rfc-editor.org/rfc/rfc1000.txt [https://perma.cc/3ZUE-ZN5U].

142. *See* MURRAY, *supra* note 73, at 98.

143. Paul A. Berkman & Oran R. Young, *Governance and Environmental Change in the Arctic Ocean*, 324 SCI. 17 (2009) (arguing that successful science diplomacy requires "knowledge-sharing and the steady generation of scientific findings").

144. *See* MURRAY, *supra* note 73, at 107 (commenting that ICANN was created by the United States "artificially"). However, even though the US government decided to form ICANN, there was a period of open discussion regarding what form the new organization should take. Indeed, one criticism is that ICANN incorporates *too many* democratic mechanisms in its decision-making. *See* Philip Corwin, *The ICANN Policy and Decision Making Process Is Seriously Flawed*, INTERNET COMMERCE ASS'N. (Aug. 15, 2012), http://internetcommerce.org/Registration_Abuse_Time_to-Fish_or_Cut_Bait [https://perma.cc/F6LZ-QN5C]. The other extreme of the governance spectrum may be considered a more state-centric, top-down model favored by some nations, such as Russia and China. *See, e.g.*, Ellery Roberts Biddle & Emma Llansó, *WCIT Watch Day 11: We Cannot Compromise on the Internet*, CTR. FOR DEMOCRACY & TECH. (Dec. 13, 2012), https://cdt.org/blog/wcit-watch-day-11-we-cannot-compromise-on-the-internet/ [https://perma.cc/9NQ4-LNQM] (describing the frustration of some countries with the ITU's decision-making approach).

On January 28, 1998, Jon Postel, whom techies call the "God" of the Internet,[145] decided to perform a "test," though others called it a "hijacking."[146] Long entrusted with the root file of the Domain Name System, Postel decided to redirect queries from the authoritative root server to a second server—his computer at the University of Southern California (USC). Few people noticed, but Postel could have eliminated "dot-com" for much of the world with just a few keystrokes.[147] His test was reversed in a matter of days as an irate Ira Magaziner, then-President Clinton's Senior Science Advisor, called Postel and said that both he and USC would be liable if he continued compromising the root.[148] But the episode served to further inflame the "DNS Wars," during which an array of private companies, nonprofits, individuals, governments, and civil society organizations emerged to vie for a stake in Internet governance.[149] Nonprofits like the Internet Society (ISOC), an umbrella organization focused on Internet technologies and policies, consulted with foreign governments, which were questioning their exclusion from decision-making in this newly global network.[150]

Phase Two also coincided with the United States' unipolar moment. While it listened to the concerns of numerous public- and private-sector stakeholders, the U.S. government elected to keep control of the root and license it to ICANN through the US Department of Commerce.[151] This role was taken over by the Federal Communications Commission through the National Telecommunications and Information Administration in 2015,[152] before the Obama Administration allowed the contract to lapse in

145. *Sci/Tech 'God of the Internet' is Dead*, BBC NEWS (Oct. 19, 1998, 12:30 PM), http://news.bbc.co.uk/2/hi/science/nature/196487.stm [https://perma.cc/EG7S-CHAB].

146. LAURA LAMBERT, THE INTERNET: A HISTORICAL ENCYCLOPEDIA 200–02 (2005).

147. JACK GOLDSMITH & TIM WU, WHO CONTROLS THE INTERNET?: ILLUSIONS OF A BORDERLESS WORLD 45 (2006).

148. *Id.* at 46.

149. *See* Jessica Litman, *The DNS Wars: Trademarks and the Internet Domain Name System*, 4 J. SMALL & EMERGING BUS. L. 149, 158 (2000).

150. *See* MURRAY, *supra* note 73, at 89, 91 (noting that the main goal of ISOC is to host and support standards-making bodies, such as IETF).

151. Markus Müller, *Who Owns the Internet? Ownership as a Legal Basis for American Control of the Internet*, 15 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 709, 717 (2005) ("This gives the United States the capacity to threaten a country with the prospect of taking away its country-code TLD."); *see also* Phillip Corwin, *The ICANN-U.S. AOC: What It Really Means*, INTERNET COMMERCE ASS'N. (Oct. 1, 2009), http://www.internetcommerce.org/ICANN-U.S._AOC [https://perma.cc/3ACT-LC4L] (discussing the changes in oversight wrought by the 2009 AOC).

152. *See, e.g.*, Fred Campbell, *ICANN, Meet Your New Master, the FCC*, RED ST. (Apr. 3, 2015), http://www.redstate.com/diary/fredcampbell/2015/04/03/icann-meet-new-master-fcc/ [https://perma.cc/XP4N-NT8M].

October 2016.[153] Problems of scarcity also began to emerge in this era, evidenced by a growing pattern of "cyber squatting," or occupying a known trademark in the hope of selling it back to the rightful owner for a profit later.[154] ICANN has played a significant role in mitigating issues of cyber squatting, such as by setting up an independent alternative dispute resolution system.[155]

Figure 2: Internet Governance Timeline from the Virtual Policy Network[156]

Year	Organization	Description
1865	International Telecommunication Union	The International Telegraph Union was formed in Paris. Now the International Telecommunication Union (ITU), it is currently a special agency of the United Nations.
***1972**	Internet Assigned Numbers Authority	The Internet Assigned Numbers Authority (IANA) emerged from the early history of the Internet through the efforts of pioneers, including Postel. * There is no agreed upon "start date" for IANA, in part because of the informality of the organization. Dates range from the 1970s to the 1990s.
1986	Internet Engineering Task Force	The IETF develops and promotes technical standards for the Internet. In 1992, the IETF became part of the Internet Society.
1992	Internet Society	The Internet Society was formed in 1992 to further technical standards for the Internet.
1998	Internet Corporation for Assigned Names and Numbers	The Internet Corporation for Assigned Names and Numbers (ICANN) was created in 1998 as a not-for-profit organization that took on elements of Internet governance from IANA.
2003	First Word Summit on the Information Society	Created the Working Group on Internet Governance (WGIG) to look deeper into the issues of Internet Governance and

153. S*ee* Grant Gross, *ICANN Transition Moves Forward, Despite Last-Minute Attempt to Block It*, PC WORLD (Oct. 3, 2016), http://www.pcworld.com/article/3126482/internet/icann-transition-moves-forward-despite-last-minute-attempt-to-block-it.html.

154. *See, e.g.*, Oliver R. Gutierrez, *Get Off My URL: Congress Outlaws Cybersquatting in the Wild West of the Internet*, 17 SANTA CLARA COMPUTER & HIGH TECH. L.J. 139, 142–43 (2001).

155. BOWREY, *supra* note 132, at 51 (discussing ICANN's trademark dispute resolution policy).

156. *Internet Governance: A Brief Timeline*, VIRTUAL POLICY NETWORK (Nov. 24, 2009), http://www.virtualpolicy.net/internet-governance-a-brief-timeline.html [https://perma.cc/H2VF-HXCU].

		prepare a report for the second phase of the World Summit on the Information Society.
2005	Second World Summit on the Information Society	The second WSIS meeting established both an agreed commitment and agenda for the development of Internet governance. The documents also established the Internet Governance Forum.
2006	New Memorandum of Understanding between ICANN and US Department of Commerce and creation of IGF	Renewal of ICANN's contract with the US government.
2012	World Conference on International Telecommunications	ITU convened the World Conference on International Telecommunications (WCIT) in December 2012.
2014	NETmundial and ITU Plenipotentiary Conference 2014 (PP-14).	NETmundial was hosted by the Brazilian government and co-sponsored by ICANN; PP-14 was convened by the ITU in 2014.
2015	Tenth World Summit on Information Systems (WSIS-10).	WSIS-10 was held in New York in December 2015 that, among other things, underscored the desirability of multi-stakeholder Internet governance and the importance of promoting human rights online.[157]

Phase Three may be considered a reaction to the unfinished business of Phase Two with efforts underway to formalize a global system of Internet governance lead predominantly by nations, address latent cyber insecurity, and find common ground to ward off a "'new digital divide."[158] Yet as with the waning influence of the United States over climate negotiations from Kyoto to Copenhagen, so too has the new multipolar status quo made itself increasingly felt. This influence manifested in 2006 with the creation of the IGF, which was intended to be "a new forum for multi-stakeholder dialogue . . . an interactive, collaborative space where all stakeholders can air their views and exchange ideas."[159] However, the IGF remains little more than a "toothless talk

157. *See, e.g.*, Stefaan G. Verhulst, *Toward WSIS 3.0: Adopting Next-Gen Governance Solutions for Tomorrow's Information Society*, CIRCLE ID (Jan. 4, 2016, 1:19 PM), http://www.circleid.com/posts/20160104_toward_wsis_3_adopting_next_gen_governance_solutions/ [https://perma.cc/K9N9-726W].

158. Downes, *supra* note 134.

159. *Background of IGF*, INTERNET GOVERNANCE FORUM, http://www.intgovforum.org/cms/aboutigf [https://perma.cc/NKS8-U8HG].

shop,"[160] highlighting the continued strength of the US position in Internet governance, though the United States faced its biggest challenge to date in late 2012.

