THE FUTURE OF FRONTIERS

by
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Many leading environmental and security concerns now facing the international community may be traced to the frontiers—that is, the areas historically outside of national jurisdiction including the deep seabed, outer space, Antarctica, the atmosphere, and, some argue, cyberspace. From climate change and cyber attacks to the associated challenges of space weaponization and orbital debris mitigation, solutions to all of these issues have at their root some form of regulation over the frontiers, sometimes—though not always accurately—called the "global commons." Yet the amorphous legal concept of the common heritage of mankind (CHM) that has in part governed some of these spaces since the 1960s is increasingly under stress. Governance is transitioning away from consensual United Nations-centered multilateral treaties to regional and bilateral accords. These burgeoning regime complexes are being influenced by the multipolar state of international relations, advancing technology, and resource scarcity. Environmental and security challenges are proliferating as a result of governance being in flux. This Article makes an original contribution by comparing and contrasting some of the principal issues facing these frontiers of the international community, analyzing how and why existing governance structures are often failing to adequately meet global collective action problems with special coverage on cybersecurity and internet governance, and proposing a new way forward incorporating lessons from successful regimes as well as the interdisciplinary scholarship on polycentric governance. Multi-stakeholder collaboration is imperative in order to avoid tragedies of the global commons. But this requires recognizing the realities of international relations and crafting nimble twenty-first century governance structures that are both responsive to the titanic geopolitical and technological changes underway and that promote sustainable development and cyber peace.

INTRODUCTION

Trust is the most important resource.

Professor Elinor Ostrom[1]

Either trust will fuel this revolution, with all the benefits it promises, or distrust will kill it.

Microsoft CEO Satya Nadella[2]

On January 22, 1997, Lottie Williams was walking with several friends through a park in Tulsa, Oklahoma. She felt what she thought was a tap on her shoulder and, fearing the worst, began to run. But after hearing no one following, she investigated. Thankfully it was not an attacker, but a piece of a second-stage Delta IV rocket that had fallen back to Earth, hitting her (amazingly without any reported

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[1] *Interview with Nobel Laureate Elinor Ostrom*, ESCOTET FOUND., http://escotet.org/2010/11/interview-with-nobel-laureate-elinor-ostrom/ (last visited Dec. 14, 2019).

[2] SATYA NADELLA ET AL., HIT REFRESH: THE QUEST TO REDISCOVER MICROSOFT'S SOUL AND IMAGINE A BETTER FUTURE FOR EVERYONE 189 (2017).

injury) on the shoulder. This event made Ms. Williams the only person known to have been struck by space junk.[3] However, encounters with space junk are increasingly common. In fact, on average, roughly once per week a "large object like a defunct spacecraft" falls out of orbit and strikes the Earth somewhere, most often in an unpopulated area, but sometimes in unexpected places like Tulsa or a walnut orchard in Hanford, California.[4] Perhaps this is not too surprising given that more than 500,000 pieces of debris now orbit the Earth at such speeds and with such energy that even small particles can act like "tiny atom bombs"[5]—which is why the International Space Station has to regularly maneuver to avoid them.[6]

Back on Earth, in February 2013, Amy Krebs was just getting home from work on a Friday evening when she received a phone call that changed her life. It was a representative from the fraud department at a major credit card company who told Amy that someone had attempted to have a credit card issued using her name, address, and Social Security Number. After hanging up, Amy went to Equifax, Experian, and Transunion, but it was too late—the fraudster had "infiltrated [Amy's] credit history to the point that her information overrode" Amy's.[7] In total, the perpetrator attempted to open more than 50 fraudulent accounts, only stopping when she was finally arrested. Unfortunately, Amy's story is far from unique. In 2013, identity theft affected a new victim every two minutes, costing an average of $500 per person[8] and untold hours lost in clean up.[9] And identity theft is just one variety

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[3] *Jan. 22, 1997: Heads Up, Lottie! It's Space Junk!*, WIRED (Jan. 21, 2009), https://www.wired.com/2009/01/jan-22-1997-heads-up-lottie-its-space-junk-2/.

[4] *See* Rebecca Jacobson et al., *Steady Stream of Space Debris Rains Down on Earth*, PBS: NEWS HOUR (Apr. 30, 2013), http://www.pbs.org/newshour/rundown/low-earth-orbit-is/. Another episode occurred on November 11, 2016, when a "large metal object," which was later identified as part of a Chinese satellite, struck a jade mine in Myanmar. *See Worst Space Debris Events of All Time*, SPACE.COM (Mar. 8, 2013), http://www.space.com/9708-worst-space-debris-events-time.html; *Myanmar Debris: "Mystery Object Lands at Jade Mine,"* BBC NEWS (Nov. 11, 2016), http://www.bbc.com/news/world-asia-37946718.

[5] *Space Dust Kills Satellites like Tiny Atom Bombs*, ECONOMIST (Aug. 17, 2017), https://www.economist.com/science-and-technology/2017/08/17/space-dust-kills-satellites-like-tiny-atom-bombs; Mike Wehner, *A Big Chunk of Space Junk Came Crashing Down in California, and It's Just Been Identified*, BGR (Oct. 19, 2018), https://bgr.com/2018/10/19/space-junk-california-hanford-iridium-satellite/.

[6] Lizzie Plaugic, *This Is What Happens When a Tiny Piece of Flying Space Debris Hits the ISS*, VERGE (May 12, 2016), https://www.theverge.com/2016/5/12/11664668/iss-window-chip-space-debris-tim-peake.

[7] Laura Shin, *"Someone Had Taken Over My Life": An Identity Theft Victim's Story*, FORBES (Nov. 18, 2014), https://www.forbes.com/sites/laurashin/2014/11/18/someone-had-taken-over-my-life-an-identity-theft-victims-story/#56c99f7825be.

[8] *Id.*

[9] One way to help protect against identity theft is to either place a credit freeze or issue a fraud alert through the credit bureaus. *See Extended Fraud Alerts and Credit Freezes*, FED. TRADE

of cybercrime impacting consumers, companies, and countries. In 2015 alone, more than 300 million records were leaked[10] with projections of global losses reaching $6 trillion by 2021.[11]

Finally, on August 24, 2017, a liquid natural gas tanker named the Christophe de Margerie became the first tanker to sail from Europe to Asia through the Northwest Passage without the help of a separate ice-breaker.[12] The event is worth noting given what it portends for the future of Arctic shipping. Technological advances will likely allow these types of ships to navigate across the Arctic year-round, a route that can be as much as 30 percent faster than going through the Egyptian Suez Canal.[13] Thirty-two ships already made the trip in 2017, compared to eighteen in 2016, and sixteen in 2015.[14] However, the environmental costs of an increased human presence in the Arctic could be substantial, both in terms of the risk of spills in a fragile ecosystem and in terms of the black carbon pollution from burning heavy marine fuels, which could further speed up Arctic melting.[15] The effects of this melting and a changing climate are already felt across the world in places such as in Dakar, Senegal. There, Modou Pouye, a local student, has discussed the problem of rising sea levels along Senegal's coastline where communities close to the sea level have already "experienced destruction of their homes, graveyards, schools and mosques."[16]

What do these disparate events have in common? Together, they illustrate three underlying forces that are reshaping how our world works in the twenty-first century along with how what happens "out there" at the frontiers impacts the lives of real

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COMM'N, https://www.consumer.ftc.gov/articles/0279-extended-fraud-alerts-and-credit-freezes (last visited Oct. 18, 2019).

[10] Paul Szoldra, *The 9 Worst Cyberattacks of 2015*, BUS. INSIDER (Dec. 30, 2015), http://www.businessinsider.com/cyberattacks-2015-12/#hackers-breached-the-systems-of-the-health-insurer-anthem-inc-exposing-nearly-80-million-personal-records-1.

[11] Steve Morgan, *Cybercrime Damages Expected to Cost the World $6 Trillion by 2021*, CSO (Aug. 22, 2016), https://www.csoonline.com/article/3110467/security/cybercrime-damages-expected-to-cost-the-world-6-trillion-by-2021.html.

[12] *See* Matt McGrath, *First Tanker Crosses Northern Sea Route Without Ice Breaker*, BBC NEWS (Aug. 24, 2017), http://www.bbc.com/news/science-environment-41037071.

[13] *Id.* (describing the amount of time saved by the Christophe de Margerie from opting to transport goods through the Northwest Passage instead of by way of the Suez Canal).

[14] Jessica Murphy, *Is the Arctic Set to Become a Main Shipping Route?*, BBC NEWS (Nov. 1, 2018), https://www.bbc.com/news/business-45527531. Relatedly, on September 30, 2014, the Nunavik became the first cargo ship to navigate the Northwest Passage without an icebreaker escort. *See* Becky Oskin, *Cargo Ship Makes 1st-Ever Solo Trip Through Northwest Passage*, LIVE SCI. (Oct. 1, 2014), http://www.livescience.com/48105-cargo-ship-solos-northwest-passage.html.

[15] McGrath, *supra* note 12.

[16] *Climate Stories Project: Modou Pouye, Dakar, Senegal*, SOUNDCLOUD, at 1:24–1:33, https://soundcloud.com/climate-stories-project/modou-pouye-senegal (last visited Oct. 18, 2019).

people.[17] The first of these forces is the quest for scarce resources, a pursuit now being driven by rapidly advancing technology. Consider the previous example. Aside from offering a convenient thoroughfare, the Arctic houses immense fossil fuel and mineral reserves that are now opening up for development.[18] Second, the playing field is growing more crowded. An evolving, multipolar geopolitical landscape is reshuffling the cards of international diplomacy, as seen in the Arctic context with established Arctic nations such as Russia reinforcing their military presence in the region, while emerging markets like China seek to influence Arctic policymaking by, for example, extending its controversial "Belt and Road Initiative" to the high north.[19]

A similar pattern has emerged in the internet governance context with a live debate underway over multi-stakeholder (state and non-state) and multilateral (state-on-state) approaches to conceptualizing cyberspace.[20] And the stakes are high with a growing list of countries practicing "cyber sovereignty" over their domestic internet;[21] already, it has been reported that in China, "two-thirds of all internet users [are] currently subjected to some degree of censorship of criticism aimed at the government, military, or ruling families."[22] The third force is the challenge of promoting sustainable development in arenas characterized by immature legal regimes and global "collective action problems" (situations where players would benefit from taking a certain action, but are discouraged from doing so due to real or perceived costs)[23] such as outer space.[24] This issue is further complicated in some of these

[17] *See generally* GOVERNING GLOBALIZATION: POWER, AUTHORITY, AND GLOBAL GOVERNANCE (David Held & Anthony McGrew eds., 2002).

[18] *See* Feliks M. Persits & Gregory F. Ulmishek, *Maps Showing Geology, Oil and Gas Fields, and Geologic Provinces of the Arctic*, U.S. GEOLOGICAL SURV. (2003), https://ngmdb.usgs.gov/Prodesc/proddesc_62127.htm.

[19] *See* Marc Lanteigne, *Who Benefits from China's Belt and Road in the Arctic?*, DIPLOMAT (Sept. 12, 2017), https://thediplomat.com/2017/09/who-benefits-from-chinas-belt-and-road-in-the-arctic/. For the latest developments in Arctic news, see *Arctic Regions*, N.Y. TIMES, https://www.nytimes.com/topic/destination/arctic-regions (last visited Oct. 18, 2019).

[20] *See generally* Scott J. Shackelford et al., *Back to the Future of Internet Governance?*, 16 GEO. J. INT'L AFF. 83 (2015).

[21] For an analysis of the Chinese approach to cyber sovereignty, see Scott J. Shackelford & Frank Alexander, *China's Cyber Sovereignty: Paper Tiger or Rising Dragon?*, POL'Y F. (Jan. 12, 2018), https://www.policyforum.net/chinas-cyber-sovereignty/.

[22] Andrea Little Limbago, *China's Global Charm Offensive*, WAR ON ROCKS (Aug. 28, 2017), https://warontherocks.com/2017/08/chinas-global-charm-offensive/.

[23] For a discussion of the origins of collective action, see Elinor Ostrom, *Collective Action and the Evolution of Social Norms*, 14 J. ECON. PERSP. 137, 137–58 (2000).

[24] R.A., *Tragedy of the Space Commons*, ECONOMIST (Aug. 23, 2010), http://www.economist.com/blogs/freeexchange/2010/08/property_rights.

international spaces by global climate change.[25] For example, environmental degradation—particularly air pollution and black soot—is increasing in the Arctic,[26] just as a warming planet is opening the Northwest Passage to both shipping[27] and laying submarine cables that can, in turn, become targets for espionage in a future international conflict.[28] Together, these forces—which are informed by institutional analysis literature including the Ostrom Design Principles—are reshaping mitigation strategies for an array of global challenges, including cyber attacks.[29] International attention has focused on the issue of cyber attacks, as seen in recent developments in cybersecurity norm building exemplified by the 2018 Paris Peace Conference.

On November 12, 2018, French President Emmanuel Macron gave a speech at the Internet Governance Forum in Paris, announcing the Paris Call for Trust and Security in Cyberspace—a multi-stakeholder statement of principles designed to

[25] Global climate change is a broad concept incorporating processes such as ocean acidification, loss of biodiversity, soil and water pollution, and alteration of the cycles of phosphorus and nitrogen (eutrofication), among other phenomena. For more on this topic, see *Planetary Boundaries Research*, STOCKHOLM RESILIENCE CTR., http://www.stockholmresilience.org/research/planetary-boundaries.html (last visited Oct. 18, 2019). It is also important to note the extent to which climate change is playing out across the frontiers, including the oceans. *See* Matt McGrath, *Climate Change: Concerns Over Report on Ocean Heating*, BBC (Nov. 20, 2018), https://www.bbc.com/news/science-environment-46046067.

[26] *See* Kathy S. Law & Andreas Stohl, *Arctic Air Pollution: Origins and Impacts*, 315 SCI. 1537, 1537–39 (2007).

[27] *See id.*

[28] *See* Jeremy Hsu, *An Internet Cable Will Soon Cross the Arctic Circle*, SCI. AM. (June 1, 2016), https://www.scientificamerican.com/article/an-internet-cable-will-soon-cross-the-arctic-circle/; Louise Matsakis, *What Would Really Happen if Russia Attacked Undersea Internet Cables*, WIRED (Jan. 5, 2018), https://www.wired.com/story/russia-undersea-internet-cables/.

[29] These three variables build from insights derived from the Ostrom Design Principles, including the changing boundaries of each frontier, the shifting distribution of power between public and private stakeholders, the importance of engendering nested enterprises across the frontiers, and the promotion of sustainability in the use of scarce resources, which in turn implicate the "action arenas" of the Institutional Analysis and Development (IAD) Framework. *See* Michael D. McGinnis, *An Introduction to IAD and the Language of the Ostrom Workshop: A Simple Guide to a Complex Framework*, 39 POL'Y STUD. J. 163, 171–72 (2011). However, neither the Design Principles nor the frameworks analyzed herein were meant for global, dynamic environments like the frontiers considered in this study, necessitating the inclusion of these and other related forces to build out an appropriate analytical framework for investigating the governance of the global commons in the twenty-first century. Other variables also play an important role in shaping how and why these regimes have evolved in the ways in which they have, including the accessibility of dispute-resolution mechanisms, presence of monitoring schemes, implicit national security concerns, and associated climate change challenges. *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).

help guide the international community toward greater cyber stability and perhaps one day cyber peace. In particular, the agreement calls for action to safeguard civilian infrastructure and internet access, and to make democracy more difficult to hack.[30] On the day it was announced, more than 50 nations (with the notable exception of the United States), 130 companies, and 90 universities and nongovernmental groups signed the Paris Call.[31] The goal is to leverage this widespread support to help drive interest in a Digital Geneva Convention aimed, like the original Geneva Convention, at protecting civilians and promoting "digital peace."[32] Realizing this end goal, though, will involve taking on a number of thorny governance challenges from combatting cyber attacks and misinformation campaigns to defining corporate social responsibility in cyberspace. According to President Macron, "[g]iant platforms could become not just gateways but also gatekeepers."[33] Such laudable efforts should consider historical examples of international cooperation, such as the 1928 Pact of Paris that helped set the stage for the outlawing of aggressive international warfare in the U.N. Charter[34] as well as the governance of other frontiers.

There is no single reason for why governance at the frontiers is changing or a single answer for how to manage the rise of global collective action problems across the frontiers, both online and offline. Technological advancement is part of the story, but so is resource scarcity, along with the shifting distribution of power including the increasingly multipolar state of international relations.[35] The growth of

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[30] *See Paris Call for Trust and Security in Cyberspace*, MINISTRY EUR. & FOREIGN AFF. (Nov. 12, 2018), https://www.diplomatie.gouv.fr/IMG/pdf/paris_call_text_-_en_cle06f918.pdf.

[31] David E. Sanger, *U.S. Declines to Sign Declaration Discouraging Use of Cyberattacks*, N.Y. TIMES (Nov. 12, 2018), https://www.nytimes.com/2018/11/12/us/politics/us-cyberattacks-declaration.html; *see also Indiana University Among First to Endorse Paris Call for Trust and Security in Cyberspace*, IND. U. (Nov. 12, 2018), https://news.iu.edu/stories/2018/11/iu/releases/12-paris-call-for-trust-and-security-in-cyberspace.html.

[32] *Digital Peace Now*, MICROSOFT, https://digitalpeace.microsoft.com/ (last visited Oct. 18, 2019).

[33] Romain Dillet, *With the Paris Call, Macron Wants to Limit Cyberattacks*, TECHCRUNCH (Nov. 12, 2018), https://techcrunch.com/2018/11/12/with-the-paris-call-macron-wants-to-limit-cyberattacks/.

[34] *See* OONA A. HATHAWAY & SCOTT J. SHAPIRO, THE INTERNATIONALISTS: HOW A RADICAL PLAN TO OUTLAW WAR REMADE THE WORLD, at xix (2017). *But see* Milton Mueller, *The Paris IGF: Convergence on Norms, or Grand Illusion?*, INTERNET GOVERNANCE PROJECT (Nov. 9, 2018), https://www.internetgovernance.org/2018/11/09/the-paris-igf-convergence-on-norms-or-grand-illusion/ ("There will be no effective operationalization of norms until there is agreement on the status of cyberspace as a global commons, a non-sovereign space.").

