COORDINATING LOCAL ADAPTIVE STRATEGIES THROUGH A NETWORK-BASED APPROACH

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As the impacts of climate change become increasingly destructive and pervasive, climate adaptation has received greater political and academic attention. The traditional top-down model for mitigating climate change, however, is ill-suited to implementing effective adaptation strategies. Yet, local communities most impacted by climate change seldom have the tools and resources to develop effective adaptive strategies on their own. This note argues that a bottom-up, network-based approach could be a promising paradigm towards implementing effective adaptive strategies and empowering affected communities.

I. INTRODUCTION

Confronted with the impacts of climate change, a growing number of communities are pursuing adaptation and resilience strategies.[1] Bangladesh is a case in point. With a large and growing population,[2] a

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1. "Adaptation" is used in different contexts and can mean a wide range of strategies. *See, e.g.*, *Climate Change Adaptation Definitions*, VICTORIAN CTR. FOR CLIMATE CHANGE ADAPTATION RES., http://www.vcccar.org.au/climate-change-adaptation-definitions (last visited Apr. 22, 2018) (listing definitions provided by governments and major international bodies). *See generally* ROB SWART, ROBBERT BIESBROEK, SVEND BINNERUP, TIMOTHY R. CARTER, CAROLINE COWAN, THOMAS HENRICHS, SOPHIE LOQUEN, HANNA MELA, MICHAEL MORECROFT, MORITZ REESE & DANIELA REY, PARTNERSHIP FOR EUROPEAN ENVIRONMENTAL RESEARCH (PEER), PEER REPORT 1: EUROPE ADAPTS TO CLIMATE CHANGE: COMPARING NATIONAL STRATEGIES (2009) (listing a wide range of adaptation strategies). This paper uses the term to refer to conventional strategies that aim to modify human activities in response to environmental risks, and not strategies that attempt to modify the environment itself, such as geoengineering.

2. *See* Saleemul Huq & James Totton, *Basket Case No More? Bangladesh's Successes Portend Resilience in Face of Change*, WOODROW WILSON INT'L CTR. FOR SCHOLARS: NEW SECURITY BEAT (Feb. 17, 2014), https://www.newsecuritybeat.org/2014/02/basket-case-more-bangladeshs-development-successes-portend-resilience-face-change/ (noting that "[a]fter independence, Bangladesh's population growth rate was one of the highest in the world").

heavy dependence on agriculture,[3] and a geographic location particularly prone to extreme weather events,[4] Bangladesh is among the countries most vulnerable to sea level rise and other climate-related impacts.[5] At the same time, it is also one of the most informed countries about adapting to climate change.[6] With its effective emergency warning system, Bangladesh has been able to drastically reduce casualties from natural disasters,[7] and it has heavily invested in long-term resilience building by reducing poverty, promoting education for women, and ensuring food security through agricultural innovations.[8]

National governments are not the only actors adapting to climate change. In recent years, subnational communities adopting adaptive strategies have proliferated. Cities are at the forefront of this trend. For example, New Orleans, in anticipation of rising sea levels and more intense storms due to climate change, has improved its water management system, updated building codes, and established a citywide evacuation system.[9] Some neighborhoods have also begun implementing creative solutions specifically tailored to addressing local climate risks. For example, St. Kjeld, a neighborhood in Copenhagen recently hit by a devastating cloudburst, replaced asphalt

3. *See The World Factbook: Bangladesh*, U.S. CENT. INTELLIGENCE AGENCY (Apr. 24, 2018), https://www.cia.gov/library/publications/the-world-factbook/geos/bg.html (noting that "almost half of Bangladesh is are employed in the agriculture sector").

4. *See* Gardiner Harris, *Borrowed Time on Disappearing Land: Facing Rising Seas, Bangladesh Confronts the Consequences of Climate Change*, N.Y. TIMES (Mar. 28, 2014), https://www.nytimes.com/2014/03/29/world/asia/facing-rising-seas-bangladesh-confronts-the-consequences-of-climate-change.html ("Even without climate change, Bangladesh is among the most vulnerable places in the world to bad weather: The V-shaped Bay of Bengal funnels cyclones straight into the country's fan-shaped coastline.").