The so-called "Rise of the Rest" was felt most prominently in the ITU's 2012 World Conference on International Telecommunications (WCIT) when the 193 ITU member states reviewed and considered revising the International Telecommunication Regulations, which were last negotiated in 1988 and "facilitate international interconnection and [the] interoperability of information and communication services."[161] As with the UNFCCC annual COP gatherings, the difficulties of reaching consensus in a divided world replete with emerging power centers were on display. Here, nations identifying either with "Internet sovereignty" or "Internet freedom" designations came to loggerheads.[162] The U.S. government has opposed a larger Internet governance role for foreign nations or the ITU,[163] but authoritarian regimes lobbied UN member states to vote their way.[164] Ultimately eighty-nine countries signed the WCIT final resolution that, on the one hand, embraces multi-stakeholder governance, but, on the other, determines that "all governments should have an equal role and responsibility for international Internet governance and for ensuring the stability, security and

160. Khadija Patel, *Internet Governing Rights: World Powers Butt Heads*, DAILY MAVERICK (Dec. 5, 2012, 2:15 PM), http://www.dailymaverick.co.za/article/2012-12-05-internet-governing-rights-world-powers-butt-heads/#.UYFlMbXqmn8 [https://perma.cc/NRE2-SJRN].

161. *The Rise of the Rest*, *supra* note 49; *see e.g.*, World Conference on International Telecommunications (WCIT-12), ITU, http://www.itu.int/en/wcit-12/Pages/default.aspx [https://perma.cc/ZTX7-8BBA]; *see* ITU, FINAL ACTS OF THE WORLD CONFERENCE ON INTERNATIONAL TELECOMMUNICATIONS (2012) [hereinafter ITU RESOLUTIONS], http://www.itu.int/en/wcit-12/Documents/final-acts-wcit-12.pdf [https://perma.cc/BPM7-U5XR].

162. The term "Internet sovereignty" as used here refers to the growing state-centric approach to both Internet governance and cybersecurity. For one iteration of the Chinese perspective on this topic, see *White Paper Explains 'Internet Sovereignty,'* PEOPLE'S DAILY (June 9, 2010), http://en.peopledaily.com.cn/90001/90776/90785/7018630.html [https://perma.cc/A738-R5WM]. For a discussion of Internet freedom, see *Defining the Cyber Threat in Internet Governance*, *in* SHACKELFORD, *supra* note 27; see also Hillary Rodham Clinton, U.S. Sec'y of State, Remarks on Internet Freedom (Jan. 21, 2010), http://www.state.gov/secretary/20092013clinton/rm/2010/01/135519.htm [https://perma.cc/NF3F-YSET] (emphasizing the need for behavioral norms and respect among states to encourage the free flow of information and protect against cyber attacks).

163. *See, e.g.*, Leo Kelion, *US Resists Control of Internet Passing to UN Agency*, BBC NEWS (Aug. 3, 2012), http://www.bbc.co.uk/news/technology-19106420 [https://perma.cc/5UXM-6G4P].

164. *See id.* (voicing the ITU's opposition to voting and affirming that any changes to the Internal Telecommunication Regulations (ITRs) must have unanimous support).

continuity of the existing Internet . . . ."[165] This language only appears in a non-binding resolution entitled "Fostering an Enabling Environment for the Internet," but it has been seized on by some commentators as heralding a growing state-centric view of cyberspace held by many nations, especially in Asia (with the notable exceptions of India and Japan), Australia, and Africa.[166]

However, developments since 2012 seem to set the stage for a continuation of the multi-stakeholder status quo for the foreseeable future with back-to-back "wins" for the U.S.-endorsed multi-stakeholder approach at NETmundial in Brazil and the ITU's latest gathering as of this writing, PP-14 in Busan, South Korea. Russian plans to allow the ITU to allocate IP addresses, Arab proposals to strengthen the ITU's role in shaping international online surveillance law and policy, and Brazilian efforts to allow the ITU to address privacy largely went nowhere or were watered down to such an extent that their practical impact is minimal.[167] The same can be said of the 2015 World Summit of the Information Society.[168] Yet from Postel to the present, the continuation of our fractured system of governance has contributed to a proliferation in cyber insecurity. This issue requires an investigation of polycentric governance to see whether and how such a framework can help mitigate this global collective action problem.

B. Applying Polycentric Governance to Cybersecurity

Professor Elinor Ostrom and other scholars have argued for the adoption of polycentric management solutions to collective action problems in situations where the international community is either unable or unwilling to take necessary action.[169] Simply put, nations that are not bound by legal commitments enjoy the benefits

165. *Resolution Plen/3 (Dubai 2012): To Foster an Enabling Environment for the Greater Growth of the Internet*, *in* FINAL ACTS OF THE WORLD CONFERENCE ON INTERNATIONAL TELECOMMUNICATIONS 20 (2012), http://www.itu.int/en/wcit-12/Pages/default.aspx [https://perma.cc/EG9C-XGE3] [hereinafter ITU Resolution].

166. *See WTIT-12 Final Acts Signatories*, ITU (Dec. 14, 2012), http://www.itu.int/osg/wcit-12/highlights/signatories.html [https://perma.cc/62ZU-WMRC] [hereinafter ITU Signatories].

167. *See* Samantha Dickinson, *How Will Internet Governance Change After the ITU Conference?*, GUARDIAN (Nov. 7, 2014, 10:24 PM), http://www.theguardian.com/technology/2014/nov/07/how-will-internet-governance-change-after-the-itu-conference [https://perma.cc/NK6C-8K8Q].

168. *See* Alex Grigsby, *The Top Five Cyber Policy Developments of 2015: The WSIS+10 Review*, COUNCIL ON FOREIGN REL. (Dec. 22, 2015), http://blogs.cfr.org/cyber/2015/12/22/the-top-five-cyber-policy-issues-of-2015-the-wsis10-review/.

169. *See* Ostrom, *supra* note 5, at 3–4, 32.

of other nations' sacrifices without realizing the costs.[170] Those actors advocating for a polycentric approach argue that instead of the creation of a centralized artificial organization in the vein of ICANN, local institutions relying to the extent possible on organic self-organization, more reminiscent of the IETF, should be created to promote trust and bottom-up governance.[171] Such a polycentric approach would enjoy active oversight at multiple scales and from diverse stakeholders, though it does have its drawbacks as explored in Part V.

As applied to cybersecurity, such a polycentric approach affords a rich array of lessons on best practices ranging from addressing technical vulnerabilities to how best to leverage the power of the private sector to promote cyber peace.[172] To summarize, the importance of "smaller-scale effects" and local actors—be they technical communities, individual firms, or even nations—should be recognized within a polycentric framework.[173] As discussed above, the range of entities now active in cyberspace demonstrates the extent to which governance is fragmenting. Polycentric governance can help conceptualize such a dynamic system, given its embrace of multi-stakeholder governance, norms, bottom-up regulation, and targeted measures to enhance cybersecurity in the face of multipolar politics.[174] Regulation is happening at various levels and through various modalities, including laws, norms, markets, code,[175] self-regulation, and multilateral collaboration, all of which can contribute to enhancing global cybersecurity. Each of these regulatory approaches has unique benefits and drawbacks, but together they contribute to a governance regime that is multi-level, multi-purpose, multi-type, and multi-sectoral in scope[176] and that complements the top-down governance model favored by certain nations.[177] To more fully

170. Ostrom, *supra* note 5, at 4.

171. *Id*. at 4–5, 35.

172. For a deep dive into such an approach, see generally SHACKELFORD, *supra* note 27.

173. *See* Elinor Ostrom, *Polycentric Systems: Multilevel Governance Involving a Diversity of Organizations*, *in* GLOBAL ENVIRONMENTAL COMMONS: ANALYTICAL AND POLITICAL CHALLENGES INVOLVING A DIVERSITY OF ORGANIZATIONS 105, 117 (Eric Brousseau et al. eds., 2012) (noting that polycentric systems frequently enjoyed better outcomes than those of central governments).

174. *See* McGinnis, *supra* note 22, at 171–72.

175. *See* LAWRENCE LESSIG, CODE: VERSION 2.0 125 (2006).

176. McGinnis, *supra* note 22, at 170–72.

177. *See* ITU Signatories, *supra* note 166.

comprehend what lessons the field of atmospheric governance may hold for Internet governance, this chapter next turns to unpacking the literature on polycentric governance more fully and to applying it to both the global collective action problems of climate change and cyber attacks.

V. MITIGATING CLIMATE CHANGE AND CYBER ATTACKS THROUGH POLYCENTRIC GOVERNANCE

This Part assesses the potential and pitfalls of relying on a polycentric approach to mitigating the dual global collective action problems of climate change and cyber attacks. The analysis begins with applying Professor Elinor Ostrom's design principles from *Governing the Commons* to the arenas of atmospheric and Internet governance before moving on to briefly consider the Institutional Analysis and Design (IAD) and Social-Ecological Systems (SES) frameworks. The chapter concludes with an investigation of comparative regime effectiveness in the cybersecurity and climate contexts.