[35] *See* Arthur A. Stein, *Incentive Compatibility and Global Governance: Existential Multilateralism, a Weakly Confederal World, and Hegemony*, *in* CAN THE WORLD BE GOVERNED?: POSSIBILITIES FOR EFFECTIVE MULTILATERALISM 17, 25 (Alan S. Alexandroff ed., 2008) (discussing the evolution of multipolar governance structures in international relations).

cyberspace—which will reach its apex through the realization of the Internet of Everything[36]—is likewise influencing governance structures across the frontiers, from the deep seabed to outer space. As a result, "polycentric" (nested) governance that features multiple power centers structures are needed to help ensure the sustainable use of resources, both tangible and virtual, and to build trust across distributed systems and regions.[37]

Indeed, the quality of humanity's future depends in part on our peaceful, joint use of the frontiers.[38] Yet, so far at least, we have not measured up. The deep seabed, outer space, and Antarctica are home to significant resource reserves and are already the subject of global tensions that will only increase along with resource scarcity.[39] Cyberspace is transforming economies and societies around the world, while spam and cyber attacks are hurting productivity and undermining security.[40] Mitigating global collective action problems and providing for the sustainable, peaceful use of global resources is a central requirement for enhancing international peace and security in the twenty-first century.[41] Regime complexes are being enacted across the frontiers to supplement multilateral agreements to varying degrees of success.

The goal of this Article is to synthesize relevant research that analyzes the future of frontiers while noting the necessary limitations of any conclusions. As is evident, the regimes governing the surveyed areas share certain fundamental similarities, such as the fact that the Common Heritage of Mankind (CHM) concept remains influential, particularly in its more modern form of sustainable development.[42] Moreover, some resources exploitable across each frontier are rival and non-excludable and

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[36] See Part VI for a discussion of the "Internet of Everything."

[37] Vincent Ostrom, *Polycentricity—Part 1*, *in* POLYCENTRICITY AND LOCAL PUBLIC ECONOMIES 57 (Michael McGinnis ed., 1999) (defining a "polycentric order" as "one where many elements are capable of making mutual adjustments for ordering their relationships with one another within a general system of rules where each element acts with independence of other elements").

[38] SUSAN J. BUCK, THE GLOBAL COMMONS: AN INTRODUCTION, at xiv (1998).

[39] *See* DEV. CONCEPTS & DOCTRINE CTR., MINISTRY OF DEF., GLOBAL STRATEGIC TRENDS - OUT TO 2040, at 15 (4th ed. 2010).

[40] *See* TECHNOLOGY, POLICY, LAW, AND ETHICS REGARDING U.S. ACQUISITION AND USE OF CYBERATTACK CAPABILITIES 162 (William A. Owens et al. eds., 2009).

[41] *See* DEV. CONCEPTS & DOCTRINE CTR., MINISTRY OF DEF., *supra* note 39, at 1.

[42] *See* Christopher C. Joyner, *Legal Implications of the Concept of the Common Heritage of Mankind*, 35 INT'L & COMP. L.Q. 190, 190–99 (1986). Although no universal definition exists, most conceptions of the CHM share five primary elements. First, there can be no private or public appropriation; no one legally owns common heritage spaces. Jennifer Frakes, *The Common Heritage of Mankind Principle and the Deep Seabed, Outer Space, and Antarctica: Will Developed and Developing Nations Reach a Compromise?*, 21 WIS. INT'L. L.J. 409, 411 (2003). Second, "representatives from all nations" must work together to manage global common pool resources. *Id.* at 412. Third, all nations must "actively share" in the "benefits acquired from exploitation of the resources from the common heritage region." *Id.* Fourth, there can be no weaponry or military

so are subject to overexploitation and collective action problems. The variables of technological advancement, resource scarcity, and politics provide the beginnings of a useful analytical framework for investigating the development of polycentric structures to manage these challenges. Enclosure is similarly increasing across the frontiers of international relations, driven by both public and private sector demands and the ambiguities in the applicable international law.

This Article is structured as follows. It begins with a summary of the impacts of cyber-enabled technological advancement, resource scarcity, and multipolar politics on the evolution of strategies for mitigating global collective action problems, describing how and why they are doing so, and what that means for cybersecurity and internet governance going forward. It then discusses the rise and fall of the CHM and the extent to which sustainable development principles are reinvigorating the central tenants of this concept. It also discusses the sustainable use of global common pool resources and, potentially, cyberspace. The Article concludes with a global study of regime effectiveness across the frontiers with a special emphasis on cyberspace and explores how new technologies like blockchain can help build trust and promote cyber peace in the burgeoning Internet of Everything.

I. THE IMPACT OF TECHNOLOGICAL ADVANCEMENT, RESOURCE SCARCITY, AND POLITICS ON GOVERNANCE AT THE FRONTIERS

The influences of technological advancement, resource scarcity, and shifting power dynamics including the rise of multipolar politics are contributing to the regime complexes growing up around the climate, cyberspace, the deep seabed, and outer space.[43] These influences help explain how and why the regimes governing the frontiers are evolving in the ways they are. But what lessons do they reveal about where we may be headed?

A. Redrawing the Frontiers

Technological progress catalyzes the evolution of governance at the frontiers both by reducing the cost of accessing scarce resources or—as is the case with cyberspace—creating entirely new domains. In the deep seabed, advances in mining technology have allowed corporations to exploit fossil fuel and mineral resources under the oceans.[44] In outer space, advances in rocketry are on track to potentially lower the cost of accessing orbital space 100-fold, opening up new industries such as space

installations established in common heritage areas as they should be used for "peaceful purposes." *Id.* at 413. Fifth, the commons "must be preserved for the benefit of future generations." *Id.*

[43] These three variables build from insights derived from the Ostrom Design Principles. *See supra* note 29.

[44] *See* Nathanial Gronewold, *Alarms Sound as Tech Industry Dives into Seabed Mining*, GREENWIRE (Aug. 7, 2018), https://www.eenews.net/greenwire/2018/08/07/stories/1060092931.

tourism and mining.[45] In cyberspace, a technological arms race between attackers and defenders is underway, featuring technologies such as artificial intelligence, quantum computing, and blockchain that hold the potential to both exacerbate and redefine the possibilities of cyber peace.[46] Prior to the introduction of new technologies that would provide access to resources in remote areas of the classic global commons, sovereign nations were content to proceed under a CHM regime in which all humanity possessed these resource domains. However, with advancing technology, developed nations began exerting pressure to enclose these territories. In essence, such technological change raises pressure on traditional communal-property mechanisms, an issue exacerbated by latent legal ambiguities in the underlying treaties. In this post-WWII era, rapid technological progress has made exploiting the resources of the deep seabed, exploring space, and indeed creating a new frontier in the form of cyberspace technically possible. It has not yet offered the means to address the resulting collective action problems, an issue at the intersection of sustainable development and blockchain technology.[47]

B. Scarcity at the Frontiers

Alongside technology, resource scarcity is impacting governance across the frontiers of international relations. In the deep seabed, growing energy demand is catalyzing the growth of offshore resource exploitation, including hydrocarbons and minerals found in the deep seabed.[48] Ambiguities in the law of the sea, such as in Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS), are allowing coastal nations to enclose these resources.[49] The attempt at a solution has evolved into the Commission on the Limits of the Continental Shelf (CLCS), a

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[45] *See* Abigail Beall, *Space Mining is Going to Seriously Disrupt Earth's Economy. And We're Nowhere Near Ready for the Shock*, WIRED (Jan. 20, 2018), https://www.wired.co.uk/article/international-laws-are-not-ready-for-space-mining.

[46] *See* Gil Press, *The AI Cybersecurity Arms-Race: The Bad Guys Are Way Ahead*, FORBES (Apr. 26, 2018), https://www.forbes.com/sites/gilpress/2018/04/26/the-ai-cybersecurity-arms-race-the-bad-guys-are-way-ahead/#2a6c3e4148ea.

[47] *See infra* Part II.C.

[48] *See* David Dodwell, *As China Leads the Hunt for Deep-Sea Minerals, Environmental and Financial Concerns Come to the Surface*, CNBC (May 7, 2018), https://www.cnbc.com/2018/05/07/china-leads-hunt-for-deep-sea-minerals-environmental-concerns-surface.html.

[49] Article 76(1) of UNCLOS defines the continental shelf as comprising of "the sea-bed and subsoil of the submarine areas that extend . . . to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines." U.N. Convention on the Law of the Sea art. 76, ¶ 1, *opened for signature* Dec. 10, 1982, 1833 U.N.T.S. 397 (entered into force Nov. 16, 1994); *see also* Philip Allott, *Power Sharing in the Law of the Sea*, 77 AM. J. INT'L L. 1, 20 (1983) (noting that the parties knew of the ambiguities of Article 76 at the time of the drafting of UNCLOS).

process characterized as just as daunting as the negotiation of UNCLOS itself.[50] Similarly, space-based services and resources hold the promise of nearly inexhaustible resource reserves. Private and public entities will look to this resource frontier when the marginal cost is sufficiently high and the underlying technologies have advanced. Simultaneously, the growing scarcity of geosynchronous orbital slots and prevalence of orbital debris are causing a surge in interest in governing the final frontier.[51] Overuse in cyberspace can occur in the form of "information pollution" and Distributed Denial of Service (DDoS) attacks.[52] Scarcity, then, may be seen as catalyzing the growth of new regulations across the frontiers.

Resource scarcity is also driven by climate change, which is in part fueled by new developments of the Information Age such as Bitcoin mining—which already uses more energy than Serbia and causes emissions of more than 17 million tons of carbon dioxide annually.[53] Over the next 30 years, the U.K. Ministry of Defense predicts that climate change "will shape the physical environment within which a rapidly expanding world population will live, influencing variable access to habitable land, food, and water."[54] The U.S. Department of Defense has echoed these views, particularly under the Obama Administration.[55] Consequences will likely include melting icecaps and rising sea levels—made worse by the thermal expansion of the oceans—and changes to ocean currents and flows, increasing desertification on land, reduced land for habitation, and an increased risk of extreme weather events.[56] These events will likely worsen the problems associated with scarcity, including the risk of international conflict over resources at the frontiers, which is made more likely by volatile international relations in an increasingly multipolar world.

C. Multipolar Political Economy at the Frontiers

As with advancing technology and resource scarcity, politics has been a driving influence in the evolution of governance across the frontiers.[57] Critically, multipolar

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[50] KEMAL BASLAR, THE CONCEPT OF THE COMMON HERITAGE OF MANKIND IN INTERNATIONAL LAW 226 (1998).

[51] For more on this topic, see Scott J. Shackelford, *Governing the Final Frontier: A Polycentric Approach to Managing Space Weaponization and Debris*, 51 AM. BUS. L.J. 429, 430 (2014).

[52] *See* Phil Lee, *Information Pollution and the Internet of Things*, INT'L ASS'N PRIV. PROF. (Sept. 4, 2013), https://iapp.org/news/a/information-pollution-and-the-internet-of-things-2/.

[53] *See* Adam Rogers, *The Hard Math Behind Bitcoin's Global Warming Problem*, WIRED (Dec. 15, 2017), https://www.wired.com/story/bitcoin-global-warming/.

[54] DEV. CONCEPTS & DOCTRINE CTR., MINISTRY OF DEF., THE DCDC GLOBAL STRATEGIC TRENDS PROGRAMME 2007–2036, at 1 (3d ed. 2010).

[55] *DoD Releases Report on Security Implications of Climate Change*, U.S. DEP'T DEF. (July 29, 2015), https://www.defense.gov/News/Article/Article/612710/.

[56] DEV. CONCEPTS & DOCTRINE CTR., MINISTRY OF DEF., *supra* note 39, at 1.

[57] *See Has Finance Been Fixed? Ten Years After Lehman*, ECONOMIST, Sept. 8th–14th, 2018, at 11, 11 ("[F]racturing geopolitics make globalised finance even harder to deal with.").

international relations driven by nationalist sentiments can make it more difficult to reach consensus across a broad range of global issues, thereby limiting the effectiveness of multilateral organizations. This may be seen in outer space, with the end of the golden age of space law coinciding with the failure of the CHM concept in the Moon Treaty, the end of the Cold War, and the decreasing effectiveness of the Committee for the Peaceful Uses of Outer Space (COPUOS).[58] Similarly, in cyberspace, multilateral progress has been slow, in part due to the desire of the cyber powers to embrace a certain degree of strategic ambiguity.[59] The Law of the Sea has enjoyed the most progress owing to the success of the 1994 UNCLOS Amendments and regional cooperation through organizations like the Arctic Council.[60] But even there, multipolar politics has complicated regulatory action as seen by the prevalence of overlapping territorial claims in hot spots like the South China Sea.[61] From the U.N. Disarmament Committee to COPUOS to the G20, the same story is playing out in negotiations over the future of the frontiers across a wide range of issues.

Domestic politics also drive governance choices across the frontiers. In space, for example, vacillating U.S. attitudes toward a space-weapons ban has played an important part in the only partial progress toward regulating this area.[62] The Obama Administration was eventually more supportive of multilateral engagement, but Congress and the Trump Administration remain suspicious of sovereignty-limiting commitments.[63] Yet the United States has long played an important role in propagating regulations at the frontiers from the Truman Declaration of 1945 to the Trump Administration's 2017 decision to withdraw the United States from the Paris Agreement, meaning that its domestic politics will continue to influence the

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[58] *See* Scott J. Shackelford, *Renewed Space Rivalry Between Nations Ignores a Tradition of Cooperation*, CONVERSATION (Jan. 10, 2019), https://theconversation.com/renewed-space-rivalry-between-nations-ignores-a-tradition-of-cooperation-108810.

[59] *See, e.g.*, BENJAMIN BRAKE, COUNCIL ON FOREIGN RELATIONS, STRATEGIC RISKS OF AMBIGUITY IN CYBERSPACE 1 (2015).

[60] After a series of meetings on July 28, 1994, the final text of the Agreement Relating to the Implementation of Part XI of UNCLOS was adopted. The Agreement featured six main changes: (1) initial operations would be joint collaborations between the Enterprise and mining states; (2) developed nations would have more control over formal decisions; (3) technology transfer was not required; (4) production limitations were removed; (5) the CHM was preserved, but the ISA was modified; and (6) assistance was offered to land-based mining concerns. BUCK, *supra* note 38, at 91.

[61] *See* Scott J. Shackelford, *Time for a South China Sea Council*, HUFFINGTON POST (Aug. 18, 2013), https://www.huffingtonpost.com/scott-j-shackelford/time-for-a-south-china-se_b_3442529.html.

[62] *See* Justin Bachman & Travis J. Tritten, *Why Trump Wants a Space Force for the Final Frontier*, BLOOMBERG BUSINESSWEEK (Feb. 19, 2019), https://www.bloomberg.com/news/articles/2018-08-06/what-s-a-space-force-and-can-trump-really-start-one-quicktake.

[63] *See Trump's Sovereignty Doctrine*, WASH. EXAMINER (Sept. 25, 2018), https://www.washingtonexaminer.com/opinion/editorials/trumps-sovereignty-doctrine.

universe of available governance choices. And given the U.S.'s still-dominant military position, its policies to secure freedom of access to the frontiers necessarily influence the positions of other interested nations.[64]

Finally, the applicable international law across the frontiers is in need of clarification, particularly in the cyber context.[65] Progress has been made, such as in regards to crystallizing international cybersecurity norms[66] and in beginning the process of reaching an agreement on acceptable state conduct in cyberspace both above and below the armed attack threshold.[67] However, much work remains to be done if the promise of cyber peace is to be realized. Across the frontiers, so-called "sleeping treaties" (international agreements that lack mechanisms for institutional supervision) should also be updated and made enforceable given that such ambiguity breeds uncertainty.[68] Among such ambiguous concepts is the CHM, which is next addressed.

II. THE RISE AND FALL OF THE CHM CONCEPT: RESURRECTING THE SPIRIT OF THE COMMON HERITAGE FOR THE TWENTY-FIRST CENTURY

The reason for the rise of the CHM was technological disparity between developed and developing countries, as well as resource scarcity and related equitable considerations.[69] Nations were unable to exercise sovereign control over much of the historic global commons until relatively recently due to technological limitations.[70] As technology advanced, the race was on, but the playing field was far from level. Dr. Arvid Pardo sought to change that through the CHM concept, which was designed to more equitably distribute the endowments of the deep seabed.[71] Since

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[64] *See* James Kraska, *Indistinct Legal Regimes*, *in* SECURING FREEDOM IN THE GLOBAL COMMONS 49, 58–59 (Scott Jasper ed., 2010).

[65] For more on this topic, see Scott J. Shackelford, *The Law of Cyber Peace*, 18 CHI. J. INT'L L. 1 (2017).

[66] *See infra* Part II.B.

[67] *See* TALLINN MANUAL 2.0 ON THE INTERNATIONAL LAW APPLICABLE TO CYBER OPERATIONS (Michael N. Schmitt & Liis Vihul eds., 2d ed. 2017); SCOTT J. SHACKELFORD, MANAGING CYBER ATTACKS IN INTERNATIONAL LAW, BUSINESS, AND RELATIONS: IN SEARCH OF CYBER PEACE 263–311 (2014).

[68] *See* MICHAEL BOWMAN ET AL., LYSTER'S INTERNATIONAL WILDLIFE LAW 288–89 (2d ed. 2010).

[69] For more on the rise and fall of the CHM concept, see Scott J. Shackelford, *The Tragedy of the Common Heritage of Mankind*, 28 STAN. ENVTL. L.J. 109 (2009).

[70] *See* BUCK, *supra* note 38, at 29.

[71] Press Release, United Nations, Arvid Pardo, "Father of Law of Sea Conference," Dies at 85, in Hous., Tex., (July 16, 1999), https://www.un.org/press/en/1999/19990716.SEA1619.html.

that time, the CHM has been extended to the moon,[72] and proposals have been made to extend it further to Antarctica,[73] outer space, the atmosphere,[74] and cyberspace.[75]

The decline of the classic CHM began when developed nations balked at the CHM's conception of mandatory technology transfer policies, equitable benefit-sharing requirements, and, above all, the notion of supranational administration of the frontiers.[76] This resulted in UNCLOS and later the Moon Treaty, which became sleeping treaties until the 1994 Amendments revived UNCLOS (the Moon Treaty, as of 2018, remains largely dormant).[77] Because of this rejection, many areas of the global commons remain ripe for overexploitation. It is time to consider alternatives to the CHM to better meet modern challenges given that the frontiers are at a crisis point, as seen in problems ranging from climate change to the weaponization of outer space to cyber attacks. This section attempts such a reinterpretation, focusing on the issues of equitable benefit-sharing, technology transfer, and supranational administration, as well as the potential for sustainable development to help bridge these divides.

A. Lessons from Equitable Benefit-Sharing

Equitable benefit-sharing lies at the heart of the CHM concept.[78] As long as there is inequality in the international community, both in terms of technology and capital, then some version of the CHM concept with a provision for benefit-sharing will be attractive. Unfortunately, despite progress catalyzed by the Millennium Development Goals, such inequality will continue for the foreseeable future; indeed, there are already signs that global climate change will only deepen the divide.[79] As

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[72] *See* Agreement Governing the Activities of States on the Moon and Other Celestial Bodies art. 11, ¶ 1, *adopted on* Dec. 5, 1979, 1363 U.N.T.S. 3.

[73] U.N. GAOR, 37th Sess., 10th plen. mtg. at 132, U.N. Doc A/37/PV.10 (Sept. 29, 1982).