5. *See id.*; *see also* Arastoo Khan, *Bangladesh – The Most Climate Vulnerable Country*, THE WORLD BANK: ENDING POVERTY IN SOUTH ASIA (Nov. 21, 2013), http://blogs.worldbank.org/endpovertyinsouthasia/bangladesh-most-climate-vulnerable-country (noting that the Intergovernmental Panel on Climate Change (IPCC), the World Bank, and Maplecroft have noticed the particular vulnerability of Bangladesh to climate change).

6. *See* Huq & Totton, *supra* note 2 ("Bangladesh remains one of the most informed countries on how to adapt to changing environmental conditions.").

7. *See id.* ("Cyclone Bhola in 1970 had an official death toll between 300,000 and 500,000; . . . Cyclone Aila in 2009, less than 200.").

8. *See generally Bangladesh: Growing the Economy Through Advances in Agriculture*, THE WORLD BANK (Oct. 9, 2016), http://www.worldbank.org/en/results/2016/10/07/bangladesh-growing-economy-through-advances-in-agriculture ("Bangladesh's agricultural sector has benefited from a sound and consistent policy framework backed up by substantial public investments in technology, rural infrastructure and human capital.").

9. CITY OF NEW ORLEANS, LA., CLIMATE ACTION FOR A RESILIENT NEW ORLEANS 14 (July 2017), https://www.nola.gov/nola/media/Climate-Action/Climate-Action-for-a-Resilient-New-Orleans.pdf (outlining the City of New Orleans's adaptation initiatives).

with grass to collect and redirect water during floods and storms.[10] Tribes and other indigenous communities have also adopted community-wide adaptation plans.[11]

Indeed, unlike climate change mitigation, which calls for a centralized coordinating regime based on a single institution applying the same standard to all actors, adaptation can be better addressed by a decentralized approach that relies on local efforts.[12] Since climate change impacts communities differently depending on their locations and development statuses, adapting to climate change calls for "tailor-made policy strategies that are fine-tuned within their context."[13] Local actors are better suited for implementing adaptive strategies since they are more attuned to the particular environmental and social conditions of the community than national and international actors. Local actors also have the greatest incentive to adapt since they benefit directly from adaptation. In fact, local actors have spearheaded climate change adaptation. The most innovative and progressive adaptation methods are typically found among highly granular community units.[14] Given the momentum of local adaptation initiatives, some have touted that climate strategies are entering a new bottom-up paradigm with cities and local governments leading the way.[15]

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10. *See* Elisabeth Braw, *Copenhagen Unveils First Climate-Change Adapted Neighborhood*, AL JAZEERA AMERICA (Jan. 26, 2015, 5:00AM ET), http://america.aljazeera.com/articles/2015/1/26/copenhagen-worlds-first-climate-adjusted-neighborhood.html (describing St. Kjeld's transformation).

11. *See generally* Elizabeth Ann Kronk Warner, *Indigenous Adaptation in the Face of Climate Change*, 21 J. ENVTL. & SUSTAINABILITY L. 129, 146–65 (2015) (describing the climate assessments and adaptation plans of four tribes in the U.S.).

12. As used in this paper, "mitigation" refers to conventional measures to reduce emissions of greenhouse gases (GHGs) and does not include environmental modification methods such as geoengineering. "Adaptation" broadly refers to "new strategies for avoiding and recovering from . . . [the] harms [of climate change] and capturing and harnessing its benefits." J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363, 381 (2010). The discussion set forth is limited to modifications aimed at protecting human activities from the impact of climate change and does not include modifications to the climate itself (such as geoengineering). For different definitions of adaptation, see *Climate Change Adaptation Definitions*, *supra* note 1, (listing definitions provided by governments and major international bodies).