A. Applying the Ostrom's Design Principles to Climate Change and Cyber Attacks

In her groundbreaking 1990 book *Governing the Commons*, Professor Ostrom laid out an informative framework of eight design principles for the effective management of CPRs.[178] These principles were distilled from the common traits that Ostrom discovered through her meta-analysis of successful common property regimes.[179] The design principles, in turn, are helpful in making predictions about the governance of CPRs under various scenarios, and include the importance of: (1) "clearly defined boundaries for the user pool . . . and the resource domain";[180] (2) "proportional equivalence between benefits and costs";[181] (3) "collective choice arrangements" ensuring "that the resource users participate in setting . . . rules";[182] (4) "monitoring . . . by the appropriators or by their agents";[183] (5) "graduated sanctions" for

178. *See* ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION 90 (1990).

179. *See* Elinor Ostrom, *Beyond Markets and States: Polycentric Governance of Complex Economic Systems* 408, 422 (Nobel Prize Lecture, 2009), http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2009/ostrom_lecture.pdf.

180. BUCK, *supra* note 178, at 32.

181. *See* OSTROM, *supra* note 178, at 90.

182. BUCK, *supra* note 178, at 32.

183. *Id*.

rule violators;[184] (6) "conflict-resolution mechanisms [that] are readily available, low cost, and legitimate";[185] (7) "minimal recognition of rights to organize";[186] and (8) "governance activities [being] . . . organized in multiple layers of nested enterprises."[187] Not all of Professor Ostrom's design principles are applicable in either the context of climate change or cyber attacks, given that they were designed primarily for managing small-scale common pool resources, such as forests and lakes. However, many of Professor Ostrom's principles are still salient and are addressed in turn to inform a discussion of appropriate policy responses to global collective action problems.

1. Defined Boundaries

According to Professor Ostrom, "The boundary rules relate to who can enter, harvest, manage, and potentially exclude others' impacts. Participants then have more assurance about trustworthiness and cooperation of the others involved."[188] However, applying this element of the IAD Framework to both atmospheric and Internet governance presents challenges. In the climate context, one of the most divisive and ongoing issues is how to exclude actors from the atmospheric commons by limiting their ability to pollute. But there has been some important progress on this question of defining common but differentiated responsibilities in the UNFCCC-led climate change negotiations,[189] as seen in the 2015 Paris Agreement.[190]

As with the atmosphere, boundaries in cyberspace can also be difficult to draw, though they are created both through legal mechanisms, such as enclosure and the Internet sovereignty movement discussed above,[191] and organically, such as through the

184. *Id*.

185. *Id*.

186. Ostrom, *supra* note 173, at 118 tbl. 5.3.

187. *Id*.

188. *Id*. at 119.

189. *See* Pieter Pauw et al., *Different Perspectives on Differentiated Responsibilities: A State-of-the-Art Review of the Notion of Common but Differentiated Responsibilities in International Negotiations* tbls. 12 (German Dev. Inst. Discussion Paper, 2014), https://www.die-gdi.de/uploads/media/DP_6.2014.pdf [https://perma.cc/66T3-B5RF].

190. *See* Davenport, *supra* note 55 (noting that while "the individual countries' plans are voluntary, . . . the legal requirements that they publicly monitor, verify and report what they are doing, as well as publicly put forth updated plans, are designed to create a 'name-and-shame' system of global peer pressure, in hopes that countries will not want to be seen as international laggards.").

191. *See infra* Part IV.

creation of micro communities.[192] This element of the IAD Framework also engages with the prevailing question of whether cyberspace is in fact a commons, or whether its physical infrastructure—the hardware from routers to fiber optic cables that comprise the "tubes" of the Internet[193]—make it a different kind of "new commons," or "pseudo commons."[194]

2. Proportionality

Proportionality underscores the need for equity in a system so that some of the "users [do not] get all the benefits and pay few of the costs[.]"[195] This principle evokes debate over the core question about how to best enhance equity in the atmospheric commons, such as through some application of the CHM concept to help ensure that developing nations maintain access to the atmosphere through pollution credits, allowing them to better meet the basic needs of their populations. Likewise, proportionality in the atmospheric commons would be hurt if a final accord was perceived to permit one population—be it a developed or developing nation—to pay lower costs relative to the other while receiving greater benefits over some time horizon.[196] This issue raises the specter of balancing equity with what is politically possible, both through the UNFCCC and as a matter of domestic politics when it comes time to ratify the final accord.

Proportionality also emphasizes why the creation of a level playing field for firms is so important in the cybersecurity context whereby some businesses do not bear the costs for others' omissions, which is why some have argued for the presence of a cybersecurity market failure.[197] This fact could play out in the critical infrastructure context; some businesses, such as insurance

192. *See* MURRAY, *supra* note 73, at 164 (explaining how members of micro-communities tend to focus only on what directly impacts their own activities).

193. *See, e.g.*, ANDREW BLUM, TUBES: A JOURNEY TO THE CENTER OF THE INTERNET 1 (2013); *Hacking the Internet, the Dalai Lama, and You: Managing Technical Vulnerabilities in the Internet*, *in* SHACKELFORD, *supra* note 27.

194. Charlotte Hess, Mapping the New Commons 1 (July 1418, 2008) (Unpublished paper presented at the Twelfth Biennial Conf. of the Int'l Ass'n for the Study of the Commons, Cheltenbaum, U.K.). For more on this topic, and the importance of this designation, see Chapter 1 in SHACKELFORD, *supra* note 27.

195. Ostrom, *supra* note 172, at 120.

196. *Id*.

197. *See* Eli Dourado, *Is There a Cybersecurity Market Failure?* (George Mason Univ. Mercatus Ctr., Working Paper No. 12–05, 2012), http://mercatus.org/publication/there-cybersecurity-market-failure-0 (arguing that market failures are not so common in the cybersecurity realm); Jerry Brito & Tate Watkins, *Loving the Cyber Bomb? The Dangers of Threat Inflation in Cybersecurity Policy*, 3 HARV. NAT'L SEC. J. 39, 82 (2011) (making the case against there being a cybersecurity market failure).

companies, may be at greater risk of a cyber attack. The electrical grid is a particular concern given that if it was targeted as part of a sophisticated campaign, losses could exceed $1 trillion.[198]

3. Collective-Choice Arrangements and Minimal Recognition of Rights

Professor Ostrom's third design principle states "that most of the individuals affected by a resource regime are authorized to participate in making and modifying the rules related to boundaries, assessment of costs, . . . etc."[199] This principle underscores the importance of engaged and proactive rulemaking by technical communities, the private sector, and the international community.[200] Such a multi-stakeholder approach is evident in both the atmospheric and Internet contexts. Many thousands of NGOs and other interested organizations have participated in the UNFCCC process.[201] This level of involvement by civil society can breed success, as seen in the designation of Antarctica as a world park, establishment of the Southern Ocean Whale Sanctuary, and the moratorium on high seas drift net fishing.[202] Similarly, the history of Internet governance has been marked by its multi-stakeholder approach to governance with an array of private entities such as ICANN and IETF cooperating with a range of governments and other organizations to make policy. Yet it is also true that more remains to be done to promote engagement, such as through a revamped IGF and now independent ICANN. Moreover, this principle recognizes the need to modify rules as the regulatory and technological environments change.[203] As has been seen, the cyber threat matrix is continuously evolving, making it vital for local rules in the form of industry best practices to proactively evolve along with cyberspace, and providing a cautionary tale against heavy-handed government regulation. One example of this practice being manifest has been the rollout and

198. *See* LLOYDS & CTR. OF RISK STUDIES, UNV. OF CAMBRIDGE, BUSINESS BLACKOUT: THE INSURANCE IMPLICATIONS OF A CYBER ATTACK ON THE US POWER GRID 334 (2015).

199. Ostrom, *supra* note 172, at 120.

200. *See* George J. Siedel & Helena Haapio, *Law as a Source of Strategic Advantage: Using Proactive Law for Competitive Advantage*, 47 AM. BUS. L.J. 641, 656–57 (2010) (discussing the origins of the proactive law movement, which may be considered "a future-oriented approach to law placing an emphasis on legal knowledge to be applied before things go wrong").

201. *See* BUCK, *supra* note 178, at 8.

202. *See* Siedel & Haapio, *supra* note 209, at 656–57.

203. Ostrom, *supra* note 172, at 120.

wide adoption of the National Institute for Standards and Technology (NIST) Cybersecurity Framework, which is helping to establish a standard of cybersecurity care from the bottom up both in the United States and around the world.[204] Much of the same could be said in the climate context given the rapid rate at which technologies are evolving and pricing structures are changing, such as in the renewable energy context with the steep fall in price of solar panels in recent years.[205]

4. Monitoring

According to Professor Ostrom, trust can typically only do so much to mitigate rule-breaking behavior.[206] Eventually, some level of monitoring becomes important. In self-organized communities, monitors are typically chosen among the members to ensure "the conformance of others to local rules."[207] However, in the global context, verification becomes difficult. This enforcement problem is one of the principal issues that held up negotiators at COP15 with some nations, including China, balking at letting inspectors monitor their compliance with a final agreement,[208] a topic that was ultimately resolved in the Paris Agreement.[209] Verification is similarly difficult in the cybersecurity context with the technical knowhow and necessary hardware being widely diffused and oftentimes capable of dual-use purposes.