[74] *See* M.A. Sayar, *Is Technology a Common Heritage of All Mankind?*, FOUNTAIN (Jan. 4, 1993), https://fountainmagazine.com/1993/issue-2-april-june-1993/is-technology-a-common-heritage-of-all-mankind.

[75] *See* Scott J. Shackelford, *Toward Cyberpeace: Managing Cyber Attacks Through Polycentric Governance*, 62 AM. U. L. REV. 1273, 1288 (2013).

[76] *See* Shackelford, *supra* note 69, at 112–19.

[77] For more on this topic, see Roncevert Ganan Almond, *Building a Durable Legal Framework in Space: The Extraterrestrial Impact of the South China Sea Dispute*, YALE J. INT'L L. (Oct. 24, 2017), http://www.yjil.yale.edu/building-a-durable-legal-framework-in-space-the-extraterrestrial-impact-of-the-south-china-sea-dispute/.

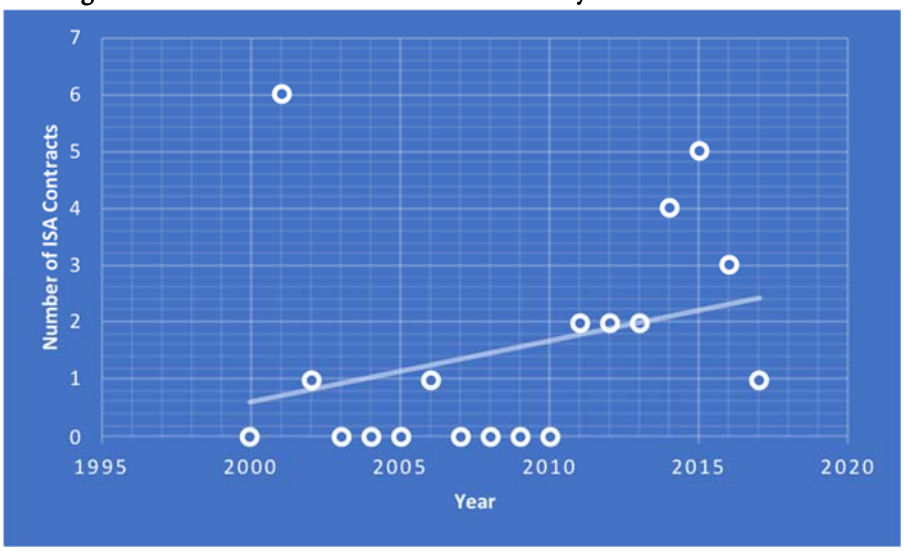
[78] *See* BASLAR, *supra* note 50, at 97.

[79] *See Millennium Development Goals: 2015 Progress Chart*, UNITED NATIONS, http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20PC%20final.pdf (last visited Oct. 18, 2019).

the U.K. Ministry of Defense predicts, "[w]hile life for most people is likely to improve materially [through 2040], a significant number will continue to experience hardship."[80] Codifying equitable benefit-sharing into successful multilateral treaties has proven difficult, though there is hope in the form of both new technologies—such as blockchain—and governance structures.[81]

Both Article 11 of the Moon Treaty and Article 137 of UNCLOS establish equitable benefit-sharing for resources found in these frontiers.[82] UNCLOS created the International Seabed Authority (ISA) to regulate mining activities in the deep seabed on behalf of all humanity. While it is true that since 2001 the ISA has entered into relatively few contracts with governments and companies to explore and eventually develop these resources,[83] the pace has been picking up, as is shown in Figure 1.

Figure 1: New International Seabed Authority Contracts 2000–2017[84]



[80] DEV. CONCEPTS & DOCTRINE CTR., MINISTRY OF DEF., *supra* note 54, at 1 (emphasis omitted).

[81] *See infra* Part V.

[82] Agreement Governing the Activities of States on the Moon, *supra* note 72, at 32; Convention on the Law of the Sea, *supra* note 49, at 52.

[83] Malcolm D. Evans, *The Law of the Sea*, *in* INTERNATIONAL LAW 623, 646 (2d ed. 2006).

[84] These data were compiled from *Deep Seabed Mineral Contractors*, INT'L SEABED AUTHORITY, https://www.isa.org.jm/deep-seabed-minerals-contractors (last visited Oct. 18, 2019).

The 2018 ISA gathering made progress on a number of fronts, including draft regulations on deep seabed mining.[85] Conversely, the international regime envisioned in the Moon Treaty has not yet been created. One study from 1999 estimated the total economic benefit of the CHM concept on the 40 poorest nations at just 50 cents per capita.[86] Discussions of incorporating cyberspace into some version of the CHM concept remain nascent despite the best efforts of some nations such as Malta, and government figures such as retired Admiral Mike Rogers, who said at a cyber conference in 2015: "I'd like to see if we can create something equivalent to the maritime world in the cyber world that enables us to keep moving information, keep moving commerce, keep moving ideas on a global basis."[87] Thus far, the CHM concept has not done an effective job of fulfilling the equitable benefit-sharing mission for which it was created. Neither the CHM nor the "common concern of humankind" are being discussed in the context of atmospheric governance.[88] Instead, emerging markets have long pushed the notion of equal access to atmospheric space, with a right for their per capita emissions to rise to the level prevalent in developed nations.[89] Yet India's emissions per capita being approximately one-tenth those of the United States, while having four times the population,[90] underscores the environmental danger of this argument. The 2015 Paris Climate Agreement has helped to recast this debate to move away from a notion of pure equal access and instead has begun to formalize the notion of "common but differentiated responsibility" in the climate change context.[91] Nevertheless, equal access as an organizing property rights concept, especially in the net neutrality context, still resonates across the frontiers.[92]

As the development of resources across the frontiers ramps up, calls for the equitable distribution of benefits from developing countries that do not have the

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[85] *See* Catherine Benson Wahlén, *International Seabed Authority Adopts Strategic Plan, Discusses Draft Regulations*, IISD (July 31, 2018), http://sdg.iisd.org/news/isa-adopts-strategic-plan-discusses-draft-regulations/.

[86] R.R. CHURCHILL & A.V. LOWE, THE LAW OF THE SEA 194 (rev. ed. 1988).

[87] *US Security Chief Cites Principle Introduced by Malta for Common Heritage of the Internet*, TIMES MALTA (May 31, 2015), https://timesofmalta.com/articles/view/us-security-chief-cites-principle-introduced-by-malta-for-common.570558.amp.

[88] Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 79 (1992).

[89] KEVIN A. BAUMERT ET AL., NAVIGATING THE NUMBERS: GREENHOUSE GAS DATA AND INTERNATIONAL CLIMATE POLICY 23 (2005).

[90] *Id.* at 21; *2019 World Population by Country*, WORLD POPULATION REV., http://worldpopulationreview.com/ (last visited Oct. 18, 2019).

[91] Robinson Meyer, *A Reader's Guide to the Paris Agreement*, ATLANTIC (Dec. 16, 2015), https://www.theatlantic.com/science/archive/2015/12/a-readers-guide-to-the-paris-agreement/420345/.

[92] *See* Keith Collins, *Net Neutrality Has Officially Been Repealed. Here's How that Could Affect You.*, N.Y. TIMES (June 11, 2018), https://www.nytimes.com/2018/06/11/technology/net-neutrality-repeal.html.

same capabilities to access and exploit these resources will likely only increase. Achieving this equality, though, will require both creating and spreading new technologies, which may be accomplished through either a modified technology transfer agreement, such as that found in the 1994 Amendments, or through innovation centers.

B. Technology Transfer That Works

Mandatory tech transfer was one of the death knells of both UNCLOS (until 1994) and the Moon Treaty. Indeed, some critics contend that the significance of tech transfer in these and other treaties, such as the Basel Convention on Hazardous Waste, was merely to provide a framework for financial assistance programs.[93] Modern alternatives to these mechanisms have proven to be more politically palatable and will likely become features of future governance structures at the frontiers. These alternatives include the idea of private-sector driven innovation centers born in the context of climate negotiations along with blockchain technology.

Instead of technology transfer in the classic sense, several scholars are now pushing for the establishment of innovation cooperation to help speed the deployment of technical and sustainable best practices among resource users. In developing nations, climate change exacerbates existing sustainable development problems: nearly 800 million people worldwide are malnourished, nearly 2.6 billion are reliant on biomass for their energy, 1.2 billion lack access to electricity, and only roughly half of the world's population is connected to the internet as of 2016.[94] Technology plays a key role in catalyzing development to address these disparities, such as through energy efficient devices, building methods, and even by using drones, balloons, and satellites to spread internet access.[95] The transfer of commercial technology is one avenue to address technical inequalities, either voluntarily or through

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[93] *See* PETER H. SAND, LESSONS LEARNED IN GLOBAL ENVIRONMENTAL GOVERNANCE 12 (1990).

[94] *See* World Energy Council, *Bioenergy 2016*, *in* WORLD ENERGY RESOURCES 7 (2016); Adam Taylor, *47 Percent of the World's Population Now Use the Internet, Study Says*, WASH. POST (Nov. 22, 2016), https://www.washingtonpost.com/news/worldviews/wp/2016/11/22/47-percent-of-the-worlds-population-now-use-the-internet-users-study-says/?noredirect=on&utm_term=.a6d4365797f1; Rockefeller Foundation, *One Billion People Don't Have Access to Electricity and This Map Shows You Who*, MASHABLE (Sept. 15, 2017), https://mashable.com/2017/09/15/one-billion-people-dont-have-access-to-electricity/#DXC4ESLHSOqo; *Hunger Statistics*, FOOD AID FOUND., http://www.foodaidfoundation.org/world-hunger-statistics.html (last visited Oct. 13, 2019). To see how these trend lines have changed since 2009, see Ambuj Sagar, *"Innovation Cooperation" to Meet Climate Challenges*, SCIDEV.NET (Nov. 26, 2009), http://www.scidev.net/en/opinions/-innovation-cooperation-to-meet-climate-challenges.html.

[95] *See* Tom Simonite, *Facebook's Drones Will Battle Google's Balloons to Spread Internet Access*, MIT TECH. REV. (Mar. 27, 2014), https://www.technologyreview.com/s/525951/facebooks-drones-will-battle-googles-balloons-to-spread-internet-access.

cyber-enabled intellectual property theft.[96] Large-scale research and development (R&D) programs focused on the unique problems of developing nations are another option. Some companies are already engaging in such R&D programs voluntarily to increase their access to emerging markets.[97] At a more micro level, for example, improved cooking stoves, small-scale biomass gasifiers, and solar lanterns may be deployed to help address climate change from the bottom up, a riff on George H.W. Bush's "thousand points of light" notion.[98] But developing these technologies requires varying levels of support, along with pursuing international norms aimed at controlling the spread of state-supported cyber espionage campaigns designed to steal such intellectual property.[99] Support could take the form of innovation centers, which are collaborative R&D facilities. These centers have enjoyed the support of both the United States and the European Union since they promote flexibility over the mandatory tech transfer policies codified in earlier agreements.[100]

C. Supranatural Management of Scarce Resources

As with technology, the supranational management of the frontiers has proven to be politically divisive with some exceptions such as the accelerating activity and multi-stakeholder support for ISA, which makes supranational management a model for global governance at the frontiers.[101] Supranational control of the moon was one reason the L5 Society (an original parent organization of the National Space Society) lobbied against the treaty, causing it to fail in the U.S. Senate.[102] Calls for similar authorities to manage the atmosphere, or cyberspace, have also been rebuffed

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[96] *See* Scott J. Shackelford et al., *Using BITs to Protect Bytes: Promoting Cyber Peace by Safeguarding Trade Secrets Through Bilateral Investment Treaties*, 52 AM. BUS. L.J. 1, 2–3 (2015).

[97] *See* Nick Carey & James B. Kelleher, *Special Report: Does Corporate America Kowtow to China?*, REUTERS (Apr. 26, 2011) http://www.reuters.com/article/2011/04/27/us-special-report-china-idUSTRE73Q10X20110427.

[98] *See* Jacqueline Thomsen, *Jenna Bush Hager Clarifies Bush 41's "Thousand Points of Light" for Trump*, HILL (July 7, 2018), http://thehill.com/blogs/blog-briefing-room/news/395948-jenna-bush-hager-clarifies-bushs-thousand-points-of-light-for.

[99] *See* Tim Maurer & Kathryn Taylor, *Outlook on International Cyber Norms: Three Avenues for Future Progress*, JUST SECURITY (Mar. 2, 2018), https://www.justsecurity.org/53329/outlook-international-cyber-norms-avenues-future-progress/.

[100] *See* CLIMATE INNOVATION CENTRES: A NEW WAY TO FOSTER CLIMATE TECHNOLOGIES IN THE DEVELOPING WORLD? 9 (Ambuj Sagar & Bloomberg New Energy Fin. eds., 2010), http://www.infodev.org/articles/climate-innovation-centers-new-way-foster-climate-technologies-developing-world.

[101] There were 168 ISA member states as of July 2018, though not all are dues-paying members. *See* Jason Cross, *Pay Up! - Charles Jr Appeals to Seabed Authority Members to Pay Dues*, GLEANER (July 25, 2018), http://jamaica-gleaner.com/article/news/20180725/pay-charles-jr-appeals-seabed-authority-members-pay-dues.

[102] *See* NAT'L SPACE SOC'Y, REJECTING THE LAW OF THE SEA TREATY 2 (2009), http://space.nss.org/media/National-Space-Society-LoST-WhitePaper.pdf.

by nations weary of organizations that threaten their sovereignty and unfettered access to the frontiers.[103] In a multipolar world replete with increasing national control over scarce resources, many nations—especially those experiencing a resurgence in nationalist sentiments—consider supranational control to be simply too politically and economically costly.[104] Yet certain international organizations, like the International Telecommunication Union (ITU) in the case of geosynchronous orbital slots, have successfully managed portions of the global commons.[105] These successes demonstrate the potential benefits of multilateral engagement, at least as part of larger polycentric ecosystems. Only through such initiatives, as well as U.N. reform, can the frontiers be peacefully and sustainably managed in the twenty-first century.

D. Sustainable Development at the Frontiers

The CHM concept is a bundle of theories comparable to sustainable development. The open question then is: given the decreasing importance of the CHM in negotiations over the future of the frontiers, can sustainable development offer an alternative governance model—similar to how the notion of humanitarian intervention was recast as the "Responsibility to Protect"?[106] The U.N.'s Brundtland Report defined "sustainable development" as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[107] The concept has enjoyed traction across an array of legal agreements, private contracts, and civil society movements.[108] It could even be regarded as its own distinct area of law, one that is increasingly important across the frontiers.[109] For example, the mandate of the Arctic Council includes the promotion of sustainable

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[103] *See* Mike Manor & Kurt Neuman, *Space Assurance*, *in* SECURING FREEDOM IN THE GLOBAL COMMONS 99, 99–100 (Scott Jasper ed., 2010).

[104] Nikitas Konstantinidis et al., *"Take Back Control"? The Effects of Supranational Integration on Party-System Polarization*, 14 REV. INT'L ORGS. 297, 298 (2019); T.N., *Europe's Civil War of Sovereignty Is Tearing Its Soul Apart*, ECONOMIST (July 18, 2018), https://www.economist.com/open-future/2018/07/18/europes-civil-war-of-sovereignty-is-tearing-its-soul-apart.

[105] *See* CHRISTOPHER C. JOYNER, INTERNATIONAL LAW IN THE 21ST CENTURY: RULES FOR GLOBAL GOVERNANCE 245 (2005).

[106] *See* David Chandler, *Understanding the Gap Between the Promise and the Reality of "The Responsibility to Protect*," *in* REASSESSING THE RESPONSIBILITY TO PROTECT: CONCEPTUAL AND OPERATIONAL CHALLENGES 35, 37 (Brett R. O'Bannon ed., 2016).

[107] WORLD COMMISSION ON ENV'T & DEV., OUR COMMON FUTURE 43 (Oxford Univ. Press 1990) (1987) (chaired by former Norwegian Prime Minister Gro Harlem Brundtland).

[108] JOHN PEZZEY, WORLD BANK, SUSTAINABLE DEVELOPMENT CONCEPTS: AN ECONOMIC ANALYSIS 55–62 (1992).

[109] *See* MARIE-CLAIRE CORDONIER SEGGER & ASHFAQ KHALFAN, SUSTAINABLE DEVELOPMENT LAW: PRINCIPLES, PRACTICES AND PROSPECTS 45 (2004).

development in the Arctic.[110] The U.N. Office for Outer Space Affairs (OOSA) has also been active in working to carry out the Plan of Implementation of the World Summit on Sustainable Development.[111] Sustainability is even entering debates about cybersecurity and internet governance.[112] Soft law instruments related to sustainable development in the global commons abound, including the Stockholm and Rio Declarations, and various U.N. Conference on Environment and Development (UNCED) and Organization for Economic Cooperation and Development (OECD) guidelines and principles.[113] Such non-binding agreements have the benefit of political expedience, lower transaction costs, and the ability for strategies that will respond quicker to rapid changes in scientific understanding and social or economic conditions.[114] These agreements may also be starting to exert a "persuasive force," but these efforts are nascent compared with the scope of the problems facing the frontiers.[115]

Much work remains to be done, particularly in defining the extent and requirements of sustainable development, lest it fall victim to the same ambiguities that have limited the usefulness of the CHM concept. Limited progress, though, may be seen by unpacking the International Law Association's (ILA) New Delhi Declaration on Principles of International Law Relating to Sustainable Development, including: "integrated policy assessment, environmental sustainability, intergenerational equity, robust political participation, and intergenerational responsibility."[116] These principles largely mirror the core elements of the CHM concept. The only omissions in the New Delhi Declaration are non-appropriation, which has been shown to be neither substantially supported by State practice nor definitively part of the CHM itself, and peaceful use, which may be read implicitly into the Decla-

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[110] *History of the Arctic Council*, ARCTIC COUNCIL (June 6, 2018), https://arctic-council.org/index.php/en/about-us/arctic-council.

[111] *See Space Tools for Monitoring Air Pollution and Energy Use for Sustainable Development*, U.N. OFF. OUTER SPACE AFF., http://www.unoosa.org/oosa/en/ourwork/psa/schedule/2006/symposium_austria_space_applications_wssd.html (last visited Oct. 18, 2019).

[112] *See* Scott J. Shackelford et al., *Sustainable Cybersecurity: Applying Lessons from the Green Movement to Managing Cyber Attacks*, 2016 U. ILL. L. REV. 1995, 1997 (2016); Deborah Brown, *UN General Assembly Adopts Record Number of Resolutions on Internet Governance and Policy: Mixed Outcomes for Human Rights Online*, ASSOC. PROGRESSIVE COMM. (Jan. 10, 2019), https://www.apc.org/en/node/35253.

[113] SEGGER & KHALFAN, *supra* note 109, at 48.

[114] *Id.* at 49.

[115] *See id.* at 98.