13. G. Robbert Biesbroek, Rob J. Swart & Wim G.M. van der Knaap, *The Mitigation-Adaptation Dichotomy and the Role of Spatial Planning*, 33 HABITAT INT'L 230, 232 (2009).

14. *See generally* Jerome Ross, *How to Eat an Elephant: A Bottom-Up Approach to Climate Policy*, BREAKTHROUGH (Dec. 1, 2010) http://thebreakthrough.org/archive/how_to_eat_an_elephant_a_botto_1.

15. *See, e.g.*, Steve Rayner, *How to Eat an Elephant: A Bottom-Up Approach to Climate Policy*, 10 CLIMATE POL'Y 615, 617 (2010) ("Individual countries, and even regional and city administrations, have the ability to revise and implement zoning, planning and building regulations and invest in infrastructure in ways that drastically reduce vulnerability to climate

The increasing public attention on local adaptation champions, however, has not given much consideration to the coordination aspect.[16] Discussions about coordinating climate action have largely focused on mitigation; only recently have some researchers and policy makers begun exploring ways to coordinate local adaptive strategies. Conceptually and practically, however, adaptation calls for different analytical and policy tools than does mitigation. An inadequate understanding of the need for and approaches to adaptation coordination can make local efforts less efficient and potentially undermine other environmental and policy priorities.[17]

This note contributes to the emerging public and academic awareness of the need for adaptation coordination by providing an overview of the difficulty of, the need for, and the potential ways of coordinating localized adaptive strategies in the context of sea level rise. The causal relationship between climate change and sea level rise has been well established.[18] Sea level rise affects communities at all different levels of economic development,[19] and there are many examples of local adaptation.[20] Part II provides an overview of the distinct challenges facing adaptation and the inadequacy of a mitigation-based framework for coordinating adaptive efforts. Part III argues that adaptation coordination requires a network-based approach and discusses possible features of such an approach. Part IV concludes.

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change in the short and medium term."); *see also* Ross, *supra* note 14 (interpreting Rayner as arguing that "adaptation should be tackled at its most effective level of governance").

16. *See, e.g.*, Carley Chavara, *John Furlow on Better Coordination for Better Climate Adaptation*, WOODROW WILSON INT'L CTR. FOR SCHOLARS: NEW SECURITY BEAT (Aug. 28, 2015), https://www.newsecuritybeat.org/2015/08/john-furlow-coordination-climate-adaptation/ (quoting John Furlow, a climate change specialist at the U.S. Agency for International Development, describing the climate discourse as having been "treating 'adaptation' like a sector" and calling for more coordination with other social and environmental goals and among governments).

17. *See infra* Part II.B ("The Inadequacy of a Mitigation-Based Coordination Framework").

18. *See, e.g.*, *Is Sea Level Rising?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN, https://oceanservice.noaa.gov/facts/sealevel.html (last visited Apr. 28, 2018) ("The two major causes of global sea level rise are thermal expansion caused by warming of the ocean . . . and increased melting of land-based ice . . . .").

19. *See, e.g.*, *Sea Level Trends*, NAT'L OCEANIC & ATMOSPHERIC ADMIN, https://tidesandcurrents.noaa.gov/sltrends/sltrends.html (last visited Apr. 24, 2018) (showing local sea levels rising in parts of Europe and North America that are mostly located in developed countries).

20. *See, e.g.*, *supra* notes 7–11 and accompanying text.

II. THE NEED FOR A NEW APPROACH TO ADAPTATION COORDINATION

The lack of a consistent approach to adaptation coordination is not surprising, since adaptation itself did not gather much serious attention in the climate change discourse until recently.[21] Adaptation has been one of the most controversial topics related to climate change. On one hand, climate change skeptics question the gravity of the threat and what actions should be taken to address it.[22] On the other hand, scientists and policymakers committed to combating climate change are worried that investing in adaptation may divert attention and resources away from mitigation.[23] Only in the past few years has adaptation received serious political and academic attention, especially as headline-grabbing extreme weather events impact countries and communities with increasing frequency. Local adaptive strategies have proliferated, but coordination of these local initiatives is lacking.[24]

This neglect is problematic. Adaptation has distinct scientific and policy challenges, and uncoordinated local efforts can have significant geographical, temporal, and sectoral spillovers that exacerbate existing inequalities among countries and communities.[25] The debate over the merits of and the need for coordinating sub-global climate actions has been focused on mitigation. However, mitigation is a conceptually and politically different issue from adaptation, and the same analysis in the mitigation context is inadequate for adaptation.