One way to promote cybersecurity is to leverage information-sharing organizations to diffuse both cyber threat data as well as best practices. The Cybersecurity Act of 2015 has aided cyber threat information sharing,[210] while other proposed

204. *See* Scott J. Shackelford et al., *Toward a Global Standard of Cybersecurity Care?: Exploring the Implications of the 2014 Cybersecurity Framework on Shaping Reasonable National and International Cybersecurity Practices*, 50 TEX. INT'L L.J. 287, 288 (2015); Scott J. Shackelford, Scott Russell, & Jeffrey Haut, *Bottoms Up: A Comparison of "Voluntary" Cybersecurity Frameworks*, __ UNIV. OF CAL. DAVIS BUS. L.J. __ (forthcoming 2016).

205. *See, e.g.*, Giles Parkinson, *Solar Costs Will Fall Another 40% in 2 Years. Here's Why*, CLEAN TECHNICA (Jan. 29, 2015), http://cleantechnica.com/2015/01/29/solar-costs-will-fall-40-next-2-years-heres/ [https://perma.cc/3GPQ-S4VQ].

206. Ostrom, *supra* note 172, at 120.

207. *Id*. at 121.

208. *See* Bryan Walsh, *Frustration Mounts in Copenhagen as Talks Stall*, TIME (Dec. 15, 2009), http://content.time.com/time/specials/packages/article/0,28804,1929071_1929070_1948020,00.html [https://perma.cc/TH3Z-L439].

209. *See* Yamide Dagnet, *Why Transparency Is a Prerequisite for Delivering on the Paris Agreement*, WORLD RESOURCES INST. (May 20, 2016), http://www.wri.org/blog/2016/05/insider-why-transparency-prerequisite-delivering-paris-agreement.

210. *See, e.g.*, Boris Segalis, Andrew Hoffman, & Kathryn Linsky, *Federal Cybersecurity Information Sharing Act Signed into Law*, DATA PROTECTION REP. (Jan. 3, 2016),

legislation would create industry councils in the United States and empower them "to develop and coordinate the enforcement of cybersecurity guidelines for key U.S. sectors."[211] However, these efforts have not been codified into US law.

5. Graduated Sanctions and Dispute Resolution

Other insights from Professor Ostrom's principles, such as the need for graduated sanctions for rule violators and effective dispute resolution, speak to the importance of addressing legal ambiguities and establishing norms of behavior. The former point underscores the significance of not "[l]etting an infraction pass unnoticed,"[212] meaning that the cost of flouting agreed-upon climate goals and cyber norms alike need to be recognized through some combination of market reaction and governmental action. The latter point is a key component of creating a functioning body of international climate and cybersecurity law in which the rules of the road are clear for companies, countries, and the international community alike. Some progress has been made in the cybersecurity context, such as "the recognition that international law applies to state activity in cyberspace and that human rights protections that apply offline also apply online."[213] Indeed, various minilateral forums have been engaged in cybersecurity norm building, including the G2, G7, the G20, and the UN Group of Governmental Experts.[214] Yet challenges remain, as may be seen by the Obama Administration weighing how best to respond to the Office of Personal Management breach, and Russian involvement in hacking the Democratic National Committee.[215]

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http://www.dataprotectionreport.com/2016/01/federal-cybersecurity-information-sharing-act-signed-into-law/.

211. Alexei Alexis, *House Homeland Security Leaders Said Close To Unveiling Cybersecurity Bill*, BLOOMBERG BNA (June 10, 2013), http://www.bna.com/house-homeland-security-n17179874424/ [https://perma.cc/YV25-AWLQ].

212. Ostrom, *supra* note 172, at 121.

213. Henry Farrell, *Promoting Norms for Cyberspace*, COUNCIL ON FOREIGN RE. (Apr. 2015), http://www.cfr.org/cybersecurity/promoting-norms-cyberspace/p36358?cid=nlc-npbnews-2015_national_conference_confirmation_and_background--link22-20150602&sp_mid=48790069&sp_rid=a3plZ3VyYUBjZnIub3JnS0 [https://perma.cc/VD29-PUA2].

214. *See, e.g.*, Scott J. Shackelford, *How to Make Democracy Harder to Hack*, CHRISTIAN SCI. MONITOR (July 29, 2016), http://www.csmonitor.com/World/Passcode/Passcode-Voices/2016/0729/Opinion-How-to-make-democracy-harder-to-hack.

215. *See* David E. Sanger, *U.S. Decides to Retaliate Against China's Hacking*, N.Y. TIMES (July 31, 2015), http://www.nytimes.com/2015/08/01/world/asia/us-decides-to-retaliate-against-chinas-hacking.html?_r=0 [https://perma.cc/9QQJ-J5GL]; Katie Bo Williams, *Obama Administration Publicly Blames Russia for DNC Hack*, HILL (Oct. 7, 2016),

6. Nested Enterprises

As stated by Professor Ostrom, "When common-pool resources that are being managed by a group are part of a larger set of resource systems, an eighth design principle is usually present in robust systems. The nested enterprise principle states that governance activities are organized in multiple layers of related governance regimes."[216] Such nesting can "occur either between user groups and larger governmental jurisdictions, or between user groups themselves" with an example being the varying components of irrigation systems.[217] Just as this multilevel system is imperative for environmental governance in large ecological systems with distinct local dynamics,[218] so too is it essential for enhancing cybersecurity given the local, national, and global impact of cyber attacks on economic development and security.[219]

7. Summary

As helpful as Professor Ostrom's design principles are to analyzing the factors necessary to create a functioning system of polycentric governance to address a given global collective action problem, it is far from perfect, as Professor Ostrom would be the first to admit.[220] Insights such as boundaries being difficult to define, the need for proportionality, a robust role for civil society, and effective monitoring coupled with graduated sanctions only take us so far in crafting effective regimes for both atmospheric and Internet governance. Nor are the design principles the whole story; indeed, work is now underway to build on these design principles by creating a common vocabulary for CPR assessment. This is being done through augmenting the Institutional Analysis and Design Framework (IAD)—which may be understood as a "meta-theoretical conceptual map"[221] replete with numerous

http://thehill.com/policy/cybersecurity/299874-obama-administration-publicly-blames-russia-for-dnc-hack.

216. Ostrom, *supra* note 172, at 122.

217. *See* Michael Cox et al., *A Review of Design Principles for Community-Based Natural Resource Management*, 15 ECOLOGY & SOC'Y 38 (2010), http://www.ecologyandsociety.org/vol15/iss4/art38/main.html [https://perma.cc/J767-WT5G].

218. Ostrom, *supra* note 172, at 122.

219. For further examples of the successes and failures of polycentric governance in the Internet governance context, see *Cyber Peace*, *in* SHACKELFORD, *supra* note 27.

220. *See* Elinor Ostrom, et al., *Revisiting the Commons: Local Lessons, Global Challenges*, 284 SCI. 282, 282 (1999) (noting that some of her work in the global commons context to "provide starting points for addressing future challenges").

221. BEATRICE MOSELLO, HOW TO DEAL WITH CLIMATE CHANGE?: INSTITUTIONAL ADAPTIVE CAPACITY AS A MEANS TO PROMOTE SUSTAINABLE WATER GOVERNANCE 31 (2015).

theories, models, and concepts that together provide a common vocabulary for the interdisciplinary analysis of collective action problems[222]—with the Social-Ecological-Systems (SES) Framework, discussed below. Professors Michael McGinnis, Dan Cole, and Graham Epstein have analyzed the IAD Framework and have pointed out that, among other challenges, it suffers from a lack of specification in community attributes, an insufficient differentiation of outputs and mediated outcomes, insufficient treatment of ecological variables, difficulties surrounding exogenous variables, and the interactions between these factors.[223] Thus, there have lately been efforts to update and supplement the IAD Framework by combining it with lessons from the literature examining social-ecological systems. Those studies are briefly addressed next in the context of the dual global collective action problems of climate change and cyber attacks.

B. Marrying the Institutional Analysis and Design Framework with the Study of Social-Ecological Systems

Though Professor Ostrom's important work on the design principles and the IAD Framework often get much of the attention in public policy circles, given its emphasis on self-understanding beyond classical rational choice rather than black letter law (that may or may not be enforced in a particular context),[224] her work on the SES Framework offers an even more "comprehensive approach to the study of closely-coupled systems" drawing from both social and ecological factors.[225] Running throughout her work, which was in support of Professor Vincent Ostrom's 1961 theoretical argument in favor of polycentric governance,[226] is an empirical demonstration that "public services can be most efficiently

222. Ostrom, *supra* note 179, at 408-09.

223. *See* Dan Cole, Michael McGinnis, & Graham Epstein, *Toward a Combined IAD-SES Framework* 5 (Vincent and Elinor Ostrom Workshop in Political Theory and Policy Analysis, Indiana Univ., Bloomington, Ind., 2013), http://ostromworkshop.indiana.edu/colloquia/materials/papers/Cole,%20McGinnis,%20Epstein_PowerPoint.pdf [https://perma.cc/D493-Z8KA].

224. Michael D. McGinnis, *Elinor Ostrom: Politics as Problem-Solving in Polycentric Settings*, *in* ELINOR OSTROM AND THE BLOOMINGTON SCHOOL OF POLITICAL ECONOMY 281, 285, 292 (Daniel H. Cole & Michael D. McGinnis eds., 2014).