[116] World Summit on Sustainable Development, *ILA New Delhi Declaration on Principles of International Law Relating to Sustainable Development*, U.N. Doc. A/Conf. 199/8 (Aug. 9, 2002); Reed D. Benson, *Recommendations for an Environmentally Sound Policy on Western Water*, 17 STAN. ENVTL. L.J. 247, 255 (1998); Douglas A. Kysar, *Sustainable Development and Private Global Governance*, 83 TEX. L. REV. 2109, 2116 (2005).

ration. Moreover, these principles, and other similar pronouncements, have incorporated international environmental law, human rights law, and development within the rubric of sustainable development.[117] But, like the CHM concept, ambiguity persists. What is agreed, though, is that sustainable development "challenges traditional international law concepts such as acquisition of territory, [and] sovereignty."[118] In the end, both concepts seek to mitigate collective action problems, though the CHM concept goes further in declaring the frontiers to be parts of the global commons, governed internationally "for the common good of all humanity" and not for individual organizations or nation states.[119]

Given the growth of polycentric governance at the frontiers, sustainable development may well even be an improvement as an organizing concept over the CHM. It is interdisciplinary by its nature, recognizing that law is but one facet of sustainable use alongside public policy and economics and that institutions may need to be changed to encourage the adoption of sustainable policies.[120] It also moves beyond the rigid supranational control required by the CHM, allowing for regulations to sustainably manage resources through multi-stakeholder governance mechanisms, as is apparent in cyberspace.[121] The New Delhi Declaration similarly calls for waste and environmental pollution to be minimized, and for nations to collaborate under the rubric of common but differentiated responsibilities in sustainably managing global resources.[122] It does not require nations to undertake certain behavior, but does suggest that they consider affected stakeholders—through, for example, integrated reporting schemes[123]—while respecting the rights of other nations akin to the way in which the freedom of the seas is limited by the obligation to respect the rights of other states.[124] Sustainable development, then, takes into account the growth of enclosure but also the important role of non-state actors in multi-stakeholder governance,[125] while serving as convenient shorthand for a range of factors

[117] *See* Niko Schrijver, *ILA New Delhi Declaration of Principles of International Law Relating to Sustainable Development*, 49 NETH. INT'L L. REV. 299, 299 (2002).

[118] Prue Taylor, *The Common Heritage of Mankind: A Bold Doctrine Kept Within Strict Boundaries*, WEALTH COMMONS, http://wealthofthecommons.org/essay/common-heritage-mankind-bold-doctrine-kept-within-strict-boundaries (last visited Oct. 18, 2019).

[119] *Id.*

[120] Montserrat Gorina-Ysern, *World Ocean Public Trust: High Seas Fisheries After Grotius—Towards a New Ocean Ethos?*, 34 GOLDEN GATE U. L. REV. 645, 645 (2004).

[121] *Id.*; Shackelford et al., *supra* note 112, at 2029.

[122] World Summit on Sustainable Development, *supra* note 116, at 4–5.

[123] For more on this topic, see Janine S. Hiller & Scott J. Shackelford, *The Firm and Common Pool Resource Theory: Understanding the Rise of Benefit Corporations*, 55 AM. BUS. L.J. 5 (2018).

[124] Jaye Ellis, *Sustainable Development as a Legal Principle: A Rhetorical Analysis*, *in* 2 SELECT PROCEEDINGS OF THE EUROPEAN SOCIETY OF INTERNATIONAL LAW 641, 647 (Hélène Ruiz Fabri et al. eds., 2010).

[125] SEGGER & KHALFAN, *supra* note 109, at 49.

to be weighed in decision-making processes regarding the exploitation of global common pool resources (CPRs). Realizing the promise of sustainable development, though, requires education and public participation by, for example, leveraging the "Protect, Respect, and Remedy" Framework ("PRR framework") and the Guiding Principles on Business and Human Rights ("Guiding Principles") spearheaded by John Ruggie, former Special Representative of the U.N. Secretary-General.[126]

In summary, sustainable development may be at least thought of as a normative "concept," according to the International Court of Justice,[127] akin to the CHM itself and influencing the growth of international law.[128] Some see it as an interstitial[129] or umbrella principle,[130] others as a unique body of law.[131] But sustainable development is more than just a "softer" version of environmental law since, as Judge Weeramantry stated, there is "wide and general acceptance by the global community" of sustainable development.[132] Sustainable development is thus neither an established principle of customary international law nor a meaningless notion, but instead may be "an emerging area of international law in its own right."[133] Regardless of its classification, the salient point is that sustainable development can help remind stakeholders of their responsibility as increasingly important stewards of the frontiers. It is designed to curb the worst social and environmental impacts of economic development activities. Interested nations, including the United Kingdom and United States, should push for its inclusion in legal instruments at all governance levels so as to create a gradually more sustainable and functional polycentric system.[134]

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[126] World Summit on Sustainable Development, *supra* note 116, at 5–6; Jamie Darin Prenkert & Scott J. Shackelford, *Business, Human Rights, and the Promise of Polycentricity*, 47 VAND. J. TRANSNAT'L L. 451, 454 (2014).

[127] *See generally* Gabčíkovo-Nagymaros Project (Hung./Slovk.), Judgment, 1997 I.C.J. Rep. 7, ¶ 140 (Sept. 25).

[128] *See* Ellis, *supra* note 124, at 651.

[129] *E.g.*, Vaughan Lowe, *Sustainable Development and Unsustainable Arguments*, *in* INTERNATIONAL LAW AND SUSTAINABLE DEVELOPMENT: PAST ACHIEVEMENTS AND FUTURE CHALLENGES 19, 33 (Alan Boyle & David Freestone eds., 1999).

[130] *E.g.*, World Summit on Sustainable Development, *supra* note 116, at 4.

[131] *See* SEGGER & KHALFAN, *supra* note 109, at 45.

[132] Gabčíkovo-Nagymaros Project (Hung./Slovk.), Separate Opinion, 1997 I.C.J. Rep. 7, 95 (Sept. 25) (Weeramantry, J.); *see also* ALISTAIR RIEU-CLARKE, INTERNATIONAL LAW AND SUSTAINABLE DEVELOPMENT 53 (2005); Erika L. Preiss, Student Article, *The International Obligation to Conduct an Environmental Impact Assessment: The ICJ Case Concerning the Gabcikovo-Nagymaros Project*, 7 N.Y.U. ENVTL. L.J. 307, 308 n.5, 347 (1999).

[133] SEGGER & KHALFAN, *supra* note 109, at 46.

[134] *See* Andreas Fischer-Lescano & Gunther Teubner, *Regime-Collisions: The Vain Search for Legal Unity in the Fragmentation of Global Law*, 25 MICH. J. INT'L L. 999, 1004 (Michelle Everson trans., 2004).

Though it may not dictate outcomes, sustainable development does carry normative weight and, as has been shown, is already influencing political discourse regarding frontiers governance that is imperative for the long-term, sustainable, peaceful use of global CPRs generally, and cyberspace specifically. Sustainable development also connects the disciplines of economics, political science, and international law and is critical for successful global governance both online and offline. Already, there is evidence that the international community is increasingly making this connection, as seen in the record number of U.N. General Assembly Resolutions related to internet governance and human rights adopted in 2018.[135]

E. Summary

The CHM concept has fallen out of favor, due in large part to its ambiguity, as well as to the rapid pace of technological advancement, changing conceptions of sovereignty, multipolar politics, growing scarcity, and economic development pressures. It is a concept that has been overshadowed by the reality of geopolitics. It is not a customary principle of international law since it lacks definition and widespread state practice.[136] A revised and flexible property system is thus required that better reflects the titanic changes in international relations since the CHM concept was introduced in the 1960s and that recognizes the growing importance of sustainable development in commons discourse. What might such an alternative approach look like? It would be comprised of at least four elements. First, it would recognize that the specter of increasing national control across the frontiers does not necessarily run afoul of the CHM concept.[137] Second, it would consider that exclusive supranational control over the frontiers is not necessary. Third, it would clarify peaceful use to avoid global collective action problems. This could simply include a prohibition on offensive military action, though the robust prohibitions on military use in Antarctica are unlikely to be replicated in other frontiers, as seen in increasing concerns over both a space and cyber arms race.[138] Fourth, it would harness the potential of sustainable development. Indeed, given the widespread public and private sector support the concept enjoys, it is in an ideal position to carry the torch of the core equitable benefit-sharing and preservation components of the CHM concept into the twenty-first century.

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[135] *See* Brown, *supra* note 112.

[136] BASLAR, *supra* note 50, at 4.

[137] ANTONY J. DOLMAN, RESOURCES, REGIMES, WORLD ORDER 248 (1981).

[138] *See* Garrett M. Graff, *The New Arms Race Threatening to Explode in Space*, WIRED (June 26, 2018), https://www.wired.com/story/new-arms-race-threatening-to-explode-in-space/.

III. THE PROMISE AND PERIL OF POLYCENTRIC GOVERNANCE AT THE FRONTIERS

Instead of a supranational common heritage authority, polycentric governance seems to be gaining traction across the frontiers. But what are the benefits and drawbacks of this development? On the positive side, such regime complexes can encourage regulatory innovation, competition,[139] and "flexibility across issues and adaptability over time."[140] This may be seen in the regulatory innovations taking place in the Arctic Council, in cyberspace, and in outer space.[141] However, polycentric networks are also susceptible to institutional fragmentation and gridlock caused by overlapping authority that must still "meet standards of coherence [and] . . . sustainability."[142] This fragmentation and gridlock was on display in the space weaponization and junk debate.[143]

There are also moral considerations about polycentric regimes to consider. For example, negotiating climate agreements exclusively between the major emitters omits at-risk developing nations. Side agreements with at-risk nations are thus critical to avoid unethical outcomes. Given the slowness and the conflict involved in building a global consensus on climate change through the U.N. system, a polycentric approach engenders progress while also having the benefit of being a laboratory in which multiple methods may be tested across various regimes to see which combination works best. But there are also problems associated with foregoing multilateral negotiation in favor of more targeted initiatives, including incentivizing nations to become free riders, which could impede progress toward global cybersecurity norms. Regime complexes are also laden with legal inconsistencies, often leading negotiators to adopt broad rules subject to multiple interpretations. The latter has been evident in global cybersecurity policymaking, for example, with minilateral agreements from the G7 and G20 to protect civilian critical infrastructure,[144] but which fail to define the scope of what those protections entail.

In summary, at their best, polycentric regime complexes provide a path to address pressing international security and environmental challenges while avoiding

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[139] Robert O. Keohane & David G. Victor, *The Regime Complex for Climate Change*, PERSP. ON POL., March 2011, at 7, 18.

[140] *Id.* at 15.

[141] *See infra* Part I.

[142] *Id.* at 8.

[143] *See* Shackelford, *supra* note 51, at 430.

[144] *See* Teri Robinson, *U.S., China Agree to Cybersecurity Code of Conduct*, SC MEDIA (June 26, 2015), https://www.scmagazine.com/home/security-news/u-s-china-agree-to-cybersecurity-code-of-conduct/; *G7 Leaders Approve Historic Cybersecurity Agreement*, BOS. GLOBAL F. (June 5, 2016), http://bostonglobalforum.org/2016/06/g7-leaders-produce-historic-cybersecurity-agreement/; *G20 Leaders' Communiqué Agreed in Antalya*, G20 TURK., http://g20.org.tr/g20-leaders-commenced-the-antalya-summit/ (last visited Oct. 18, 2019).

some of the political pitfalls of consensus-driven U.N. treatymaking. At their worst, they can cause gridlock and fragmentation that does little to ameliorate collective action problems at the frontiers, and indeed may even make them worse if they are used as a substitute for meaningful multilateral action. Crafting polycentric networks around successful examples, such as the Montreal Protocol, would help fulfill the promise while avoiding the pitfalls of polycentric governance. This Part expands on these conclusions by first summarizing the role of the United Nations in managing the frontiers in a multipolar world before moving on to analyze the potential of bilateral and regional treaty groupings in managing global CPRs. Finally, regime effectiveness findings are summarized to help highlight governance gaps and chart the road ahead.

A. The Role of the United Nations in Managing the Frontiers

The United Nations played a critical role in the development of the legal regimes governing the deep seabed and outer space. Since the 1980s, though, progress has slowed. COPUOS, once the locus of space law, has seen its clout diminish as its membership has expanded with consensus, becoming more elusive as a result.[145] Minilateral forums such as the Arctic Council are gaining prominence. Climate change negotiations, while still making limited progress through the United Nations Framework Convention on Climate Change (UNFCCC) process in the wake of the 2015 Paris Accord,[146] are also taking place in other forums, such as Mayors for Climate and Energy.[147] The lack of political consensus on divisive issues of transboundary governance is regrettably calling into question the continued role of the United

[145] *See, e.g.*, U.N. Office for Outer Space Affairs, Long-Term Sustainability of Outer Space Activities, UN OFF. OUTER SPACE AFF, http://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html (last visited Oct. 18, 2019) ("In June 2016 the Committee agreed to a first set of guidelines for the long-term sustainability of outer space activities. In 2018, consensus was reached on a preamble and nine additional guidelines, although the Working Group could not agree on its final report." (citations omitted)).

[146] *But see* Veerabhadran Ramanathan et al., *Climate Extremes and Global Health: New Ways to Make Progress*, FOREIGN AFF. (July 31, 2018), https://www.foreignaffairs.com/articles/2018-07-31/climate-extremes-and-global-health ("Politically, the 2015 Paris agreement on climate change is stalling. The United States has announced that it will abandon the pact, and no other country has stepped up to fill the vacuum. Emissions rose 1.4 percent [in 2017] and no major industrialized country is on track to meet the emission control pledges it made in Paris, which means that the world is way off track to meeting the target of limiting warming to two degrees Celsius above preindustrial temperatures.").

[147] *See* Scott J. Shackelford, *On Climate Change and Cyber Attacks: Leveraging Polycentric Governance to Mitigate Global Collective Action Problems*, 18 VAND. J. ENT. & TECH. L. 653, 674–75 (2016); *Why Cities Matter*, GLOBAL COVENANT MAYORS, https://www.globalcovenantofmayors.org/ (last visited Oct. 18, 2019).

Nations in governing the global commons.[148] However, relative U.S. disengagement from global internet governance discussions paired with a resurgent interest on the part of China and its allies to promote cyber sovereignty could well change the multi-stakeholder status quo and make the United Nations more central in twenty-first century cyberspace.[149] These same trend lines are evident in oceanic and space governance.

1. Challenges to U.N. Rulemaking at the Poles

The deep seabed has arguably enjoyed the greatest degree of multilateral regulatory support of any frontier since the 1980s, owing to the success of the 1994 Amendments that led to widespread ratification of UNCLOS. So far, despite surging demand, the CLCS has helped avoid maritime conflicts over continental shelf delimitation. But the Commission risks being overwhelmed due to resource constraints.[150] If the CLCS were to lose legitimacy, such an outcome could have dire consequences for international peace and security in the deep seabed and in Antarctica. The future of the Antarctic Treaty System (ATS) should also be secured. Former U.S. Secretary of State Hillary Clinton noted in April 2009, during the Antarctic Treaty Consultative Meeting, that "the genius of the Antarctic Treaty lies in its relevance today."[151] The prominence of the CLCS, and other organizations like the Arctic Council and the ATS, showcase the challenge to the United Nations remaining at the center of rulemaking, including at the poles. Fragmented, difficult to define, polluted, fought over, the Arctic is a symbol of what the world is; Antarctica is a symbol of what the world could be. And like the Arctic and Antarctic, there is a regime complex forming to govern outer space.[152]

2. The Second Golden Age of Space Law

Instead of a single governing entity, what has emerged in outer space are a number of "partly overlapping, often unco-ordinated, and sometimes contradictory

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[148] *See, e.g.*, Scott J. Shackelford & Amanda N. Craig, *Beyond the New "Digital Divide": Analyzing the Evolving Role of National Governments in Internet Governance and Enhancing Cybersecurity*, 50 STAN. J. INT'L L. 119 (2014) (discussing proposals to give the International Telecommunication Union a larger role in Internet governance).

[149] *See, e.g.*, Evan Osnos, *Making China Great Again*, NEW YORKER (Jan. 1, 2018), https://www.newyorker.com/magazine/2018/01/08/making-china-great-again.

[150] *Cf.* Signe Veierud Busch, *Establishing Continental Shelf Limits Beyond 200 Nautical Miles by the Coastal State: A Right of Involvement for Other States?*, *in* PUBLICATIONS ON OCEAN DEVELOPMENT 130 (Robin Churchill & Alex Oude Elferink eds., 2016) ("The number of disputes asserted before the CLCS is not overwhelming considering the total number of States parties to the LOSC . . . .").

[151] Peter Rejcek, *Antarctic Treaty Meeting*, ANTARCTIC SUN (Apr. 24, 2009), https://antarcticsun.usap.gov/features/1757/.

[152] Jill Stuart, *Regime Theory and the Study of Outer Space Politics*, E-INT'L REL. (Sept. 10, 2013), https://www.e-ir.info/2013/09/10/regime-theory-and-the-study-of-outer-space-politics/.

or competing regimes"[153]—in other words, a polycentric system.[154] The role of the United Nations is still key in this system to promote coordination and interaction between these disparate elements, but its unique importance is in decline. This is illustrated by the inactivity of COPUOS in propagating binding, enforceable treaties dealing with orbital debris—even though progress has been made generally in the sustainable use of outer space[155]—as well as the difficulty with reaching consensus in the U.N. Conference on Disarmament on space weaponization.[156] Yet the central role of the United Nations as the leading multilateral forum to discuss issues of governance in the classic global commons should not be underestimated. Space law is arguably in need of a second golden age to address the mounting collective action problems of weaponization and debris that the first golden age failed to adequately manage, arguably making it more of a gilded age.[157] But in order to do this, multilateral collaboration is needed, as it is in cyberspace, which shares similarities with outer space such as the fact that comprehensive tracking is difficult in both environments. As with outer space, cyberspace is not immune from national and regional regulations that ripple across borders as seen in the EU's General Data Protection Regulation and China's 2017 Cybersecurity Law.[158] Additional polycentric measures and multilateral collaboration should be taken in both arenas, which requires applying the lessons learned from successful polycentric systems.

3. Summary

U.N.-centered multilateral treaty making has become relatively less popular in promoting good governance in the global commons relative to polycentric accords that more readily address the political realities of a multipolar world. Yet this is a paradox of globalization—in an increasingly interconnected international community facing common problems ranging from climate change to cyber attacks, all of which require multilateral action, the movement toward minilateral agreements can make it more difficult to reach a consensus. Still, the United Nations remains an invaluable forum to discuss transboundary problems. To make the United Nations

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[153] EDWARD W. PLOMAN, SPACE, EARTH AND COMMUNICATION 155 (1984).

[154] *See* Vincent Ostrom et al., *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55 AM. POL. SCI. REV. 831, 831 (1961).