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21. *See* Biesbroek et al., *supra* note 13, at 230 (discussing that adaptation approaches were seen as "defeatist" until recently).

22. *See The Pillars of Climate Change Denial*, NAT'L CTR. FOR SCI. EDUC., https://ncse.com/library-resource/pillars-climate-change-denial (last visited Sept. 23, 2018) (noting the elements of climate change denial).

23. F. DENTON, T.J. WILBANKS, A.C. ABEYSINGHE, I. BURTON, Q. GAO, M.C. LEMOS, T. MASUI, K.L. O'BRIEN & K. WARNER, CLIMATE-RESILIENT PATHWAYS: ADAPTATION, MITIGATION, AND SUSTAINABLE DEVELOPMENT, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY. PART A: GLOBAL AND SECTORAL ASPECTS. CONTRIBUTION OF WORKING GROUP II TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 1117 (2014) [hereinafter IPCC FIFTH ASSESSMENT REPORT].

24. Only in the past few years did newspapers, international organizations, and climate scientists and policymakers begin considering the coordination problem. *See generally supra* note 23; Biesbroek et al., *supra* note 13; Julia Laukkonen, Paola Kim Blanco, Jennifer Lenhart, Marco Keiner, Branko Cavric, & Cecilia Kinuthia-Njenga, *Combining Climate Change Adaptation and Mitigation Measures at the Local Level*, 33 HABITAT INT'L 287 (2009).

25. *See* IPCC FIFTH ASSESSMENT REPORT, *supra* note 23, at 1104 ("Added to other stresses such as poverty, inequality, or diseases, the effects of climate change will make sustainable development objectives such as food and livelihood security, poverty reduction, health, and access to clean water more difficult to achieve for many locations, systems, and affected populations.").

A. Distinct Challenges to Adaptation

A major challenge to combatting climate change is scientific uncertainty. Predictions of global temperature change are only meaningfully accurate for a couple of decades,[26] and they cannot fully comprehend all possible secondary effects that a rising temperature has on the environment and human society. However, mitigation strategies are better able to accommodate uncertainty than adaptive strategies. Mitigation goals are typically benchmarked by numerical values (e.g., the Paris Agreement's goal of limiting temperature increase to "well below 2 degrees Celsius above pre-industrial levels,"[27] G8's goal of "cut[ting] emissions by 80 percent by 2050,"[28] and concerns over atmospheric carbon dioxide exceeding 400 parts per million).[29] Accordingly, these numerical benchmarks are established through a "positivistic research strategy," which "[uses] information from a limited number of scientific disciplines (mainly technology and economics) and are embedded in sectoral policy domains."[30] Uncertainty can thus be quantified in climate models to better project variables such as global temperature and carbon dioxide concentration.[31] Thus, despite uncertainty, researchers and policymakers can still establish clear, meaningful, and generally applicable greenhouse gas (GHG) reduction goals.

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26. Zeke Hausfather, *Analysis: How Well Have Climate Models Projected Global Warming?*, CARBON BRIEF (Oct. 5, 2017), https://www.carbonbrief.org/analysis-how-well-have-climate-models-projected-global-warming.

27. *The Paris Agreement*, UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE, https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement (last visited Apr. 30, 2018).

28. *G8 Agrees to Climate Targets Despite Differences with Developing Nations*, GUARDIAN (July 8, 2009), https://www.theguardian.com/world/2009/jul/08/g8-climate-carbon-emission-targets.