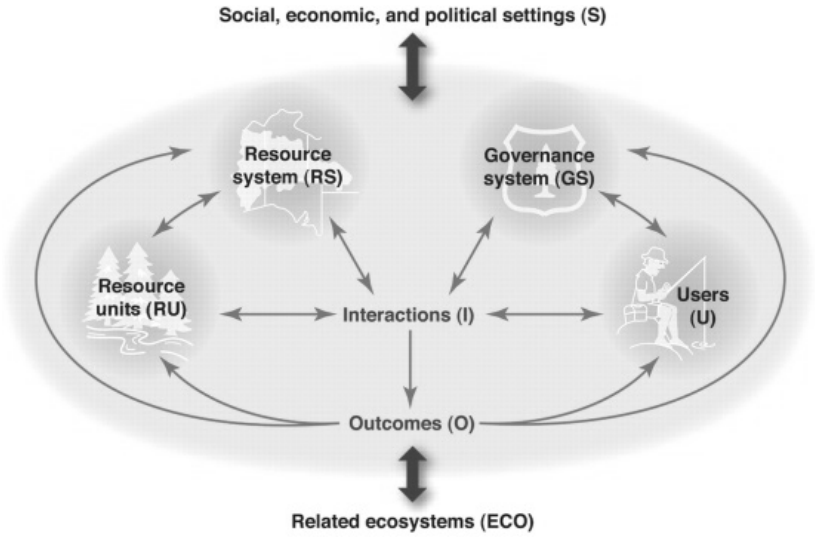
225. *Id*.

226. *See* Vincent Ostrom, Charles M. Tiebout, & Robert Warren, *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55 Am. POL SCI. REV. 831, 831 (1961).

provided under a system of multiple and overlapping jurisdictions."[227]

The SES Framework grew up as a result of the need to distribute resources efficiently and equitably in an era increasingly defined by scarcity, especially when considering global climate change.[228] In Professor Ostrom's own words, the SES Framework helps show "the relationships among four first-level core subsystems" including "resource systems . . . resource units . . . governance systems . . . and users[.]"[229] Each of these core subsystems is then composed of "multiple second-level variables," which "are further composed of deeper-level variables."[230] In other words, it is "complicated,"[231] but so is policymaking. Professor Ostrom's SES model is shown in Figure 3.

Figure 3: Ostrom's SES Framework.[232]



Although work on a combined IAD-SES Framework continues as of this writing, early results, including by those of Professors Cole and McGinnis, show great promise.[233] A rich

227. McGinnis, *supra* note 224, at 286.
228. *Id*. at 294.
229. Elinor Ostrom, *A General Framework for Analyzing Sustainability of Social-Ecological Systems*, 325 SCI. 419, 420 (2012).
230. *Id*.
231. McGinnis, *supra* note 227, at 294.
232. Ostrom, *supra* note 231.
233. *See, e.g.*, Cole, McGinnis, & Epstein, *supra* note 226, at 9.

array of ten new factors comprises the SES, including: (1) the size of the resource system—with a preference for medium-scale domains (the trick being to parse global commons arenas into this size such as through the establishment of micro communities[234]); (2) productivity—including the need for scarcity to drive governance change, highlighting the importance of this structural variable; (3) predictability—a problem given the diverse array of factors at play in both climate change and cybersecurity; (4) resource mobility—making self-organization more likely in stationary settings, a difficult concept for a moving atmosphere and knowledge commons; (5) the number of users—with a necessary correlation between the size of the resource domain and user base to aid in good governance; (6) leadership—particularly norm entrepreneurs in this context, as is occurring in both the public and private sectors in both the climate change and Internet governance contexts; (7) norms; (8) knowledge about the SES—a tall order given the complexities inherent in both atmospheric and Internet governance; (9) importance of the SES—the stakes could not be higher to the global community, whether people realize it or not; and (10) collective-choice rules (bottom-up rulemaking lowers transaction costs, among other benefits, showing the importance of multi-stakeholder engagement).[235] Together, parsed and updated, these factors, combined with the IAD, hold the potential to better inform twenty-first century global commons governance.

However, there are issues with the SES Framework as well, including the fact that it is "[p]urely descriptive, diagnostic, and static," as well as an "absence of economic variables" and "[d]ubious specifications of some variables."[236] A combined IAD-SES Framework promises to be more dynamic, logically structured, and includes other factors, such as transaction costs into the model's overarching design.[237] It also could help avoid some of the drawbacks of polycentric governance discussed below.

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234. The Chinese government is trying a massive experiment along these lines with its social capital ranking scheme. *See* Celia Hatton, *China 'Social Credit': Beijing Sets up Huge System*, BBC (Oct. 26, 2015), http://www.bbc.com/news/world-asia-china-34592186.

235. *See* Ostrom, *supra* note 231, at 221.

236. *See, e.g.*, Cole, McGinnis, & Epstein, *supra* note 226, at 8.

237. *Id*. at 9.

C. The Political and Ethical Pitfalls of Polycentric Governance

Not all aspects of polycentric governance easily apply to either atmospheric or Internet governance. Given that the climate impacts all humans, just as cyberspace includes an online community of more than two billion users, the concept of self-organization, for example, is strained due to the sheer scale of collective action involved.[238] Additionally, there are important drawbacks of polycentric regulation to be addressed, such as the risk of gridlock,[239] which could lead to inconsistency and systemic failures.[240]

There are also political and ethical issues to consider, such as Hardin's "lifeboat ethics" concept introduced in Chapter One.[241] In the climate context, this is already arguably playing out because the least-developed nations are those most vulnerable to—and least able to adapt to—a rapidly changing climate.[242] In the cyber context, this conflict may take the form of developing nations' inability to make needed cybersecurity gains in the absence of a multilateral framework without resource and technology transfers from developed nations. Second, there is a school of thought that some nations may be less inclined to cooperate in smaller forums because they are unable to hide behind others.[243] For example, the cyber powers have long been reluctant to negotiate thorny verification and attribution issues, among other concerns, in a minilateral (typically bilateral or regional) forum given their current asymmetric advantages.[244] However, progress toward a

238. *See* Roger Hurwitz, *The Prospects for Regulating Cyberspace: A Schematic Analysis on the Basis of Elinor Ostrom, "General Framework for Analyzing Sustainability of Social Ecological Systems*," 325 SCI. 419, 419–22 (2009).

239. Keohane & Victor, *supra* note 23, at 15.

240. *Id.* at 3, 19–20.

241. *See* Garrett Hardin, *Lifeboat Ethics: The Case Against Helping the Poor*, PSYCHOLOGY TODAY, Sept. 1974, at 38–40, 123–124, 126 (examining, from an ethical viewpoint, when swimmers surrounding a lifeboat should be taken aboard as an analogy for analyzing resource distribution policies given the divide between developed and developing nations).

242. *See, e.g.*, John Vidal, *Climate Change Will Hit Poor Countries Hardest, Study Shows*, THE GUARDIAN (Sept. 27, 2013, 04:01 AM), http://www.theguardian.com/global-development/2013/sep/27/climate-change-poor-countries-ipcc [https://perma.cc/F4Q3-UA9U].

243. In the climate context, one example of this phenomenon is the Indian government's resistance to establish a US-India Climate Change Working Group patterned on the successful US-China Climate Change Working Group. *See* Steven Mufson, *Obama, India's PM Modi Promise Future Deal on Climate Change and Energy*, STAR (June 7, 2016), https://www.thestar.com/news/world/2016/06/07/obama-indias-pm-modi-promise-future-deal-on-climate-change-and-energy.html.

244. *Cf.* Jeremy Kirk, *Russia Pushes for Online Code of Conduct at United Nations General Assembly*, COMPUT. WORLD UK (Oct. 3, 2011), http://www.computerworlduk.com/news/

cybersecurity code of conduct in the G2, G7, and G20 contexts calls such arguments into question.[245] Similarly, this thinking may no longer apply in the climate context given the array of bilateral and minilateral GHG reduction announcements, including by the G2,[246] and the rapid ratification of the Paris Agreement discussed next. Still, the question must still be addressed: even with a polycentric status quo taking hold in both Internet and atmospheric governance, will it be enough to address the challenges of climate change and cyber attacks?

D. Will it be Enough? A Look at Regime Effectiveness

An effective system of polycentric governance for both cyberspace and the atmosphere would use a mixture of laws and norms; market-based incentives; code; self-regulation; public-private partnerships; and bilateral, regional, and multilateral collaboration to enhance cybersecurity and fight climate change. Yet even if such a system was practicable, polycentric networks are susceptible to the array of issues including gridlock discussed above and in Chapter One.[247] Thus, it is useful to assess the desirability of such an approach by analyzing the current state of affairs, especially as both these arenas move increasingly in the direction of polycentric governance. However, measuring the effectiveness of these regimes is problematic and is posed here merely to couch the debate about how best to address global collective action problems in greater context and to help illustrate the difficulties involved with realizing the promise of polycentric governance in promoting cyber peace and addressing climate change.[248]

Regime effectiveness has become increasingly central to investigating the utility of international institutions toward

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it-management/russia-pushes-for-online-code-of--conduct-at-united-nations-general-assembly-3307976/3, 2011), [https://perma.cc/7WL5-ZVAQ] (reporting on the push for an online code of conduct).