[155] *See* Long-Term Sustainability of Outer Space Activities, *supra* note 145.

[156] *See* U.N. G.A. First Comm., Momentum Gathering for Weaponization of Outer Space, Risk of Outer Space Arms Race Rising, Warns China's Delegation in First Committee, Urging Binding New Treaty (Oct. 25, 2010), https://www.un.org/press/en/2010/gadis3421.doc.htm; Gbenga Oduntan, *Donald Trump's Space Force and the Dangerous Militarisation of Outer Space*, WIRE (June 28, 2018), https://thewire.in/space/donald-trump-space-policy-militarisation-space.

[157] *See generally* MARK TWAIN & CHARLES DUDLEY WARNER, THE GILDED AGE: A TALE OF TODAY (Trident Press 1964) (1873).

[158] *See* Ian Lopez, *The GDPR and China's Cyber Law: Following One Doesn't Mean Following Both*, AM. LAW. (May 24, 2018), https://www.law.com/international/2018/05/24/the-gdpr-and-chinas-cyber-law-following-one-doesnt-mean-following-both-396-3471/?slreturn=20180728135826.

even more effective, and as Secretary General António Guterres has stated, the U.N. bureaucracy should be reformed and streamlined, with "decision-making closer to the people we serve,"[159] an exercise in subsidiarity, which is a core principle of polycentric governance. Given that traditional multilateral diplomacy is becoming more difficult, mutually reinforcing networks of polycentric accords could provide an ever more vital mechanism to promote security, sustainability, and equity across the frontiers of international relations, while simultaneously helping to restore trust in the U.N. system.[160]

B. Join the Club: Unpacking Our Polycentric Future

The potential for complementary polycentric accords to better manage collective action problems at the frontiers has been a central topic of this study, owing to the proliferation of such agreements in the space, climate, deep seabed, and cyber regime complexes. As of 2018, there was a growing proportion of the more than 3,000 bilateral investment treaties (BITs) along with new trade agreements that protect intellectual property.[161] As early as 2004, according to one U.N. report, there were 266 partnerships in support of diverse legal regimes ranging from the oceans to air pollution.[162] This state of affairs is due to the fact that it can be easier to reach agreements in forums with limited subject matter and targeted membership, as seen in the International Corporation for Assigning Names and Numbers (ICANN), the Arctic Council, or the Space Situational Awareness Partnership between the United States and Australia.[163] Geography also plays an important role in the popularity of these treaties. Consider the geopolitics of the poles, with nearby nations such as South Africa in the Antarctic and Germany in the Arctic, seeking to generally play larger roles than equatorial nations. Proximity then, not distance, can make the heart

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[159] U.N. Secretary-General, Remarks at U.N. Reform Event (Sept. 18, 2017), https://www.un.org/sg/en/content/sg/speeches/2017-09-18/secretary-generals-reform-remarks.

[160] *See United Nations*, GALLUP, https://news.gallup.com/poll/116347/united-nations.aspx (last visited Oct. 18, 2019) (reporting that, as of February 2018, only 34% of Americans thought that the United Nations was doing a "good job" at "solv[ing] the problems it has had to face").

[161] *See* Shackelford et al., *supra* note 96, at 3. *See generally* EU BILATERAL TRADE AGREEMENTS AND INTELLECTUAL PROPERTY: FOR BETTER OR WORSE? (Joseph Drexl, Henning Grosse Ruse-Khan, & Souheir Naddle-Phlix eds., 2014) (discussing the new wave of trade agreements between the EU and developing nations that include intellectual property protections).

[162] *See* Comm'n on Sustainable Dev. on its Twelfth Session, U.N. Doc. E/CN.17/2004/16 (Feb. 10, 2004).

[163] *See, e.g.*, Stine Aakre et al., *Incentives for Small Clubs of Arctic Countries to Limit Black Carbon and Methane Emissions*, 8 NATURE CLIMATE CHANGE 85, 85 (2018) ("These difficulties in achieving effective global cooperation have animated a search for strategies that could align with the interests of key countries and facilitate deeper cooperation over time." (citation omitted)).

grow fonder from an international relations perspective.[164] In fact, many of the agreements governing the classic global commons as identified by Professor John Vogler are not in fact open to global membership.[165] Networking bilateral and regional accords into mutually reinforcing polycentric structures may be either an alternative to multilateral treaties, or at least a useful stopgap strategy that would allow time and space for experimentation that could engender a more effective global approach in due course.[166] UNCLOS already calls for the establishment of polycentric mechanisms through international organizations to sustainably manage offshore resources, while empirical studies have shown that there is modest support that such agreements can improve the status quo.[167] This is consistent with the view that global problems are best treated through regional cooperation that includes smaller and more manageable numbers of participants.[168]

Consider climate governance. There was some effort to create a law of the atmosphere in the 1980s, as an analogy to the Law of the Sea at a time when "[t]he world's major powers came within several signatures of endorsing a binding, global framework to reduce carbon emissions."[169] This grand project did bear important fruits, as seen with the success and quick implementation of the Montreal Protocol, but ultimately governance fragmented.[170] Now, there are hundreds of agreements that help humanity govern Earth's atmosphere.[171] These legal regimes are overlapping and are far from comprehensive, yet together they are enabling progress in the fight against climate change. From U.S.-China R&D partnerships on advanced energy research to sustainable forestry practices to the U.N. Group of Government

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[164] Though there are exceptions, as seen in China's growing interest in the Arctic as a "Near-Arctic State." *See* Charlotte Gao, *China Issues Its Arctic Policy*, DIPLOMAT (Jan. 26, 2018), https://thediplomat.com/2018/01/china-issues-its-arctic-policy/.

[165] JOHN VOGLER, THE GLOBAL COMMONS: A REGIME ANALYSIS 156 (1995).

[166] *See* Aakre et al., *supra* note 163, at 85 ("Efforts to build trust and confidence could benefit from monitoring and enforcement systems that could be much easier to establish and refine in smaller groups before being applied globally." (citations omitted)).

[167] Scott Barrett, *Self-Enforcing International Environmental Agreements*, 46 OXFORD ECON. PAPERS 878, 878 (1994); *id.* at 891 ("This paper has shown that self-enforcing international environmental agreements (IEAs), which establish rules for managing shared environmental resources, may not be able to improve substantially upon the noncooperative outcome.").

[168] *See, e.g.*, Björn Hettne & Fredrik Söderbaum, *Regional Cooperation: A Tool for Addressing Regional and Global Challenges*, *in* MEETING GLOBAL CHALLENGES: INTERNATIONAL COOPERATION IN THE NATIONAL INTEREST 179, 179 (2006).

[169] Nathaniel Rich, *Losing Earth: The Decade We Almost Stopped Climate Change*, N.Y. TIMES MAG. (Aug. 1, 2018), https://www.nytimes.com/interactive/2018/08/01/magazine/climate-change-losing-earth.html.

[170] *Id.*

[171] *Id.*

Experts in the cybersecurity context, clubs have been shown to help facilitate bottom-up processes that "catalyz[e] deeper cooperation,"—so much so that they are an important aspect of the 2015 Paris Agreement.[172]

If international environmental law were a spectrum, then at one end would be the Montreal Protocol, being among the most comprehensive international environmental treaties to date, enjoying all the elements of success, including universal membership and an effective compliance mechanism. The UNFCCC then would be somewhere in the middle, since it is ambitious in scope but lacks binding obligations.[173] The opposite extreme from the Montreal Protocol is populated with a range of less successful treaties.[174] Such a governance spectrum is offered in Table 1 and the associated figures.

Investment law provides an analogue to the growing preference of polycentric agreements at the frontiers. There, for more than 50 years, a revolution has happened in the protection of investor property rights with the proliferation of BITs, which help protect the rights of foreign investors.[175] The growth of foreign direct investment (FDI) has been the driving force behind these treaties, which, according to the World Bank, "increased sevenfold from 1.2 percent to 8.9 percent of world production from 1970 to 2000."[176] By 2012, global FDI stocks had risen to some $22 trillion,[177] though FDI flows contracted from 2015 to 2018.[178] These FDI flows have always been subject to political and contractual hazards that increase the cost of investing in a foreign jurisdiction.[179] Yet, unlike other facets of the global economy, FDI is relatively lightly regulated under international law,[180] which is why BITs have become so important.[181]

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[172] *See* Aakre et al., *supra* note 163, at 85.

[173] Rich, *supra* note 169.

[174] *See, e.g.*, Convention for the Prevention of Marine Pollution from Land-Based Sources art. 12, ¶ 1, June 4, 1974, 1546 U.N.T.S. 120.

[175] *See* Zachary Elkins et al., *Competing for Capital: The Diffusion of Bilateral Investment Treaties, 1960–2000*, 60 INT'L ORG. 811, 813–14 (2006).

[176] *Id.* at 811.

[177] Daniel Ikenson, *Policymakers Must Remove the Barriers to Foreign Investment in the United States*, FORBES (Oct. 30, 2013), http://www.forbes.com/sites/realspin/2013/10/30/policymakers-must-remove-the-barriers-to-foreign-investment-in-the-united-states/.

[178] *See Global Foreign Direct Investment Slides for Third Consecutive Year*, UNCTAD (June 12, 2019), https://unctad.org/en/pages/newsdetails.aspx?OriginalVersionID=2118.

[179] Elkins et al., *supra* note 175, at 812–13; Witold J. Henisz, *The Institutional Environment for Multinational Investment*, 16 J.L. ECON. & ORG. 334, 334–35 (2000).

[180] Rudolf Dolzer, *New Foundations of the Law of Expropriation of Alien Property*, 75 AM. J. INT'L L. 553, 574 (1981); Michael S. Minor, *The Demise of Expropriation as an Instrument of LDC Policy, 1980–1992*, 25 J. INT'L BUS. STUD. 177, 182–83 (1994).

[181] An earlier version of this research was published in Shackelford et al., *supra* note 96.

The BIT revolution symbolizes a polycentric approach to a global problem—in this case, guaranteeing investor property rights to help spur investment. These treaties have created a network of protections that, together with trade agreements, could help boost intellectual property and cybersecurity protections. Although these accords are far from perfect, as seen with well-publicized concerns over the investor-state dispute resolution process,[182] they do help highlight a polycentric trend that is similarly unfolding to a greater or lesser extent across the frontiers.[183] These accords provide flexibility for different nations to sign on to particular agreements, making it more likely that they will meet their obligations than if they were imposed through a process in which they had less control. This is similar to how nations accede to the World Trade Organization (WTO)—each experience is tailored to the unique qualities of the acceding nation, which may also have some application to cyber peace if national security concerns could be overcome.[184]

At their best then, polycentric bilateral and regional accords hold the potential to spur targeted governance measures to help address global collective action problems. In particular, these accords could incentivize nations to: (1) adopt mechanisms to implement horizontal collaboration between administrative bodies and thereby decrease gridlock (such as with the Budapest Convention); (2) provide a conducive environment in which local actors may enact regulations; and (3) offer incentives and supply mechanisms for persuasion such that "activities by one group do not

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[182] *See, e.g.*, Elizabeth Warren, *The Trans-Pacific Partnership Clause Everyone Should Oppose*, WASH. POST (Feb. 25, 2015), https://www.washingtonpost.com/opinions/kill-the-dispute-settlement-language-in-the-trans-pacific-partnership/2015/02/25/ec7705a2-bd1e-11e4-b274-e5209a3bc9a9_story.html?utm_term=.8eca92c7b2c1.

[183] *See* Timothy G. Nelson, *The Moon Agreement and Private Enterprise: Lessons from Investment Law*, 17 ILSA J. INT'L & COMP. L. 393, 399 (2011). It should be noted, though, that the number of new BITs entering into force has been declining in recent years, given that some countries, like China, have increased attention to trade secret protection through legislation. *See* SHAN HAILING, THE PROTECTION OF TRADE SECRETS IN CHINA 26 (2d ed. 2012).

[184] While the WTO has been used as a forum to air broader concerns among the member states, it has to date been a factor in the cybersecurity context because of provisions allowing nations to shirk their free trade commitments when they conflict with national security. *See, e.g.*, ALLAN A. FRIEDMAN, BROOKINGS, CYBERSECURITY AND TRADE: NATIONAL POLICIES, GLOBAL AND LOCAL CONSEQUENCES 10–11 (2013), https://www.brookings.edu/wp-content/uploads/2016/06/BrookingsCybersecurityNEW.pdf; JAMES A. LEWIS, CTR. FOR STRATEGIC & INT'L STUDIES, CONFLICT AND NEGOTIATION IN CYBERSPACE 49–51 (2013) (discussing the applicability of the WTO dispute resolution processes to help manage cyber espionage); Mark L. Movsesian, *Enforcement of WTO Rulings: An Interest Group Analysis*, 32 HOFSTRA L. REV. 1, 1 (2003) (describing the WTO Dispute Settlement Understanding and noting that trade disputes between nations "are to be resolved in adversarial proceedings before impartial panels of experts" under this system). This limitation in the WTO composition underscores the need for bilateral and regional approaches to enhancing cybersecurity.

cause harm to another."[185] Yet, despite increasing interest in polycentric clubs "as an antidote to the gridlock of global diplomacy,"[186] insufficient research exists across the frontiers to offer definitive conclusions. From the case studies surveyed, though, there is cause for hope. In the climate context, such clubs "can help lower the cost for governments to obtain reliable information about the costs and benefits of controlling pollution" while allowing for deeper cooperation that can, in time, extend to additional stakeholders.[187] This is why, for example, "effective, large multilateral institutions are rare" in the international community. Where they do exist, such as with the WTO, they have often been an outgrowth of a pre-existing minilateral forum, which in that context was the twenty-three member General Agreement on Tariffs and Trade (GATT).[188]

Polycentric clubs can help promote sustainable use and improved welfare across the frontiers through better information sharing and through more robust monitoring and enforcement mechanisms.[189] Regarding the former, gains have resulted in pollution reductions totaling nearly $600 billion in net monetary value.[190] A similar story has played out in the cybersecurity context, with small groups of trusted stakeholders comprising some of the most effective polycentric clubs, such as the member-owned, non-profit Security Operations Center, backed by the Financial Services Information Sharing and Analysis Center (FS-ISAC).[191] Other examples include the Cybersecurity Tech Accord, the Microsoft-led push for a Digital Geneva Convention, the Forum of Incident Response and Security Teams (FIRST) community comprised of Cyber Emergency Response Teams (CERTs) from around the world, the Global Commission on the Stability of Cyberspace, and the Siemens' Charter of Trust.[192] But to be as effective as possible, polycentric efforts require partnerships with a diverse range of nested stakeholders, including those who can help frame debates about sustainable use at the frontiers in terms of justice and morality, which

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[185] Insa Theesfeld, Linking the Precautionary Principle to Polycentricity: Investigating Climate Change Adaptation in Agricultural Water Agencies 18 (Sept. 2010) (unpublished manuscript), https://www.researchgate.net/publication/228689781_Linking_the_precautionary_principle_to_Polycentricity_Investigating_cli-mate_climate_change_adaptation_in_agricultural_water_agencies.

[186] Aakre et al., *supra* note 163, at 85.

[187] *Id.* at 85–86.

[188] *Id.* at 85.

[189] *Id.* at 88.

[190] *Id.*

[191] *See About FS-ISAC*, FIN. SERVS. INFO. SHARING & ANALYSIS CTR., https://www.fsisac.com/about (last visited Oct. 18, 2019).

[192] *About FIRST*, FIRST.ORG, https://www.first.org/about/ (last visited Oct. 18, 2019); Garrett Hinck, *Private-Sector Initiatives for Cyber Norms: A Summary*, LAWFARE (June 25, 2018), https://www.lawfareblog.com/private-sector-initiatives-cyber-norms-summary; Maurer & Taylor, *supra* note 99.

includes religious institutions.[193] This may not be as outlandish as it might seem; indeed, it is already happening to an extent with Pope Francis's Encyclical Laudato si' and the Vatican's Pontifical Academy of Sciences in December 2008,[194] which led to the "Erice Declaration on Principles for Cyber Stability and Cyber Peace."[195]

Like it or not, polycentric governance is happening. It is time to apply "Ostrom's Law"—the idea that "[i]nstitutional arrangements that work in practice can work in theory"[196]—to reconceptualize governance at the frontiers. It requires that "bottom-up, rules-based structures with multiple nodes of decision-making" comprising "open systems that manifest enough spontaneity to be self-organizing and self-governing"[197] should be allowed to flourish so as to promote deeper information sharing, reduced transaction costs, and ultimately more sustainable and peaceful frontiers. Breaking down global challenges like climate change and cybersecurity into more manageable units and sub-topics that can be overseen by polycentric clubs is an important step toward this end[198] and can also help rebuild trust in our institutions.[199] In some ways, these notions are nothing new—in fact, they date back to diverse historical epochs from "[t]he Holy Roman Empire, the Hanseatic League, and the gold standard" up to the founding of the American republic. For example, Vincent Ostrom cited Madison 51 and Tocqueville's description of the nascent United States "as a place 'where society governs itself for itself'" to argue that "aspects of polycentricity are likely to arise in all systems of social order because human beings are capable of thinking for themselves."[200] Instead of ready-made solutions to the varied problems of governance at the frontiers, then, policymakers

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[193] Ramanathan et al., *supra* note 146.

[194] Jody R. Westby, *Conclusion*, *in* THE QUEST FOR CYBER PEACE 112 (2011).

[195] *Id.*; *see World Federation of Scientists - Erice Declaration on Principles for Cyber Stability and Cyber Peace*, APS PHYSICS, https://www.aps.org/units/fip/newsletters/201109/barletta.cfm (last visited Oct. 18, 2019).

[196] Dalibor Rohac, *Indiana's Gift to the International Order*, AM. INTEREST (May 10, 2018), https://www.the-american-interest.com/2018/05/10/indianas-gift-to-the-international-order/ (quotation marks omitted).

[197] *Id.*

[198] *See* Charles F. Sabel & David G. Victor, *An Evolutionary Approach to Governing Global Problems: Climate Policy After Paris*, STANLEY CTR. PEACE & SECURITY (Aug. 2016), https://stanleycenter.org/publications/an-evolutionary-approach-to-governing-global-problems-climate-policy-after-paris/.

[199] *See* Nathaniel Persily & Jon Cohen, *Americans Are Losing Faith in Democracy — and in Each Other*, WASH. POST (Oct. 14, 2016), https://www.washingtonpost.com/opinions/americans-are-losing-faith-in-democracy—and-in-each-other/2016/10/14/b35234ea-90c6-11e6-9c52-0b10449e33c4_story.html?utm_term=.4c43fd721ef3.