29. *See* Nicola Jones, *How the World Passed a Carbon Threshold and Why It Matters*, YALE SCH. OF FORESTRY & ENVTL. STUD.: YALE E360 (Jan. 26, 2017), https://e360.yale.edu/features/how-the-world-passed-a-carbon-threshold-400ppm-and-why-it-matters (quoting Ralph Keeling saying that exceeding the 400 ppm threshold put humanity "in a new era").

30. Biesbroek et al., *supra* note 13, at 231.

31. *See generally* Andrew J. Majda & Boris Gershgorin, *Quantifying Uncertainty in Climate Change Science Through Empirical Information Theory*, 107 APPLIED MATHEMATICS 14958 (2010) (using empirical information theory to quantify uncertainty in projecting coarse-grained large scale climate indicators such as CO2 concentration and temperature); Jussi S. Ylhäisi, *Quantifying Sources of Climate Uncertainty to Inform Risk Analysis for Climate Change Decision-Making*, 20 INT'L J. JUST. & SUSTAINABILITY 811 (2015) (quantifying uncertainty in existing climate models).

By contrast, scientific uncertainty poses a greater challenge to adaptation because adaptation is highly context-specific and interdisciplinary. Adaptation involves a wide range of actors, sectors, and jurisdictions, and it needs to balance different policy priorities. A successful adaptive strategy—one that not only effectively protects the community from climate risks but also receives sufficient popular, political, and financial support—needs to measure the impact of both climate change itself and the proposed strategy's impact on other policy goals. Compared to mitigation, adaptation depends on a more robust scientific foundation and requires a higher degree of accuracy. Since climate change involves "dynamic, feedback-plagued, nonlinear physical and biological trends,"[32] predicting long-term climate patterns and projecting the effects of adaptation efforts are extremely difficult.

Unfortunately, adaptive strategies have not received the level of support they deserve. Adaptation requires committing resources and capital towards projects that must be periodically revisited in light of scientific and technological advances, which is politically unpopular. A comprehensive study conducted in Australia shows that scientific uncertainty is a major barrier to implementing adaptive strategies to mitigate the risk of sea level rise for public and private actors across all sectors and decision-making levels.[33] Uncertainty jeopardizes the return on commitments to addressing sea level change and makes it more difficult for decision makers to justify these commitments to constituents and stakeholders.

Furthermore, no adaptive strategy can escape the possibility of systemic risk, which can lead to cascading damages to other locations and sectors. For example, as the earth's permafrost thaws due to rising temperature, bacteria and viruses buried underneath could release and re-infect humans.[34] No amount of existing information allows us to predict the kind of pathogens that could be released. Since we simply

32. Ruhl, *supra* note 12, at 378.

33. *See* JON BARNETT, ELISSA WATERS, SAM PENDERGAST & AEDAN PULESTON, UNIV. OF MELBOURNE & AUSTRALIA NAT'L CLIMATE CHANGE ADAPTATION RES. FACILITY, THE LEGAL, INSTITUTIONAL AND CULTURAL BARRIERS TO ADAPTATION TO SEA-LEVEL RISE IN AUSTRALIA 30 (2013), https://www.nccarf.edu.au/sites/default/files/attached_files_publications/Barnett_2013_Barriers_to_adaptation_to_sea_level_rise.pdf (noting that "[a] lack of relevant, reliable, consistent and comprehensible climate projections is a key barrier [to implementing adaptive strategies] for all respondent groups"). Respondents of the study come from private individuals, industry and professional associations, community organizations, local governments, the federal government, and academia. *See id.* at 7 fig.2 (identifying respondent affiliations).