245. *See, e.g.*, Felicia Schwartz, *U.S., China Conclude Annual Talks Amid Tensions*, WALL ST. J. (June 24, 2015, 7:37 PM), http://www.wsj.com/articles/u-s-china-conclude-annual-talks-amid-tensions-1435188788 [https://perma.cc/8CGV-EVJC].

246. *See* Tollefson, *supra* note 110.

247. *See* Keohane & Victor, *supra* note 23, at 14, 17 (explaining that different components within a partially fragmented regime complex may compete with each other, resulting in a gridlock of innovation).

248. A prior version of this research as applied to cyberspace was published in *Cyber Peace*, *in* SHACKELFORD, *supra* note 27; Shackelford, *supra* note 131, at 123.

addressing various collective action problems.[249] However, the array of literature on regime effectiveness that has arisen in fields such as human rights law has not been applied to Internet governance partly because of the difficulty of making causal inferences under a variety of conditions, given the lack of robust data.[250] More relevant work has been done in the climate context, but there it is relatively rare to compare different global commons regimes.[251] Further, it is a challenging proposition to measure the effectiveness of regime complexes, because the governance structures at work are diverse and not easily amenable to quantifiable comparison.[252] At best, correlations may be highlighted. A comprehensive analysis of the effectiveness of international climate and cyber law is thus beyond the scope of this chapter. Nevertheless, some qualitative and quantitative analysis of the performance of these regimes is possible by comparing the performance of those regimes to an ideal type, as well as to a no-regime counterfactual. Professor Oran Young's groundbreaking work in this area is used here,[253] particularly a legal-political approach to analyze some aspects of international law underpinning both Internet and atmospheric governance.

A comprehensive approach to comparing cyber and atmospheric governance is daunting given both the amount of polycentric regulations in play as well as the lack of binding international cyber law below the armed attack threshold.[254] Diverse bodies of law and custom are applicable in both arenas to help fill in the law of cyber peace and of the atmosphere. However, some comparisons, although unsophisticated, are possible across these arenas, a sampling of which is summarized in Figure 4.

249. Michael Zürn, *The Rise of International Environmental Politics: A Review of Current Research*, 50(4) WORLD POLITICS 617, 649 (1998).

250. *See, e.g.*, Oona A. Hathaway, *Do Human Rights Treaties Make a Difference?*, 111 YALE L.J. 1935, 1938 (2002) (declaring that a quantitative approach to tracing the effectiveness of relationships within human rights law is typically difficult, if not impossible).

251. *See* Oran R. Young, *Effectiveness of International Environmental Regimes: Existing Knowledge, Cutting-Edge Themes, and Research Strategies*, 108 PROCEEDINGS OF THE NAT'L ACAD. SCI. 19853, 19853 (2011).

252. *See* Helm & Sprinz, *supra* note 250, at 632 (suggesting that scholars "focus on observable political effects of institutions rather than directly on environmental impact" because of the difficulty of measuring the actual impacts resulting from a given regulatory action).

253. Oran R. Young & Marc A. Levy, *The Effectiveness of International Environmental*, *in* THE EFFECTIVENESS OF INTERNATIONAL ENVIRONMENTAL REGIMES: CAUSAL CONNECTIONS AND BEHAVIORAL MECHANISMS 1, 4–6 (Oran R. Young ed., 1999).

254. The armed attack threshold is the line at which the law of war is activated. *See An Introduction to the Law of Cyber War and Peace*, *in* SHACKELFORD, *supra* note 27.

Figure 4: Selection of International Agreements Governing the Atmosphere and Cyberspace[255]

Name	Subject	Year	Full Members	Ratifications for Entry Into Force (EIF)	Sig. to EIF (in months)	Amendment Requirements	Reservations Allowed
Vienna Convention	Atmospheric ozone	1985	197	20	44	Three-quarters	No
Montreal Protocol	Ozone	1987	197	11	15	20	No
UNFCCC	Climate	1992	195	50	21	Three-quarters	No
Kyoto Protocol	Climate	1995	192	*Marrakesh Accords	99	Three-quarters	No
Paris Agreement	Climate	2015	197	55	11	Three-quarters	No
Convention on Cybercrime	Cybercrime	2001	41	5	31	All	Yes
ITU Constitution & Convention	Telecom	1992	193	July 1, 1994	19	Two-thirds	Yes

The data summarized in Figure 4 allude to at least five important trends in climate and Internet governance, demonstrating how these new commons regimes are departing in some ways from

255. JOHN VOGLER, THE GLOBAL COMMONS: ENVIRONMENTAL AND TECHNOLOGICAL GOVERNANCE 157–59 (2000) (table adapted and updated data from International Maritime Organization, the United Nations, International Whaling Commission, the Secretariat of the Antarctic Treaty, and the London Convention and Protocol); *e.g.*, U.N. Treaties and Principles on Outer Space, U.N. Sales No. E.08.I. ef10 (2008); Int'l Maritime Organization [IMO], MARPOL, *International Convention for the Prevention of Pollution from Ships* (Nov. 2, 1973), http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-%28MARPOL%29.aspx [https://perma.cc/WD39-4QFR]; Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 11, 1997, 2303 U.N.T.S. 162, http://unfccc.int/kyoto_protocol/items/2830.php [https://perma.cc/E99D-MUJ5] (naming the rules setting out the implementation of the Kyoto Protocol that were adopted at COP7 in Marrakesh in 2001 the "Marrakesh Accords"); *see Membership and Contracting Governments*, INT'L WHALING COMM'N, http://iwc.int/members.htm [https://perma.cc/7BAF-VSKH]; *Parties*, SECRETARIAT OF THE ANTARCTIC TREATY, http://www.ats.aq/devAS/ats_parties.aspx?lang=e [https://perma.cc/6M6L-HJ97] (including both consultative and non-consultative parties); *cf. Cyber Peace*, *in* SHACKELFORD, *supra* note 27.

historical counterpoints such as space law.[256] First, while reservations may be found in 44 percent of the accords related to global commons governance discussed further in Chapter Six, none of the climate agreements surveyed permit such reservations, arguably demonstrating the regime's relative strength and maturity. In the cyber context, the Budapest Convention permits States to opt out of specific provisions, thus potentially weakening the regime even as it functions to expand membership and speeds entry into force.[257]

Second, the time span between negotiation to entry into force of climate accords was lengthening, as may be seen in Figure 4, until the success of the Paris Agreement. This trend correlates with the rise in multipolar politics that make consensus more difficult to reach. However, notably the trend has reversed itself with regards to the unprecedentedly rapid ratification of the Paris Agreement, which took only eleven months to enter into force. Although more than one factor is at work in this regard, as is discussed below one possible explanation for this state of affairs is the extent to which the Paris Agreement embraced polycentric principles and leveraged minilateral norm building on the lead up to the multilateral meeting to build support for a global agreement. Aside from Paris, the difficulty in new treaty formation is similar to the space law regime, as is discussed in Chapter Five. Insufficient data exists to compare these findings with the Internet governance context given that the only dedicated international cybersecurity treaty is the Budapest Convention itself, which only came online in 2001.[258] However, future work could analyze various ITU documents and related endeavors.[259]

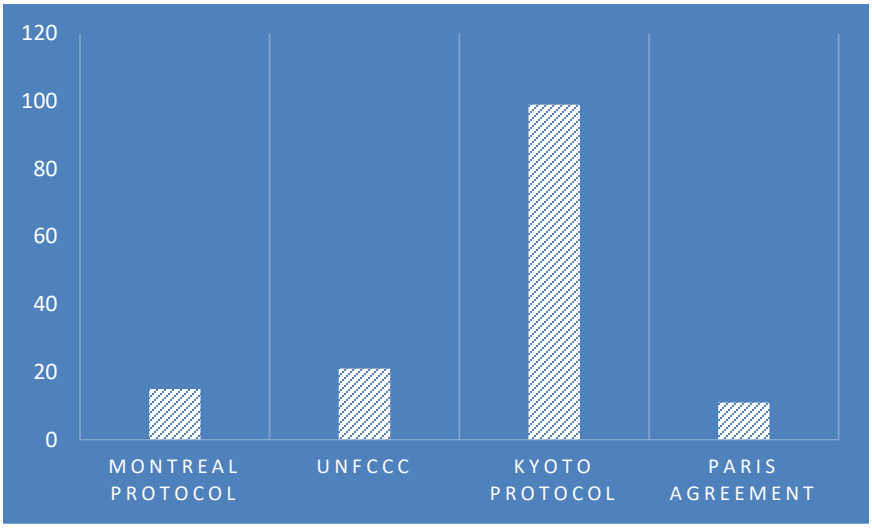
Figure 5: Number of Months for Selected Climate Treaties to Enter into Force

256. For more information, see VOGLER, *supra* note 256, at 152–81.

257. Convention on Cybercrime, arts. 42–43, Nov. 23, 2001, 2296 U.N.T.S. 167, http://conventions.coe.int/Treaty/en/Treaties/Html/185.htm [https://perma.cc/AQ94-KXBB]; *see* VOGLER, *supra* note 257, at 159.