[200] Rohac, *supra* note 196.

should promote the growth of diverse polycentric clubs to promote policy innovation and "convergence toward mutually productive arrangements."[201] Such a bottom-up approach could similarly help blunt criticisms from populist leaders, including the Trump Administration, on a number of multilateral institutions such as the WTO.[202] After all, as Vincent Ostrom argued, "when we contemplate how the principles of polycentricity might apply to the whole system of human affairs, we are exploring the fuller implications of the American experiment."[203]

The question is how to make it work well and ensure that it is a step toward more robust and effective regimes. Professor Elinor Ostrom's work in this area is meant, in her own words, to "provide starting points for addressing future challenges."[204] But in order to better understand which aspects are working and which might need revision, it is important to review the evidence for regime effectiveness at the frontiers.

C. Regime Effectiveness at the Frontiers

As is apparent from the case studies, measuring the effectiveness of any international regime is a difficult proposition as seen in the human rights context.[205] As such, any conclusions must be modest and are at best correlations of admittedly incomplete data in the presence of myriad confounding variables. Given those qualifications, though, many of the regimes surveyed were found to be an improvement on the status quo.[206] That does not mean that they have all performed as designed, or that they have yet fully met their potential; nations have already been found to be falling short of their Paris Accord promises, for example.[207]

While legal regimes do certainly matter at the frontiers, not all are born equal. Three trends are apparent, for example, in the deep seabed: (1) there has been a

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[201] *Id.*

[202] *See id.*; Gregory Korte, *Trump Escalates His Threats to Blow Up Trade Deals: "I Would Withdraw from the WTO,"* USA TODAY (Aug. 31, 2018), https://www.usatoday.com/story/news/politics/2018/08/30/wto-trump-threatens-pull-out-world-trade-organization/1149421002. Indeed, the approach has bipartisan appeal and was called for by former President Obama in the cybersecurity context. WHITE HOUSE, INTERNATIONAL STRATEGY FOR CYBERSPACE: PROSPERITY, SECURITY, AND OPENNESS IN A NETWORKED WORLD 9 (2011) ("The United States will work with like-minded states to establish an environment of expectations, or norms of behavior, that ground foreign and defense policies and guide international partnerships.").

[203] Rohac, *supra* note 196.

[204] Elinor Ostrom et al., *Revisiting the Commons: Local Lessons, Global Challenges*, 284 SCI. 278, 282 (1999).

[205] *See* Oona A. Hathaway, *Do Human Rights Treaties Make a Difference?*, 111 YALE L.J. 1935, 1938 (2002).

[206] *See, e.g.*, Barrett, *supra* note 167, at 891.

[207] David G. Victor et al., *Prove Paris Was More than Paper Promises*, NATURE, Aug. 2017, at 25, 25–26.

spate of multilateral regulation of the oceans relatively recently, as compared to space law; (2) the majority of nations have ratified these agreements, with the notable exception of the United States in the case of UNCLOS III; and (3) multilateral treatymaking in the oceans is slow, averaging 75 months between signature and entry into force of the relevant treaty over the period surveyed.[208] The evidence for how well this emerging regime complex has mitigated problems of oceanic pollution and international conflict over scarce resources is mixed. For example, while the amount of oil being spilled into the ocean by tankers has decreased dramatically since the 1970s, other environmental problems such as overfishing and agricultural runoff continue.[209] Yet overall, while governance gaps persist, these legal regimes have provided a useful foundation for oceanic governance.

The effectiveness of the space regime complex has been called into question due to the decline in multilateral efforts to manage the space commons, as well as the increasing politicization of the area with the average number of months from signature to entry-into-force going from 8 for the Outer Space Treaty (OST) to 55 for the Moon Treaty. However, the time to enter into force is markedly lower for space law than the Law of the Sea (averaging 16.3 months instead of 74 months respectively), while the number of ratifying nations has fallen over time (from 100 for the OST to thirteen for the Moon Treaty). This stands in contrast to the Law of the Sea, given the success of UNCLOS, as well as the near universal ratification of major climate accords. The space and climate regimes, though, may be considered "stronger" to some degree than the Law of the Sea, given that reservations are allowed in only the OST and none of the atmospheric accords, whereas all of the surveyed ocean treaties allow reservations. Like the Law of the Sea, though, the current space law framework is preferable to the no-regime counterfactual.

Ascertaining the effectiveness of cyber law is even more challenging, particularly because of the relative lack of binding international law below the armed attack threshold.[210] The growing membership of the Budapest Convention, the relative rarity of cyber terrorism incidents, proliferation of polycentric internet governance bodies, absence of "pure" cyber wars, and the TCP/IP's successful scaling all go to support this view. However, pushing back against these positive trends is the growth of cybercrime and espionage that led to not only more than $450 billion in annual losses as of 2017[211] but also the proliferation of sophisticated cyber weapons and state-sponsored attacks used by an increasing number of cyber powers from North

[208] VOGLER, *supra* note 165, at 46.

[209] *Oil Tanker Spill Statistics 2018*, ITOPF, http://www.itopf.com/knowledge-resources/data-statistics/statistics/ (last visited Oct. 18, 2019).

[210] For more on this topic, see SHACKELFORD, *supra* note 67, at 263–366.

[211] *See* Luke Graham, *Cybercrime Costs the Global Economy $450 Billion: CEO*, CNBC (Feb. 7, 2017), https://www.cnbc.com/2017/02/07/cybercrime-costs-the-global-economy-450-billion-ceo.html.

Korea and Iran to the United States. Moreover, the Budapest Convention permits nations to opt out of specific provisions, thus potentially weakening the regime, though its popularity has been growing with the number of member states doubling over the past five years to now more than 60 parties.[212] Overall, though, insufficient data exist to compare the findings from other frontiers given the relative immaturity of Internet governance from a regulatory standpoint.[213] Future work should analyze various ITU documents and related endeavors, including the Global Cybersecurity Index effort and the Carnegie Endowment Cyber Norms Index.[214]

Name	Subject	Year	Parties	Ratifications for EIF	Signature to EIF (months)	Amendment Requirements	Reservations Allowed?
ICRW	Whaling	1946	89	6	23	Three-quarters	Yes
Antarctic Treaty	Antarctica	1959	53	All	19	All	Yes
ITU Nairobi Convention	Marine Pollution	1982	188	55	13	Two-thirds	Yes
London Convention	Marine Pollution	1972	87	15	21	Two-thirds	Yes
MARPOL Convention	Marine Pollution	1973/78	157	15	119	Two-thirds	Yes
UNCLOS	Oceans	1982	168	60	143	Two-thirds or 60; three-quarters for Seabed	No
Vienna Convention	Atmospheric Ozone	1985	197	20	44	Three-quarters	No

[212] Convention on Cybercrime, arts. 42–43, Nov. 23, 2001, 2296 U.N.T.S. 167, https://www.coe.int/en/web/conventions/full-list/-/conventions/treaty/185; *see* VOGLER, *supra* note 165, at 159 (discussing "soft laws" that enable nations to opt out of certain treaty provisions).

[213] Convention on Cybercrime, *supra* note 212, at 190.

[214] *See, e.g.*, *Cyber Norms Index*, CARNEGIE ENDOWMENT INT'L PEACE, https://carnegieendowment.org/publications/interactive/cybernorms (last visited Oct. 18, 2019); *see* INT'L TELECOMM. UNION, UNDERSTANDING CYBERCRIME: PHENOMENA, CHALLENGES AND LEGAL RESPONSE 11 (2012) (listing other relevant model laws, including the Commonwealth Model Law on Computer and Computer-related Crime).

Montreal Protocol	Ozone	1987	197	11	15	20	No
UNFCCC	Climate	1992	197	50	21	Three-quarters	No
Paris Agreement	Climate	2015	197	55	11	Three-quarters	No
Kyoto Protocol	Climate	1995	192	*Marrakesh Accords	99	Three-quarters	No
Outer Space Treaty	Outer Space	1967	107	5	8	Simple majority	Yes
Rescue Agreement	Rescue of astronauts	1968	96	3	7	All	No
Liability Convention	Definition of liability	1972	95	5	6	Simple majority	No
Registration Convention	Establish registration requirements	1976	67	5	20	Simple majority	No
Cybercrime Convention	Cybercrime	2004	61	5	31	All	Yes
Moon Treaty	Governance of Moon	1984	18	5	55	None	No

Table 1: Summary of Principal International Agreements Governing the Frontiers[215]

It should be noted that these data summarized in Table 1 represent a small sampling of the hundreds of multilateral and minilateral agreements that govern

[215] These data reflect the status of treaties as of August 2018. Table adapted from Professor John Vogler. JOHN VOGLER, THE GLOBAL COMMONS: ENVIRONMENTAL AND TECHNOLOGICAL GOVERNANCE 157 (2d ed. 2000), and updated from data available at: the International Maritime Organization, the United Nations, International Whaling Commission, the Secretariat of the Antarctic Treaty, and the London Convention and Protocol. U.N. OFF. OUTER SPACE AFF., U.N. TREATIES AND PRINCIPLES ON OUTER SPACE, U.N. Doc. ST/SPACE/11/Rev.2, U.N. Sales No. E.08.I. 10 (2008); International Convention for the Prevention of Pollution from Ships art. 13, *opened for signature* Jan. 15, 1974, 12 I.L.M. 1319; *All Ratifications*, U.N. ENV'T PROGRAMME, https://ozone.unep.org/all-ratifications (last visited Oct. 13, 2019); *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, INT'L MAR. ORG., http://www.imo.org/en/OurWork/Environment/LCLP/Pages/default.aspx (last visited Oct. 18, 2019); *Membership and Contracting Governments*, INT'L WHALING COMMISSION, https://iwc.int/members (last visited Oct. 18, 2019); *Parties*, SECRETARIAT OF THE ANTARCTIC TREATY, https://www.ats.aq/devAS/Parties?lang=e (last visited Dec. 19, 2019) (including only consultative and not the then 24 non-consultative parties); *Status of Treaties*, INT'L MAR. ORG., http://www.imo.org/en/About/Conventions/StatusOfConventions/Pages/Default.aspx (last visited Dec. 19, 2019); *United Nations Convention on the Law of the Sea*, U.N. TREATY COLLECTION, https://treaties.un.org/pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XXI-6&chapter=21&Temp=mtdsg3&clang=_en (last visited Oct. 18, 2019).

these frontiers.[216] It is not uncommon for such agreements to be regional in scope, or to have only vague objectives, making the measurement of effectiveness all the more challenging. Where member nations have conducted self-evaluations, such as for the 1985 Montreal Guidelines on Land-based Sources of Marine Pollution and the 1982 Guidelines for Offshore Mining, results have been mixed.[217] Reservations are also common in many of these accords, such as the 1944 Chicago Convention, and the 1979 Convention on Long-term Transboundary Air Pollution. Enforcement provisions are often lacking in many legal regimes governing the frontiers, as are information sharing and verification provisions pointing to the need for enhanced persuasion and shaming of violators. Overall, results of regime effectiveness have been varied, with self-reinforcing success stories like the Montreal Protocol, MARPOL, the ITU, the Budapest Convention, and the Antarctic Treaty being offset by the ongoing problems of climate change, space weaponization, marine pollution, and cyber attacks.[218]

These results highlight the fact that the most effective multilateral regime governing a classic global commons space is arguably the Law of the Sea, supplemented with the expanding polycentric governance structures such as those at work in the Arctic. This conclusion is primarily drawn from the success of UNCLOS since 1994 as shown by its widespread ratification, the growing acceptance of ISA, and ongoing activities of CLCS, which stand in contrast to the relative dearth of similar multilateral progress in space law after the Moon Treaty. However, the fact that reservations are barred in space law treaties, save for the OST, demonstrates that they are in fact relatively strong compared to accords like MARPOL.

Climate regime effectiveness is also, one could argue, showing some resilience given that the Paris Agreement took only 11 months to enter into force, does not allow reservations, and now boasts near universal membership.[219] Although the Agreement has yet to bring about the scale of emissions reductions necessary to mitigate worst-case climate change scenarios,[220] the polycentric structure of the accord has helped it achieve widespread acceptance in a relatively short time period. Moreover, the success of the Montreal Protocol in not only reaching universal ratification

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[216] VOGLER, *supra* note 215, at 157.

[217] *See* SAND, *supra* note 93, at 9.

[218] VOGLER, *supra* note 215, at 170.

[219] *See Paris Agreement*, U.N. TREATY COLLECTION, https://treaties.un.org/doc/Publication/MTDSG/Volume%20II/Chapter%20XXVII/XXVII-7-d.en.pdf (last visited Oct. 18, 2019).

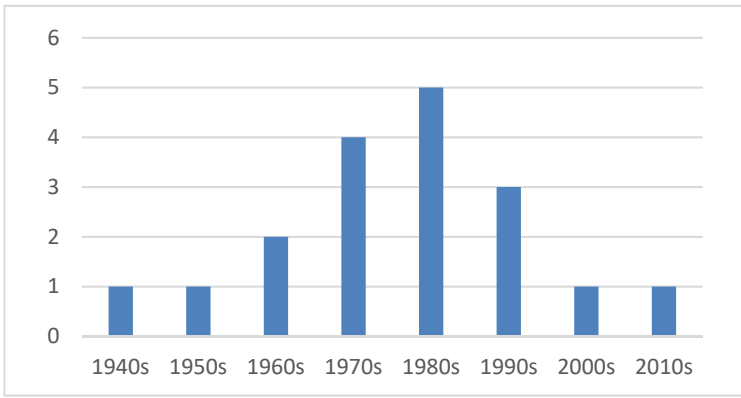
[220] *See* Somini Sengupta, *U.N. Chief Warns of a Dangerous Tipping Point on Climate Change*, N.Y. TIMES (Sept. 10, 2018), https://www.nytimes.com/2018/09/10/climate/united-nations-climate-change.html.

but in actually making impressive strides toward fixing the problem it was designed to manage—the then-growing hole in the ozone—cannot be denied.[221]

Although there has been important progress in global cybersecurity law since the early 2000s, as seen by the *Tallinn Manual* process, the fact that the Budapest Convention now boasts more than 60 members, and the array of cyber norms catalogued by Carnegie and others, the failure of the 2017 UN GGE round of negotiations means that it is important to catalyze further progress, as done through the Paris Call. This may be accomplished by building on the progress made possible by the Paris Accord process, which was catalyzed by the steady pronouncements of national action plans along with bilateral and regional initiatives.[222] The potential for such a Cyber Paris Accord and a U.N. Framework Convention for Cyber Peace is analyzed below.[223]

In general, the rate of multilateral regulation governing the frontiers seems to have peaked from 1972 to the late 1980s and is now decreasing as seen in Figure 2, which is derived from the admittedly incomplete data in Table 1 but is consistent with the difficulties of multilateral rulemaking in an increasingly multipolar world.[224]

Figure 2: Governing the Frontiers by Number of Principal Multilateral Agreements Per Decade



[221] *See* David Freeman, *The Good News About the Ozone Hole Is Even Better Than You Think*, NBC (Jan. 9, 2018), https://www.nbcnews.com/mach/science/good-news-about-ozone-hole-even-better-you-think-ncna835971.

[222] *See, e.g.*, Jeff Tollefson, *UN Gets First Pledges on Road to Paris Climate Talks*, NATURE (Apr. 1, 2015), http://www.nature.com/news/un-gets-first-pledges-on-road-to-paris-climate-talks-1.17247 ("The United States officially pledged on 31 March to reduce its greenhouse-gas emissions to 26–28% below 2005 levels by 2025, meeting the United Nations' recommended deadline for submissions.").

[223] *See* Nazli Choucri, *The Convergence of Cyberspace and Sustainability*, E-INT'L REL. (Apr. 20, 2012), https://www.e-ir.info/2012/04/20/the-convergence-of-cyberspace-and-sustainability/.

[224] SAND, *supra* note 93, at 11.

From an international relations perspective, which is more concerned with the extent to which regimes transfer authority from a national to an international level than international law, this study has shown that many regimes governing the frontiers are relatively weak. Establishing supranational organizations to manage the frontiers has been met with little political support outside the deep seabed context as seen in the common heritage authority debates during the Moon Treaty negotiations and the subsequent slow pace at which that Agreement was ratified.[225] Although the International Seabed Authority may yet buck this trend, in many cases, rather than creating new global governance structures, nations are instead opting to enclose the frontiers, from continental shelves to cyberspace.[226]

Overall, though, despite increases in orbital debris, oceanic pollution, carbon emissions, and cyber attacks, these legal regimes are arguably better than the alternative—a truly open access system. Though, no portion of the frontiers has yet reached its normative potential, meaning regimes that sustainably, equitably, and peacefully manage global commons pool resources. To that end, the next section offers a brief proposal for conserving the classic global commons before moving on to discuss the potential of a new technology—blockchain—to promote trust and peace across the frontiers.

IV. CONSERVING THE COMMONS

The frontiers remain at a crossroads. Some groups, for example, prefer to see the CHM concept further curtailed even in the regions to which it applies, such as in the outer space context to human heritage sites such as the Apollo lunar landings.[227] But its continued relevance is highlighted not only by its place in treaty regimes governing the frontiers, including the deep seabed and the moon, but also by its continued relevance in contemporary debates, such as in regards to China's Belt and Road Initiative.[228] Ultimately, though, both a centralized CHM regime and a pure open access system have significant disadvantages in terms of sustainable and peaceful management of the frontiers. A middle ground could include provisions for clarifying property rights as well as applying lessons from the case studies to identify governance best practices. Before turning to cyberspace, consider, as a vehicle for discussing property rights reform in the classic global commons, the case study of the Moon Treaty, which demonstrated that property rights over vehicles, installations, *in situ* and returned resources, and even zones around habitats and

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[225] *See* VOGLER, *supra* note 215, at 100.

[226] Scott Jasper & Paul Giarra, *Disruptions in the Commons*, *in* SECURING FREEDOM IN THE GLOBAL COMMONS 1, 14 (Scott Jasper ed., 2010).

[227] *See* Michelle L.D. Hanlon, *Our Fear of "Heritage" Imperils Our Future*, SPACE REV. (Mar. 12, 2018), http://www.thespacereview.com/article/3450/1.

[228] *See* Keyuan Zou & Wenxian Qiu, *The Belt and Road Initiative and the Common Heritage of Mankind: Some Preliminary Observations*, 17 CHINESE J. INT'L L. 749, 750 (2018).

spacecraft may be accorded property rights. Property rights could be auctioned off in a free market to the first investor(s) to arrive at a new resource area, explore and occupy the territory, improve and manage it, and equitably share the benefits—this would be similar to how the ISA functions by making use of blockchain technology.[229]

This system would award adverse possession in line with the labor theory of value.[230] It would also have the effect of not only efficiently allocating property rights to those entities most capable of using them, but also raising capital that could be used to develop new infrastructure, sharing benefits with developing nations, and funding scientific studies. The space powers could require the inclusion of sustainable development provisions in polycentric governance structures such as those being encouraged by the U.N. Office of Outer Space Affairs to protect against the proliferation of environmental threats.[231] Public-private partnerships could be created to sustainably manage the exploitation of the final frontier with a percentage of the profits going to those in need as is envisioned in the deep seabed context. Specialized dispute resolution mechanisms could also be created to help resolve conflicts as called for by the Ostrom Design Principles and an updated form of tech transfer as seen through the establishment of innovation centers. Instead of ownership, then, a modified trust or common property leasehold arrangement could be adopted, giving tradable, exclusive rights for a set period of time. This would mean that the final frontier would not be enclosed, but developed for the benefit of all humanity, though reaching agreement on how such a system would operate in practice would doubtless be difficult given differing approaches to property rights.[232] Such a system, though, could benefit all humanity, maintain the pillars of the CHM concept enshrined in the sustainable development movement, and help promote international peace and security.

Without polycentric collaboration, the international community could face a collective prisoner's dilemma at the frontiers in which each government acts in its own best interest in the worst tradition of nationalism. Outright appropriation could have dire outcomes for international peace and security, potentially leading to confrontations over scarce resources.[233] Two options exist: cooperate or defect.

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[229] *See* Nelson, *supra* note 183, at 413–15.

[230] *See* HERNANDO DE SOTO, THE OTHER PATH: THE INVISIBLE REVOLUTION IN THE THIRD WORLD 40–42 (June Abbott trans., 1989).

[231] These could be explicitly designed to further the U.N. Sustainable Development goals. *See About the Sustainable Development Goals*, UNITED NATIONS, https://www.un.org/sustainabledevelopment/sustainable-development-goals/ (last visited Oct. 18, 2019).

[232] *See* Scott J. Shackelford, *Neither Magic Bullet Nor Lost Cause: Land Titling and the Wealth of Nations*, 21 N.Y.U. ENVTL. L.J. 272, 333–34 (2014).

[233] Deep Seabed Hard Mineral Resources Act of 1980, Pub. L. No. 96-283, §§ 2–3, 94 Stat. 553, 553–55 (codified as amended at 30 U.S.C. §§ 1401–1473 (2018)) (incorporating the CHM into U.S. law); *see also* Ronald Reagan, *Statement on United States Oceans Policy*, RONAL REAGAN

Game theory demonstrates that defection is individually beneficial but collectively suboptimal. Far-sighted clubs should impose sanctions on members that overexploit or misuse a CPR to limit defection. Future regimes for managing the frontiers should include this punitive power along with incentives to promote cooperation and conserve CPRs. At a more general level, applying the conceptual framework of polycentric governance to the frontiers underscores the importance of strengthening minilateral and regional partnerships by encouraging mutual reinforcement "to form an interlocking suite of governance systems" in which sustainability and peaceful use are central.[234] The Obama Administration recognized the importance of coupling national and international action to enhance cybersecurity, but a successful polycentric framework should take note of the Ostrom Design Principles, including effective monitoring, graduated sanctions, and efficient dispute resolution.[235]

Determining exactly what forms these polycentric structures should take is beyond the scope of this study, but the case studies have revealed at least five important aspects of successful polycentric systems that may be translated into policy proposals. First, practicing ecosystem-based management is important to ensure that the frontiers are managed as comprehensively as possible, which is especially critical in an era featuring increasing enclosure. Such an ecosystem-based approach is becoming increasingly popular in the cybersecurity context, as seen in the intersection between the sustainability and cybersecurity movements explored above. Second, persuasion and verification mechanisms are imperative to include in regional and multilateral initiatives to promote adherence to treaty provisions given the problem of enforcement in open access systems. Established polycentric systems, such as the Space Debris Mitigation Guidelines, should be made binding and established public-private partnerships should be deepened to better manage global collective action problems.[236] Third, tailored sustainable development principles and provisions for peaceful use should be included in instruments at all governance levels as an alternative to the CHM regimes, with shaming and dispute resolution being used by

PRESIDENTIAL LIBR. (Mar. 10, 1983), https://www.reaganlibrary.gov/research/speeches/31083c (United States declining to sign the United Nations Law of the Sea Convention).

[234] ARCTIC GOVERNANCE PROJECT, ARCTIC GOVERNANCE IN AN ERA OF TRANSFORMATIVE CHANGE: CRITICAL QUESTIONS, GOVERNANCE PRINCIPLES, WAYS FORWARD 13 (2010), http://arcticgovernance.custompublish.com/arctic-governance-in-an-era-of-transformative-change-critical-questions-governance-principles-ways-forward.4774756-156783.html) (discussing the regime complex comprising Arctic governance).

[235] *See* BUCK, *supra* note 38, at 31.

[236] *See* U.N. OFF. OUTER SPACE AFF., SPACE DEBRIS MITIGATION GUIDELINES OF THE COMMITTEE ON THE PEACEFUL USES OF OUTER SPACE (2010), http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

nations against violators of these principles.[237] Local, national, regional, and global intergovernmental authorities should work to define group boundaries by laying out the scope and powers of communities comprising regime complexes across the frontiers. This may be done organically through codes of conduct developed by communities such as the International Standards Organization and the ISA, which may then be subsequently reinforced by national and international regulation.[238] Fourth, addressing legal ambiguities and establishing norms of behavior are critical to defining graduated sanctions for rule violators and for fostering effective dispute resolution.[239] Fifth, promoting nested enterprises as part of a multilevel system of governance is central to building trust and securing the frontiers, including cyberspace. According to Professor Ostrom, this principle posits that larger institutions are important for "govern[ing] the interdependencies among smaller [governance] units,"[240] highlighting the need for effective multi-stakeholder governance with some degree of higher-order coordination.

There is also an array of specific policy proposals building from the case studies that may be enacted to better manage the collective action problems in the deep seabed and outer space. First, in the deep seabed context, UNCLOS Article 62 could be amended through an additional protocol to better define the requirements for sustainable development in Exclusive Economic Zones (EEZs),[241] as could Article 76 to clarify the CLCS process.[242] The successes of the Arctic Council should be replicated in other areas, using sustainable development as a foundational concept of regional engagement, as has occurred in the Arctic with the Nuuk Declaration establishing the Arctic Secretariat.[243] In the outer space context, the Moon Treaty could be amended to clarify the provision of property rights, as is described above, along the lines of the successful 1994 Amendments to UNCLOS. The COPUOS

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[237] *See, e.g.*, North American Agreement on Environmental Cooperation art. 10, ¶ 7, Sept. 14, 1993, 32 I.L.M. 1480; *id.* at art. 10, ¶ 2 (laying out the extent of the cooperative functions of the agreement).

[238] *See* Press Release, Office of the Press Sec'y, White House, Executive Order on Improving Critical Infrastructure Cybersecurity (Feb. 12, 2013), http://www.whitehouse.gov/the-press-office/2013/02/12/executive-order-improving-critical-infrastructure-cybersecurity-0 (discussing Obama Administration efforts aimed at identifying and instilling cybersecurity industry best practices to help secure vulnerable networks); *cf.* David Lacey, *Whither Cyber Security*, COMPUTER WKLY.: DAVID LACEYS IT SECURITY BLOG (June 29, 2013, 11:29 PM), http://www.computerweekly.com/blogs/david_lacey/2013/06/whither_cyber_security.html ("To stop advanced threats we need advanced countermeasures, not corporate governance systems.").

[239] *See* Ostrom, *supra* note 29, at 121.

[240] *Id.*

[241] Convention on the Law of the Sea, *supra* note 49, at 25.

[242] *Id.* at 33.

[243] Nuuk Declaration on the Seventh Ministerial Meeting of the Arctic Council (May 12, 2011), https://oaarchive.arctic-council.org/handle/11374/92.

Member States could also provide the organization with greater powers and incentives to cooperate, recapturing its status as a locus of governance that it enjoyed in the 1960s and 1970s. In addition, specialized forums in the vein of the Arctic Council could be established in the outer space context, such as a space forum in which the spacefaring powers could meet to manage common problems such as orbital debris. The Hague International Space Resources Governance Working Group is a useful step forward in this regard.[244] Innovation centers could be established in both contexts, as well as to address problems in atmospheric and internet governance, given their widespread support by developed nations. These, and other public-private partnerships, could help engage diverse stakeholders and contribute necessary resources to stressed organizations, such as the CLCS, to maintain their legitimacy.

Together, these proposals support those arguing for localized and minilateral solutions as at least interim measures to help better manage global collective action problems. These proposals are also in keeping with the 2002 Johannesburg Summit, which encouraged the formation of polycentric partnerships to disaggregate general sustainable development goals into specific, localized policies.[245] Successfully governing the frontiers in the twenty-first century requires clarifying property rights and encouraging the sustainable, peaceful use of global CPRs through polycentric governance structures. Preservation is possible either through active (e.g., legislative) or passive means. Regardless, it is imperative to proactively begin laying the groundwork for appropriate governance through polycentric means, such as by encouraging national, bilateral, and regional pledges to help build momentum toward global solutions, mirroring the Paris Accord process returned to below. It is similarly worth considering the utility of new technologies such as blockchain to help promote security and sustainable development across the frontiers.

V. IN BLOCKCHAIN WE TRUST

The potentially transformative power of blockchain technology has been well documented.[246] At its root, a blockchain is a "shared, trusted, distributed ledger that

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[244] *See Hague International Space Resources Governance Working Group*, UNIVERSITEIT LEIDEN: INT'L INST. AIR & SPACE L., https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-for-air-space-law/the-hague-space-resources-governance-working-group (last visited Oct. 18, 2019).

[245] *See* Rep. of the World Summit on Sustainable Dev., at 8, U.N. Doc. A/CONF.199/20 (2002).

[246] *See* Scott J. Shackelford & Steve Myers, *Block-by-Block: Leveraging the Power of Blockchain Technology to Build Trust and Promote Cyber Peace*, 19 YALE J.L. & TECH. 334, 378–79 (2017); Scott J. Shackelford et al., *Securing the Internet of Healthcare*, 19 MINN. J.L. SCI. & TECH. 405, 417–19 (2018).

everyone can inspect, but which no single user controls."[247] Participants work together to keep the distributed ledger updated.[248] Aside from myriad private-sector investments in this space,[249] nations such as Sierra Leone, Honduras, and Greece are also seeking to leverage blockchain to help enhance social capital by helping to build trust around common governance challenges such as land titling.[250] There have even been proposals for ocean health and climate coins.[251] This subsection briefly summarizes the promise of blockchain at the frontiers, separating the hype from reality, before proceeding to discuss its potential for promoting cyber peace in the evolving Internet of Everything.

Organizations can use blockchain technology to secure certificate authorities[252] and sustainably develop the frontiers, thus enhancing cyber security. Relevant proposals include those offered by Professor Bhagwan Chowdry and World Economic Forum (WEF) Oceans Conservationist Gregory Stone, who have suggested the creation of Ocean Health and Climate Coins.[253] The idea is that these "tokens would be issued to key stakeholders in the global climate problem," and they would use them to pay for carbon credits and to decrease pollution levels.[254] The WEF would maintain a reserve of the coins to help manage their value and could destroy them as needed, depending on reports from international scientific bodies.[255] Whether proposals for a Global Commons Coin (GCC) are realistic remains to be seen, but they do serve as a fresh means by which trust could be rebuilt on the part of disaffected individuals and institutions around the world.

Imagine for a moment how a coastal developing nation could use a blockchain-powered coin to offer each of its citizens an immutable monetary stake in any mining activity in its continental shelf with an account that could be accessed via smartphone. Or imagine how the ISA could do the same thing for landlocked nations such that they see direct economic benefits from deep seabed mining, which

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[247] *The Trust Machine; The Promise of the Blockchain*, ECONOMIST (Oct. 31, 2015), https://www.economist.com/leaders/2015/10/31/the-trust-machine.

[248] *Id.*

[249] Don Tapscott & Alex Tapscott, *Here's Why Blockchains Will Change the World*, FORTUNE (May 8, 2016), http://fortune.com/2016/05/08/why-blockchains-will-change-the-world.

[250] Adrianne Jeffries, *Governments Explore Using Blockchains to Improve Service*, N.Y. TIMES (June 27, 2018), https://www.nytimes.com/2018/06/27/business/dealbook/governments-blockchains-services.html; *see also* MICHAEL J. CASEY & PAUL VIGNA, THE TRUTH MACHINE: THE BLOCKCHAIN AND THE FUTURE OF EVERYTHING 6 (2018).

[251] CASEY & VIGNA, *supra* note 250, at 118.

[252] *See, e.g.*, DERRICK ROUNTREE, SECURITY FOR MICROSOFT WINDOWS SYSTEM ADMINISTRATORS: INTRODUCTION TO KEY INFORMATION SECURITY CONCEPTS 39 (Rodney Buike ed., 2011).

[253] CASEY & VIGNA, *supra* note 250, at 118.

[254] *Id.*

[255] *Id.* at 118–19.

is potentially far beyond the 50 cents per capita mentioned above.[256] Future generations could set up similar schemes to help power space commerce by awarding crypto credits. The technology could also help provide enhanced transparency regarding ownership as is already happening in national land registries. Such mechanisms could breathe new life into the core purpose of the CHM concept; that is, they could sustainably, peacefully, and equitably develop resources at the frontiers for the benefit of present and future generations.

In short, formidable hurdles remain before blockchain technology can be effectively leveraged to help promote sustainable development, peace, and security at the frontiers, including cyberspace. No blockchain, for example, has yet scaled to the extent necessary to search the entire web, and there are concerns over hacking and integrity, including the fact that innovation is happening so quickly that defenders are put in a difficult position as they try to build resilience into their distributed systems.[257] But the potential for progress demands further research, including how it could help promote cyber peace in the burgeoning Internet of Everything.

VI. SEEKING CYBER PEACE IN AN INTERNET OF EVERYTHING

The quest for security, privacy, and ultimately peace at the frontiers is ongoing and is becoming all the more imperative as technological advancements mean that frontiers that were beyond the reach of developers such as the deep seabed are now being explored, while other arenas are being expanded as seen in the rise of smart devices, which promise a new frontier of both innovation and insecurity connecting billions of devices and even our bodies together. Regardless of the number, the end result looks to be a mind-boggling explosion in internet-connected devices, which has implications for everything from the future of the knowledge commons to the security of satellites to whether we can ever be sure if our TV, toaster, or smart speaker is eavesdropping on us.[258]

These trend lines are converging to create an Internet of Everything, which may be understood as "the intelligent connection of people, process, data and things," whereas Internet of Things (IoT) is limited to "the network of physical objects accessed through the Internet."[259] This broader lens is vital for considering the myriad security and privacy implications of smart devices becoming replete throughout society and our lives. It should be noted, though, that there are other

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[256] *See* CHURCHILL & LOWE, *supra* note 86, at 194.

[257] *See* John Villasenor, *Blockchain Technology: Five Obstacles to Mainstream Adoption*, FORBES (June 3, 2018), https://www.forbes.com/sites/johnvillasenor/2018/06/03/blockchain-technology-five-obstacles-to-mainstream-adoption/#6979b4955ad2.

[258] *See, e.g.*, Brian Barrett, *How to Stop Your Smart TV From Spying on You*, WIRED (Feb. 7, 2017), https://www.wired.com/2017/02/smart-tv-spying-vizio-settlement/.

[259] Ahmed Banafa, *The Internet of Everything*, OPEN MIND (Aug. 29, 2016), https://www.bbvaopenmind.com/en/the-internet-of-everything-ioe.

conceptions of this same idea. Some have simply called it "Internet+."[260] Others, such as former Google CEO Eric Schmidt, have argued that "the Internet will disappear" given the growing ubiquity of smart devices.[261] Regardless of what we call it, as Schneier argued:

> The point is that innovation in the Internet+ world can kill you. We chill innovation in things like drug development, aircraft design, and nuclear power plants because the cost of getting it wrong is too great. We're past the point where we need to discuss regulation versus no-regulation for connected things; we have to discuss smart regulation versus stupid regulation.[262]

Participants at the 2018 Black Hat cybersecurity conference shared Schneier's concerns: 93% of respondents said that they "saw the future of IoT not necessarily as something smarter, but more dangerous, as they predict nation states will target or exploit connected devices in their droves over the coming year."[263] Yet, for all the press that the IoT has received, it remains a topic little understood or appreciated by the public. One 2014 survey found that fully 87% of respondents had never even heard of the "Internet of Things."[264]

So, what is to be done? An array of public-private partnerships (such as the National Institute for Standards and Technology (NIST) Cybersecurity Framework (CSF)), efforts by civil society (such as the *Consumer Reports* Digital Standard), national governments (such as the UK's Cyber Essentials Plus Certificate), and EU schemes are all being pursued to help harden the Internet of Everything. Space constraints prohibit a thorough exploration of the benefits and drawbacks of each of these approaches.[265] Both purely voluntary and overly regulatory approaches to cybersecurity policymaking contain significant downsides.[266] That is in part why Professor Ostrom has argued that polycentric regulation is "the best way to address

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[260] Martin Giles, *For Safety's Sake, We Must Slow Innovation in Internet-Connected Things*, MIT TECH. REV. (Sept. 6, 2018), https://www.technologyreview.com/s/611948/for-safetys-sake-we-must-slow-innovation-in-internet-connected-things/.

[261] Christina Medici Scolaro, *Why Google's Eric Schmidt Says the "Internet will Disappear,"* CNBC (Jan. 23, 2015), https://www.cnbc.com/2015/01/23/why-googles-eric-schmidt-says-the-internet-will-disappear.html.

[262] Giles, *supra* note 260.

[263] Charlie Osborne, *The Future of IoT? State-Sponsored Attacks, Say Security Professionals,* ZDNET (Aug. 13, 2018), https://www.zdnet.com/article/the-future-of-iot-state-sponsored-attacks-say-security-professionals/.

[264] *See* Chris Merriman, *87 Percent of Consumers Haven't Heard of the Internet of Things*, INQUIRER (Aug. 22, 2014), https://www.theinquirer.net/inquirer/news/2361672/87-percent-of-consumers-havent-heard-of-the-internet-of-things.

[265] *See* Shackelford, *supra* note 51, at 510–11.

[266] *See* Bruno S. Frey & Felix Oberholzer-Gee, *The Cost of Price Incentives: An Empirical Analysis of Motivation Crowding-Out*, 87 AM. ECON. REV. 746, 753–54 (1997); Elinor Ostrom, *Beyond Markets and States: Polycentric Governance of Complex Economic Systems*, 100 AM. ECON.

transboundary problems . . . since the complexity of these problems lends itself well to many small, issue-specific units working autonomously as part of a network that is addressing collective action problems. It is an application of the maxim, 'think globally, but act locally.'"[267] Suffice it to say, what is needed, building from a polycentric model, is an "all of the above" approach to promoting cyber peace, which in turn could ultimately improve governance across the frontiers, including in the Internet of Everything.