258. Convention on Cybercrime, *supra* note 258.

259. *See, e.g.*, ITU, UNDERSTANDING CYBERCRIME: PHENOMENA, CHALLENGES AND LEGAL OPTIONS 11, 127–28 (2012), http://www.itu.int/ITU-D/cyb/cybersecurity/docs/Cybercrime%20legislation%20EV6.pdf [https://perma.cc/68NZ-7KCN] (listing other relevant model laws, including the Commonwealth Model Law on Computer and Computer-related Crime).



Third, the number of ratifying states has remained fairly constant in the climate regime with more than 190 nations ratifying the Montreal and Kyoto Protocols, as well as the UNFCCC as shown in Figure 4. This trend makes atmospheric governance stand out in some ways given the extent to which the number of ratifications has fallen off in other arenas, such as outer space as discussed in Chapter Five.[260] Again, insufficient data exists to paint a picture in the Internet governance context, though the number of ratifications to the Budapest Convention has been steadily growing.[261]

Fourth, enforcement provisions are often lacking in these agreements,[262] as are information sharing and verification mechanisms as was discussed in Parts III and IV,[263] though again the Paris Agreement stands out from this trend given its inclusion of transparency measures. Fifth, when reviewing the entirety of global commons regulations as Professor John Vogler has attempted, more than half of the total agreements analyzed further

260. *See* Shackelford, *Governing the Final Frontier*, *supra* note 24 at 429–30.

261. *See* Eur. Consult. Ass., Convention on Cybercrime, ETS No. 185 (Nov. 23, 2001), http://www.conventions.coe.int/Treaty/Commun/ChercheSig.asp?NT=185&CM=8&DF=28/06/2013&CL=ENG [https://perma.cc/S539-A82J].

262. VOGLER, *supra* note 256, at 172.

263. *See id.* at 167–69. Other trends are also prevalent in Table 7.2, especially regarding the space law treaties. For example, while the amount of time it has taken for space law treaties to enter into force has gradually increased, there was a concurrent decrease in both the number of ratifying and signatory states to the principal space law treaties from 1967 to 1984.

in Chapter Six are regional or sub-regional in scope,[264] underscoring the move toward a regime complex.[265] Again, the climate and Internet regimes stand out given that they are global in scope, even as some minilateral agreements—such as the G2 Cybersecurity Code of Conduct referenced above—seem to be catching on.

Overall, the fact that reservations are not allowed and the number of ratifying states has remained high (even as these agreements are global in scope) made the state of atmospheric governance appear relatively healthy as compared to other global commons regimes such as space law. Indeed, the Paris Agreement continued this trend in that it similarly disallows reservations.[266] However, accords, even when they are agreed to, are taking longer to enter into force across these arenas while thorny issues of attribution, verification, and enforcement remain daunting. The effectiveness of these regimes has been varied as a result of these and other factors.[267]

Focusing on cyberspace, an argument could be made that some elements of Internet governance are working rather well relative to other international spaces. The growing membership of the Budapest Convention, the relative rarity of cyber terrorism incidents, the absence of genuine cyber war, the increasing rates of e-commerce, and the TCP/IP's successful scaling all go to support this view. However, the growth of cybercrime and espionage has led to not only more than $400 billion in annual losses,[268] but also the apparent proliferation of sophisticated cyber weapons and state-sponsored attacks. These developments call Professor Ostrom's contention regarding the relative success of Internet governance into question.[269]

264. VOGLER, *supra* note 256, at 156 (noting that participation of states in various regimes is a key issue in mitigating global governance challenges).

265. *See id.*, at 179.

266. *See* Adoption of the Paris Agreement to the United Nations Framework Convention on Climate Change, U.N. Doc. FCCC/CP/2015/L.9/Rev.1 (2015), https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf [https://perma.cc/G2NL-GBUV].

267. *Id.* at 18, 161, 170–71 (providing that effectiveness in some of the more recently established regimes proves difficult to ascertain beyond a level of informed speculation).

268. *See* CTR. FOR STRATEGIC & INT'L STUDIES, *supra* note 1; *see also* BAE SYS. APPLIED INTELLIGENCE, THE COST OF CYBERCRIME 2–3 (2011), http://www.iwar.org.uk/ecoespionage/resources/cost-of-cybercrime/full-report.pdf [https://perma.cc/GG8Q-LZ9P] (estimating that cybercrime costs the British economy approximately $43 billion annually).

269. To take one other example of the continued difficulty of enhancing cybersecurity, consider the case of online voting. This is becoming more popular in parts of the world, but a pilot program in Washington, D.C., in late 2012, resulted in security specialists finding a number of lapses—a team from the University of Michigan was even able to hack the website so that the University's fight

Considering atmospheric governance, there is also some evidence that the current polycentric approach is working to help mitigate the problem of global climate change. National and minilateral undertakings, such as the Paris Agreement, China's pledge to reach peak emissions before 2030,[270] and the continuing decline in U.S. emissions, help support this view.[271] However, the slew of data from the IPCC and other organizations alluding to the unsustainable status quo in GHG emissions even with the Paris Agreement should elicit the question whether this approach will, in fact, be sufficient in the long run to promote the sustainable use of the atmospheric commons.[272]

While current laws and policies are not ideal for fostering an effective regime to manage climate change—and, for that matter, a positive cyber peace—it does seem evident that these legal systems are preferable to a no-regime counterfactual. That is, it is clear that current laws are preferable to none at all, given the anarchy possible in the absence of any regulation. Although ambiguities and gaps persist, the advancement made to enhance cybersecurity would likely not have been possible without these and other legal systems.[273] Further, the types of polycentric interaction occurring in both Internet and atmospheric governance may help speed progress towards the desired ends. Professor Hugh Ward, for example, has argued, "[W]hen nations participate in particular regimes, they also become part of a wider network. This network links nations and also individual regimes. It embodies social capital that may be used to encourage nations to behave

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song would play after a vote was cast. *See* Timothy B. Lee, *The Michigan Fight Song and Four Other Reasons to Avoid Internet Voting*, ARS TECHNICA (Oct. 24, 2012), http://arstechnica.com/tech-policy/2012/10/the-michigan-fight-song-and-four-other-reasons-to-avoid-internet-voting/ [https://perma.cc/AT2A-DMYT].

270. *See* Press Release, White House, *supra* note 112.

271. *Cf.* Brad Plumer, *After Years of Decline, U.S. Carbon Emissions Rose 2 Percent in 2013*, WASH. POST (Jan. 13, 2014), http://www.washingtonpost.com/blogs/wonkblog/wp/2014/01/13/after-years-of-decline-u-s-carbon-emissions-rose-2-percent-in-2013/ [https://perma.cc/ZJV7-PKRW].

272. *See, e.g.*, Steve Almsay, *Invest Now or Face 'Irreversible' Effects of Climate Change, U.N. Panel Warns*, CNN (Nov. 2, 2014), http://www.cnn.com/2014/11/02/world/ipcc-climate-change-report/ [https://perma.cc/3MLD-FTKF].

273. *See, e.g.*, VOGLER, *supra* note 256, at 180–81; *Europeans Charged in US Over Destructive Computer Virus*, BBC NEWS (Jan. 23, 2013), http://www.bbc.co.uk/news/world-us-canada-21174685 [https://perma.cc/47D9-NX4U] (reporting that Russian, Latvian, and Romanian defendants are in the process of being extradited to the United States to stand trial for launching a virus named Gozi that was responsible for the theft of millions of dollars) [hereinafter *Europeans Charged*].

sustainably."[274] As a result, such polycentric undertakings could help generate a synergistic effect: a virtuous cycle whereby stakeholders involved in international regimes like climate and cyber law enjoy deepening linkages allowing them to create, for example, common codes of conduct. It is to this final topic and what this all means for managers and policymakers alike that we turn to next.

E. A Path Forward: Implications for Managers and Policymakers

Much is to be lauded in the field of polycentric governance generally, and Professor Ostrom's work in particular. For example, Professor Ostrom's fieldwork shows "an abiding appreciation of the boundless creativity of individuals and the communities they inhabit . . . [as well as] her drive to pay equal attention to scientific rigor and policy relevance."[275] Indeed, it is this drive for policy relevance that makes polycentric governance such a potentially helpful, if complex, tool for various stakeholders. And it is a tool that more actors, including academics, are using whether they realize it or not. As Professor Robert Stavins predicted:

> [I]t appears that the 2015 agreement will reflect a hybrid climate policy architecture—one that combines top-down elements, such as for monitoring, reporting, and verification, with bottom-up elements, including 'Intended Nationally Determined Contributions' (INDCs), describing what a country intends to do to reduce emissions, based on domestic political feasibility and other factors.[276]

This is, in essence, describing a polycentric approach to Paris and beyond, one that was realized in the final 2015 Paris Agreement.[277] What, though, are the lessons revealed in this study that may be

274. Hugh Ward, *International Linkages and Environmental Sustainability: The Effectiveness of the Regime Network*, 43 J. PEACE RES. 149, 150 (2006); *see, e.g.*, Anne-Marie Slaughter Burley, *International Law and International Relations Theory: A Dual Agenda*, 87 AM. J. INT'L L. 205, 231 (1993). Professor Slaughter has also pioneered network theory studying transnational regulatory networks and its progeny. However, this work primarily focuses on states, making it less useful for analyzing atmospheric and Internet governance. *See* Anne-Marie Slaughter, *Sovereignty and Power in a Networked World Order*, 40 STAN. J. INT'L L. 283, 308 (2004).