Aside from laws and norms, the competitive market is crucial to promoting polycentric governance and cyber peace, as was discussed in Parts II and III. Enterprises acting as norm entrepreneurs such as Microsoft, Google, and Facebook have built proactive methods for threat management that can help inform policymaking,[268] as happened in the context of the NIST CSF.[269] There are immediate and long-term benefits for firms taking such a proactive cybersecurity stance—that is, building it in from the start rather than bolting it on after the fact, by, for example, exploring active defense.[270] Surveys have shown that firms that invest in "a more favorable security posture" pay less per compromised record than those that do not.[271] However, the type and extent of investment must be analyzed using robust information-sharing mechanisms to instill technical, budgetary, and organizational best practices.[272] Owing to the rising cost of cyber attacks along with regulatory trends, such as the European Union's groundbreaking General Data Protection Regulation (GDPR), important progress is being made, including the harmoniza-

REV. 641, 656 (2010); Andrew F. Reeson & John G. Tisdell, *Institutions, Motivations and Public Goods: An Experimental Test of Motivational Crowding*, 68 J. ECON. BEHAV. & ORG. 273, 280 (2008) ("[Our] experiments provide support for the hypothesis that experience of a formal institution can crowd out voluntary contributions to a public good.").

[267] SCOTT J. SHACKELFORD, MANAGING CYBER ATTACKS IN INTERNATIONAL LAW, BUSINESS, AND RELATIONS 96 (2014).

[268] *See* ANNEGRET FLOHR ET AL., THE ROLE OF BUSINESS IN GLOBAL GOVERNANCE: CORPORATIONS AS NORM-ENTREPRENEURS 10 (2010).

[269] For more on this topic, see Scott J. Shackelford et al., *How Businesses Can Promote Cyber Peace*, 36 U. PA. J. INT'L L. 353, 359–60 (2014).

[270] *See* Amanda N. Craig, Scott J. Shackelford & Janine S. Hiller, *Proactive Cybersecurity: A Comparative Industry and Regulatory Analysis*, 52 AM. BUS. L.J. 721, 831 (2015).

[271] PONEMON INST., 2010 ANNUAL STUDY: U.S. COST OF A DATA BREACH 7 (2011), https://www.symantec.com/content/en/us/about/media/pdfs/symantec_ponemon_data_breach_costs_report.pdf; PONEMON INST., IBM, 2018 COST OF A DATA BREACH STUDY: GLOBAL OVERVIEW 7, 9–10 (2018).

[272] For a rundown on these cybersecurity best practices, see U.S. FED. TRADE COMM'N, PROTECTING PERSONAL INFORMATION: A GUIDE FOR BUSINESS (2016), https://www.ftc.gov/tips-advice/business-center/guidance/protecting-personal-information-guide-business (last visited Oct. 18, 2019).

tion of cybersecurity due diligence. GDPR Articles 40 and 41, for example, encourage the development of codes of conduct.[273] Norm entrepreneurs are developing such agreements, such as the Microsoft-led Cybersecurity Tech Accord[274] and the Trusted IoT Alliance.[275] These forums can be vital in the exchange of cybersecurity best practices that are necessary but not sufficient to promote cyber peace.

At the next governance level up, governments can do more to promote the cyber hygiene of their citizens and the cybersecurity due diligence of their public and private sectors. There is a huge variety of ideas to leverage the power of national governments—and international law—to promote cyber peace. Relevant concepts include the establishment of a Cyber Peace Corps, a National Cybersecurity Safety Board, or even an International Criminal Tribunal for Cyberspace.[276] Globally, these discussions are happening through the lens of cybersecurity due diligence.[277] Though there is not one definitive definition of cybersecurity "due diligence," just as there is not one definition for "cyber peace." For purposes of this study it is considered to be an obligation under international law that calls for a certain "form of conduct" from a nation to be in line with its international law obligations toward other states.[278]

For cybersecurity due diligence and cyber peace to reach their potential, more robust enforcement mechanisms must be put into place, as was stated in the U.N. Group of Governmental Experts (GGE) statement committing states to "stop [cyber] attacks that emanate from their territories and also commit to not deliberately damaging other countries' critical infrastructure or IT emergency teams."[279] Yet participants in the U.N. GGE process only stated that they "should" exercise

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[273] *See* Rita Heimes, *Top 10 Operational Impacts of the GDPR: Part 9 - Codes of Conduct and Certifications*, PRIVACY ADVISOR (Feb. 24, 2016), https://iapp.org/news/a/top-10-operational-impacts-of-the-gdpr-part-9-codes-of-conduct-and-certifications/.

[274] *See About the Cybersecurity Accord*, TECH ACCORD, https://cybertechaccord.org/about/ (last visited Oct. 18, 2019).

[275] *See Securing IoT Products with Blockchain*, TRUSTED IOT ALLIANCE, https://www.trusted-iot.org (last visited Oct. 18, 2019).

[276] *See* Janaki Chadha, *Three Ideas for Solving the Cybersecurity Skills Gap*, WALL STREET J. (Sept. 19, 2018), https://www.wsj.com/amp/articles/three-ideas-for-solving-the-cybersecurity-skills-gap-1537322520; Scott J. Shackelford, *What Cybersecurity Investigators Can Learn from Airplane Crashes*, CONVERSATION (Feb. 21, 2018), https://theconversation.com/what-cybersecurity-investigators-can-learn-from-airplane-crashes-91177; Scott J. Shackelford, *Is It Time for a Cyber Peace Corps?*, CONVERSATION (Oct. 25, 2017), https://theconversation.com/is-it-time-for-a-cyber-peace-corps-85721.

[277] *See* Scott J. Shackelford et al., *Unpacking the International Law on Cybersecurity Due Diligence: Lessons from the Public and Private Sectors*, 17 CHI. J. INT'L L. 1, 4 (2016).

[278] Nicholas Tsagourias, *Economic Cyber Espionage and Due Diligence*, SYRACUSE U. CONTROLLING ECON. CYBER ESPIONAGE WORKSHOP (May 2015), http://insct.syr.edu/wp-content/uploads/2015/06/Tsagourias_Due_Diligence.pdf.

[279] ANNEGRET BENDIEK, DUE DILIGENCE IN CYBERSPACE 31 (2016).

due diligence through measures that are "reasonably available and practical" rather than that they "must do so and only then when a state *knows* of the transboundary harm; this is unfinished business to be taken up in the 2019 U.N. GGE process."[280] It should be noted, though, that the G7 has maintained that "no country should conduct or knowingly support ICT [information and communication technology]-enabled theft of intellectual property"[281] and that all nations should "preserve the global nature of the Internet."[282] In 2015, the G20 similarly stated that: (1) "international law, including the United Nations (UN) Charter, applies to nation-state conduct in cyberspace"; and (2) that "no country should conduct or support the cyber-enabled theft of intellectual property."[283]

There have also been various proposals to codify these principles into new human rights and cybersecurity treaties.[284] However, such efforts will likely face similar political and technical hurdles, including issues of attribution and verification,[285] limiting their contribution. Bilateral relationships such as the G2 (U.S. and China), minilateral clubs (including the Five Eyes, NATO, and the European Union), and ultimately the international community must also be proactive in this polycentric effort to spread cybersecurity due diligence and promote cyber peace. These polycentric forums are proving invaluable for minilateral norm building that is helping to crystallize state practice. Overall, this form of polycentric undertaking is similar to efforts from the Guiding Principles on Business and Human Rights (Guiding Principles) Framework approach, authored by Professor John Ruggie, which en-

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[280] *See* Eric Talbot Jensen, *The Tallinn Manual 2.0: Highlights and Insights*, 48 GEO. J. INT'L L. 735, 745 (2017).

[281] G7 ISE-SHIMA LEADERS' DECLARATION 15 (2016), https://www.mofa.go.jp/files/000160266.pdf.

[282] G7 PRINCIPLES AND ACTIONS ON CYBER 2 (2016), https://www.mofa.go.jp/files/000160279.pdf.

[283] Christopher Painter, *G20: Growing International Consensus on Stability in Cyberspace*, U.S. DEP'T ST. OFFICIAL BLOG (Dec. 3, 2015), http://2007-2017-blogs.state.gov/stories/2015/12/03/g20-growing-international-consensus-stability-cyberspace.html.

[284] *See, e.g.*, Robert C. Bird & Daniel R. Cahoy, *Human Rights, Technology, and Food: Coordinating Access and Innovation for 2050 and Beyond*, 52 AM. BUS. L.J. 435, 468 (2015); *Binding Treaty*, BUS. & HUM. RTS. RESOURCE CTR., http://business-humanrights.org/en/binding-treaty (last visited Oct. 18, 2019). *But see* JOHN G. RUGGIE, HARV. KENNEDY SCH., A UN BUSINESS AND HUMAN RIGHTS TREATY? 3 (2014), https://www.business-humanrights.org/en/pdf-a-un-business-and-human-rights-treaty-an-issues-brief-by-john-g-ruggie (noting that this proposal might "end in largely symbolic gestures, of little practical use to real people in real places, and with high potential for generating serious backlash against any form of further international legalization in this domain").

[285] *See, e.g.*, Mark Pomerleau, *Why WMD-Like Treaties Are Unlikely with Cyber*, DEF. SYS. (May 25, 2016), https://defensesystems.com/articles/2016/05/25/painter-wmd-type-treaties-not-likely-with-cyber.aspx.

courages greater stakeholder buy-in from diverse organizations rather than a multilateral, top-down approach to promoting human rights in business practices.[286] Such an approach could also aid in norm building by norm entrepeneurs, including having leading businesses and governments announcing efforts that could eventually cause a "norm cascade" in which cybersecurity best practices become internalized and eventually codified in national and international laws.[287] Ultimately, though, the trick is finding the appropriate "balance between simplicity and complexity" to better leverage the power of polycentric governance to promote cyber peace.[288]

The private sector and civil society have stepped in to help advance the field of cyber peace given public-sector fissures on the topic.[289] Such polycentric efforts can help build momentum toward a potential agreement on cyber peace. This may be envisioned as an effort to build from the Paris Accord model, in which individual nations and clubs could announce "Cyber Peace Pledges" to help build momentum toward global agreements on critical infrastructure protection (including making democracy harder to hack),[290] IoT governance,[291] cybercrime and terrorism investigations, and other important emerging arenas such as blockchain governance.[292] Such steps would help further the U.N.'s Sustainable Development goals, which include not only promoting internet access as a tool to promote economic development, but also addressing climate change, oceanic pollution, and promoting international peace and security.[293] Relatedly, such polycentric efforts could further advance an array of human rights, both online and offline, including the emerging right to privacy in the digital age and even a human right to cybersecurity.[294]

Ultimately, further agreement is needed on the scope of cyber peace. The U.S. government's position on such an end goal is a vision of cyberspace that is "open,

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[286] *See, e.g.*, RUGGIE, *supra* note 284, at 5.

[287] *See* Martha Finnemore & Kathryn Sikkink, *International Norm Dynamics and Political Change*, 52 INT'L ORG. 887, 895–97 (1998).

[288] Michael D. McGinnis, *Elinor Ostrom: Politics as Problem-Solving in Polycentric Settings*, *in* 1 ELINOR OSTROM AND THE BLOOMINGTON SCHOOL OF POLITICAL ECONOMY 285 (Daniel H. Cole & Michael D. McGinnis eds., 2015).

[289] *See, e.g.*, Hinck, *supra* note 192.

[290] For more on this topic, see Scott J. Shackelford et al., *Making Democracy Harder to Hack*, 50 U. MICH. J.L. REFORM 629, 659–61 (2017).

[291] *See* Shackelford & Craig, *supra* note 148.

[292] *See* Shackelford & Myers, *supra* note 246, at 379–80.

[293] U.N. OFF. OUTER SPACE AFF., *supra* note 236.

[294] *See* Scott J. Shackelford, *Should Cybersecurity Be a Human Right?*, CONVERSATION (Feb. 13, 2017), https://theconversation.com/should-cybersecurity-be-a-human-right-72342.

interoperable, reliable, and secure."[295] To reach those ends, though, the Trump Administration focuses on an approach of "peace through strength,"[296] which includes an emphasis on adherence to global cybersecurity norms, along with enhanced deterrence capabilities.[297] But it does not ignore the importance of promoting human rights in cyberspace, building from President Franklin D. Roosevelt's 1941 "Four Freedoms" speech that former Secretary of State Hillary Clinton explored in 2011, including the promotion of a cyberspace that promotes "freedom of expression, freedom of worship, freedom from want, and freedom from fear."[298] This understanding forms one component of the working definition of cyber peace, which is a global, just, and sustainable level of cybersecurity "that respects human rights, spreads Internet access along with best practices, and strengthens governance mechanisms by fostering multi-stakeholder collaboration."[299] Other commentators have defined cyber peace differently, such as "a state where immoral acts have limited effects . . . . [It] is a system property of cyberspace such that the effects of malicious activities can be contained."[300] What is clear is that more work is needed to define the end goal—what is the best we can hope for in terms of peace on the internet, and how may we be able to achieve that laudable end? Luckily, there is an emerging ecosystem of organizations engaged in this effort, including the Online Trust Alliance,[301] Cyber Peace Alliance,[302] ICT4Peace,[303] the Paris Peace Forum, and the Ostrom Workshop's Cyber Peace Working Group.[304] There is even growing support for movements such as a Cyber Peace Corps, which builds from successful programs such as

[295] WHITE HOUSE, NATIONAL CYBER STRATEGY OF THE UNITED STATES OF AMERICA I (2018), https://www.whitehouse.gov/wp-content/uploads/2018/09/National-Cyber-Strategy.pdf.

[296] *Id.* at 20.

[297] *Id.* at 21.

[298] Hillary Rodham Clinton, U.S. Sec'y of State, Remarks on Internet Freedom (Jan. 21, 2010) (transcript available at https://2009-2017.state.gov/secretary/20092013clinton/rm/2010/01/135519.htm) (emphasizing the need for behavioral norms and respect among states to encourage the free flow of information and protect against cyber attacks).

[299] SHACKELFORD, *supra* note 67, at xxvi.

[300] Florian Demont-Biaggi, *Introduction*, *in* THE NATURE OF PEACE AND THE MORALITY OF ARMED CONFLICT 1, 11 (Florian Demont-Biaggi ed., 2017).

[301] *See* ONLINE TRUST ALLIANCE, https://www.internetsociety.org/ota/ (last visited Oct. 18, 2019).

[302] *See Cybersecurity and Internet Governance*, IND. U. BLOOMINGTON: OSTROM WORKSHOP, https://ostromworkshop.indiana.edu/research/internet-cybersecurity/index.html (last visited Oct. 18, 2019); CYBER FUTURE FOUND., http://cyberfuturefoundation.org/ (last visited Oct. 18, 2019).

[303] *What We Do*, ICT4 PEACE FOUND., https://ict4peace.org/what-we-do/ (last visited Oct. 18, 2019).

[304] For information on the Cyber Peace Working Group, see *Cybersecurity and Internet Governance*, *supra* note 302.

the Peace Corps and AmeriCorps.[305] This effort could be mirrored around the world.

What other options exist to promote cybersecurity beyond adapting existing treaties? Some argue for promoting active defense with its attendant dangers of international instability and escalation.[306] Already, the U.S. government has taken a step in this direction by permitting U.S. Cyber Command to "hack back" without prior presidential approval.[307] As this Part has discussed, a perhaps more useful analogy to explore is that of sustainable development. But the long march to cyber peace is just beginning.

As Rachel Carson famously said in *Silent Spring*:

> We stand now where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road—the one less travelled by—offers our last, our only chance to reach a destination that assures the preservation of the earth.[308]

We could equally add cyberspace to this conception. Down one path lies continued cyber insecurity, made more daunting by the ever-expanding Internet of Everything. Down the other is a more sustainable cybersecurity in which the power of polycentric principles has been fully harnessed to promote cyber peace. The choice is up to us.

CONCLUSION

International law changes with events. As Justice Oliver Wendell Holmes wrote: "The life of the law has not been logic: it has been experience."[309] It is essential for policymakers to consider the full range of global collection action problems emanating from the frontiers. New technologies such as blockchain should be harnessed while being mindful of their limitations to help rebuild trust in legal concepts that are still emerging, as is happening now with the transition from the CHM concept to sustainable development. But it is equally necessary for scholars, jurists, and

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[305] *See supra* note 276.

[306] *See* Christopher C. Joyner & Catherine Lotrionte, *Information Warfare as International Coercion: Elements of a Legal Framework*, 12 EUR. J. INT'L L. 825, 857–58 (2001).

[307] David E. Sanger, *Pentagon Puts Cyberwarriors on the Offensive, Increasing Risk of Conflict*, N.Y. TIMES (June 17, 2018), https://www.nytimes.com/2018/06/17/us/politics/cyber-command-trump.html.

[308] RACHEL CARSON, SILENT SPRING 277 (1962).

[309] OLIVER WENDELL HOLMES, JR., THE COMMON LAW 1 (Little, Brown and Co. 1938) (1881).

negotiators to place a greater emphasis on developing and clarifying the international law at the frontiers, including the law of cyber peace.[310] Important work, including *Tallinn 2.0*, has contributed to this effort, but much more remains to be done, particularly with regards to ascertaining the status of customary international cybersecurity law based on data about state practice, and the overall regime effectiveness of various laws governing the frontiers, including cyberspace. Existing regimes should not be abandoned or their value underappreciated, but the international community should also not fear trying out novel governance structures. It would serve us well to bolster the process of legal clarification and norm building now. In the end, it is collectively in the best interests of all nations to cooperate, not defect—in no small part because we all live in glass houses in cyberspace, and the rocks just keep getting bigger.

The frontiers are full of tales that can inspire us to strive, to seek the impossible and to excel, even if our original goals are never attained. That is, in essence, the story of Ernest Shackleton, a famous Antarctic explorer whose ship, *Endurance*, and its crew became stranded in an ice flow short of Antarctica for almost two years. Even though their mission can be deemed a failure—none of his crew ever set foot in Antarctica, for example—we still remember it today because of the perseverance shown by Shackleton and his men.[311] "Optimism is true moral courage," he famously remarked.[312] We must similarly be optimistic about the prospects for a sustainable peace, both online and offline, for if we together strive with confidence but fall short, we will nevertheless be in a far better place and perhaps will have gained important new insights along the way. After all, as the engineer Charles F. Kettering has said: "Where there is an open mind, there will always be a frontier."[313]

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[310] *See* Mary Ellen O'Connell, *Cyber Security Without Cyber War*, 17 J. CONFLICT & SECURITY L. 187, 187–88 (2012).

[311] *See* Nancy F. Koehn, *Leadership Lessons From the Shackleton Expedition*, N.Y. TIMES (Dec. 24, 2011), https://www.nytimes.com/2011/12/25/business/leadership-lessons-from-the-shackleton-expedition.html.

[312] LEONARD SWEET, SUMMONED TO LEAD 45 (2004).

[313] EDWARD B. BARBIER, SCARCITY AND FRONTIERS: HOW ECONOMIES HAVE DEVELOPED THROUGH NATURAL RESOURCE EXPLOITATION (2011).