275. *See e.g.* McGinnis, *supra* note 227.

276. *A Challenge for the 2015 Paris Climate Agreement*, ROBERT STAVINS (Feb. 2, 2015), http://www.robertstavinsblog.org/2015/02/02/a-challenge-for-the-2015-paris-climate-agreement/ [https://perma.cc/4ZU7-BKT3].

277. *See* Davenport, *supra* note 55.

applied to increase the chances for success at COP21 and to the cybersecurity arena?

For one thing, as shown in the analysis of the Design Principles from *Governing the Commons*, terminology should be clarified to help define whether the atmosphere—and, for that matter, cyberspace—are indeed part of a common heritage regime in one form or another, aiding in the definition of group boundaries to incentivize sustainable use. Likewise, defining common but differentiated responsibilities in both contexts is vital to aid proportionality and help create a level playing field. This process could take the form of delineating enhanced requirements for major emitters and the cyber powers to aid those nations most at risk of climate change and becoming havens for cybercriminals, even as it places requirements on those nations to take the steps necessary to help themselves such as by drafting domestic cybercrime legislation and creating cyber emergency response teams. Indeed, we are arguably witnessing the beginnings of this movement in the Internet context now with the rise of cybersecurity due diligence.[278]

Engaged and proactive rulemaking by technical communities, the private sector, and the international community is also vital to the functioning of both atmospheric and Internet governance. Some tentative steps are being made in this direction such as by the NIST Cybersecurity Framework referenced above, which harmonizes consensus standards and industry best practices to provide a flexible and cost-effective approach to enhancing cybersecurity that assists owners and operators of critical infrastructure in assessing and managing cyber risk.[279] Other nations are considering a similar bottom-up approach to enhancing their own national cybersecurity.[280] An array of communities and organizations are similarly experimenting with regulatory and

278. *See* Scott J. Shackelford, Scott Russell, & Andreas Kuehn, *Unpacking the International Law on Cybersecurity Due Diligence: Lessons from the Public and Private Sectors*, 17 CHI. J. OF INT'L L. 1, 1 (2016).

279. *Improving Critical Infrastructure Cybersecurity*, Exec. Order No. 13636, 78 Fed. Reg. 11,739 (Feb. 12, 2013).

280. *See EU Eying NIST Framework With 'Great Interest,'* INSIDE CYBERSECURITY (Feb. 5, 2014), http://insidecybersecurity.com/index.php?option=com_user&view=login&return=aHR0cDovL2luc2lkZWN5YmVyc2VjdXJpdHkuY29tL0N5YmVyLURhaWx5LU5ld3MvRGFpbHktTmV3cy9vZmZpY2lhbC1ldS1leWluZy1uaXN0LWZyYW1ld29yay13aXRoLWdyZWF0LWludGVyZXN0L21lbnUtaWQtMTA3NS5odG1sP3V0bV9zb3VyY2U9ZGx2ci5pdCZ1dG1fbWVkaXVtPXR3aXR0ZXI [https://perma.cc/CD83-PTC4].

voluntary frameworks to address the problem of climate change, from "Earth Hour" to the now more than seven thousand organizations that have submitted nearly thirty thousand sustainability reports using the Global Reporting Initiative as of July 2015.[281] Such bottom-up experimentation—coupled with a propensity for increased communications, interactions, and trust building—are hallmarks of polycentric systems.[282] The importance of information-sharing organizations to the diffusion of threat information and best practices is also vital to aid in verification and enforcement in both the cyber and climate contexts. After all, aiding collaboration through better communication is a vital component of avoiding free riding and prisoner's dilemma situations; as Professor Elinor Ostrom pointed out, even "cheap talk" can increase cooperation and build trust.[283] Graduated sanctions, monitoring by peers (including competitors),[284] and effective dispute resolution mechanisms that have been largely successful in the WTO context should be encouraged in both arenas, especially since they help to deter "second-order" collective action problems.[285] One concrete example is learning from the success of Information Sharing and Analysis Centers (ISAC)—forums for sharing cyber threats and best practices organized around different industries—in the cybersecurity context and creating similar centers for sharing sustainability and climate best practices.

More generally, a push should be made, despite the challenges, to also follow the climate approach in the cyber context and encourage transparency by nations announcing both pledges and best practices that best fit their unique national circumstances as occurred in the run up to COP21. The G2 Cybersecurity Code of Conduct is a helpful step forward in this direction, but its secrecy detracts from its more widespread applicability.

281. *See About GRI*, GLOB. REPORTING INITIATIVE [GRI], https://www.globalreporting.org/Information/about-gri/Pages/default.aspx [https://perma.cc/LSB3-L5PL] (describing GRI's mission as promoting "[a] sustainable global economy where organizations manage their economic, environmental, social and governance performance and impacts responsibly, and report transparently"); EARTH HOUR, http://www.earthhour.org/.

282. *See* Cole, *supra* note 20, at 114.

283. Ostrom, *supra* note 179, at 409 ("Simply allowing communication, or "cheap talk," enables participants to reduce overharvesting and increase joint payoffs, contrary to game-theoretical predictions."); McGinnis, *supra* note 227, at 289.

284. McGinnis, *supra* note 227, at 293 ("[I]n empirical research, it often turns out that those systems that involve local participants in monitoring and sanctioning are more likely to be sustainable than those in which those functions are instead fulfilled by agents of the national government.").

285. *Id*. at 292.

Continued efforts by the G7, G20, and UN Group of Governmental Experts should also be encouraged since such interactions "multiply opportunities for communication, trust-building, policy experimentation and learning."[286]

Overall, this form of polycentric undertaking is similar to the Guiding Principles on Business and Human Rights Framework approach authored by Professor John Ruggie, which encourages greater stakeholder buy-in from diverse organizations rather than a multilateral, top-down approach to promoting human rights in business practices.[287] Such an approach could also aid in norm building by norm entrepreneurs, including leading businesses and governments, announcing efforts that could eventually cause a "norm cascade" in which cybersecurity and climate best practices become internalized and eventually codified in national and international laws.[288] One concrete example of how this could unfold is by replicating the success of the World Business Council for Sustainable Development—formed in 1992 to promote sustainable business practices and today boasting more than 200 firms—in the Internet governance context, as is discussed in Chapter Six.[289] As noted by Professor Cole, the "growing literature on experimentalist governance" lends credence to such a polycentric approach to global governance, along with the desirability of fostering communication at multiple scales and governance levels between stakeholders to promote cooperation.[290] Ultimately, the trick is finding the appropriate "balance between simplicity and complexity" to better leverage the power of polycentric governance to mitigate global collective action problems.[291]

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286. Cole, *supra* note 20, at 114, 116 (exploring the hypothesis that "formal or informal, one-on-one, or small- group communications might have a significant positive impact . . . .").

287. *See, e.g.*, JOHN G. RUGGIE, JUST BUSINESS: MULTINATIONAL CORPORATIONS AND HUMAN RIGHTS 78 (2013) ("The overriding lesson I drew . . . was that a new regulatory dynamic was required under which public and private governance systems . . . each come to add distinct value, compensate for one another's weaknesses, and play mutually reinforcing roles—out of which a more comprehensive and effective global regime might evolve, including specific legal measures. International relations scholars call this 'polycentric governance.'").

288. *See* Martha Finnemore & Kathryn Sikkink, *International Norm Dynamics and Political Change*, 52 INT'L ORG. 887, 895–98 (1998).

289. Cole, *supra* note 20, at 117-18. As an example, see StaySafeOnline.org.

290. *Id*. at 114-16 (summarizing studies that lend credence to the insight that better communication, even if it is 'cheap talk,' can promote the sustainable use of CPRs).

291. McGinnis, *supra* note 227, at 285.

CONCLUSION

This chapter has traced the evolution of the climate change regime focusing both on top-down UN Framework Convention on Climate Change and bottom-up bilateral and regional efforts. It then compared and contrasted this history with Internet governance through the lens of three variables: technological advancement, resource scarcity, and multipolar politics. Both atmospheric and Internet governance may be considered to be increasingly multi-stakeholder and polycentric—the Internet started off that way, whereas climate policy began in the hands of relatively few governments under the original Montreal Protocol and has since diffused. There are distinct benefits to this arrangement in terms of innovation, experimentation, and empowerment but also dangers in the form of gridlock due to a lack of defined hierarchy.

Both the global collective action problems of climate change and cyber attacks deserve sustained attention from all governance levels; from individuals on up to the United Nations. Polycentricity helps scholars conceptualize some of the dynamics of such a system, but ultimately a robust IAD-SES Framework is required to help translate best practices for both managers and policymakers; further research is needed to attain this goal. Yet, there is also much people can do to make the global local and, while not neglecting multilateral fora, help protect against free riding while promoting the identification and dissemination of community norms. Only by working together through polycentric partnerships can we both promote cyber peace and mitigate the effects of global climate change; that is an important legacy of Professor Ostrom's work in this arena and a torch that we should all be willing to raise.