34. Robinson Meyer, *The Zombie Diseases of Climate Change: What Lurks in the Arctic's Thawing Permafrost?*, ATLANTIC (Nov. 6, 2017), https://www.theatlantic.com/science/archive/2017/11/the-zombie-diseases-of-climate-change/ 544274/.

do not know what is out there, there is little we can do to address that risk (except for mitigating climate change). The systemic risk in the context of sea level change is not as insurmountable but is just as difficult to assess. Glaciers are melting at a faster rate than expected, and recent studies have found feedback loops that accelerate ice sheet melting and destabilization.[35] Scientists do not know enough about the melting glaciers near the Antarctic because it is "too remote, too cold, too expensive, and too complicated to have the kind of detailed observing program that [scientists] really need."[36] Projecting sea level rise is thus notoriously difficult; a recent projection "nearly doubles" prior ones and cautions against the possibility of a catastrophic scenario in the latter half of the century.[37] This projection would dwarf all existing expectations of sea level rise and would require transformative strategies to protect communities.[38]

These features of adaptation lead to the distinct institutional structure of adaptive programs. While the impact of global climate change might be hard to assess due to the complexity of the climate system, the particular risks facing each community are easier to identify. The geographic and historical trends of a locale can assist local actors to predict short-term trends. Local actors are also better positioned to navigate the interconnected political, economic, and cultural dynamics in the area to integrate adaptive strategies into the existing social fabric in a cost-effective manner.[39] Furthermore, since the benefits of adaptation are reaped immediately and locally, there is a stronger incentive for individual adaptive effort. Stakeholders with

35. *See* Brad Plumer, *The Hardest Part of Dealing with Sea-Level Rise Will Be the Uncertainty*, VOX (updated Dec. 16, 2016), https://www.vox.com/energy-and-environment/2016/12/16/13971720/sea-level-rise-uncertainty-climate (noting that ice shelfs crumble in Antarctica and Greenland and that "meltwater on the surface of ice sheets can open up crevasses that break apart ice shelves entirely, causing further destabilization and faster ice flow into the ocean").

36. *Id*.

37. *See* Robert M. DeConto, *Contribution of Antarctica to Past and Future Sea-Level Rise*, 531 NATURE 591 (Mar. 31, 2016), https://www.nature.com/articles/nature17145 (projecting that "Antarctica has the potential to contribute more than a metre of sea-level rise by 2100 and more than 15 metres by 2500 if emissions continue unabated").

38. *See* Brady Dennis & Chris Mooney, *Scientists Nearly Double Sea Level Rise Projections for 2100, Because of Antarctica*, WASH. POST (Mar. 30, 2016), https://www.washingtonpost.com/news/energy-environment/wp/2016/03/30/antarctic-loss-could-double-expected-sea-level-rise-by-2100-scientists-say (noting that Ben Strauss from Climate Central commented that "[s]hould the new research prove correct, it could trigger a 'tectonic shift' in expectations for the speed and severity of the sea level problem").

39. *See* IPCC FIFTH ASSESSMENT REPORT, *supra* note 23, at 1120 (noting that local institutions are crucial to ensure policy effectiveness).

different levels of capital, expertise, and objectives can be involved in adaptation.[40] Thus, while mitigation coordination has largely taken the form of a top-down, centralized paradigm through instruments such as international treaties that set a consistent set of goals and standards, adaptation has largely taken the form of a bottom-up approach that involves "tailor-made policy strategies that are fine-tuned within their context of application in order to effectively reduce the impact of climate change."[41]

As local adaptation programs proliferate, however, there are multiple dimensions of spillover risks due to the interdependence of the various actors, sectors, and locales involved. One locale's adaptive strategy may increase nearby locales' vulnerability to climate-related risks (geographical spillover); adaptive projects built based on short-term climate projections may make future adaptation difficult or more costly (temporal spillover); and certain adaptive strategies might undermine other policy priorities (policy spillover).[42]

Responses to sea level rise illustrate these risks. The two main responses are building barriers and relocating to areas with better adaptive capacity.[43] Building barriers can entail all three kinds of spillovers. Physical barriers can have geographical spillovers when they result in unexpected secondary effects on nearby locales. For example, upstream flood-control dikes can make downstream areas more vulnerable to floods. Specifically, studies have shown that dike construction in the Vietnamese Mekong Delta has increased downstream flood risk.[44] It may undermine other environmental policy priorities when the barriers adversely impact the local ecosystem's own

40. Professor Ruhl identified seven adaptation design parameters: actor (public-planned vs. private-autonomous), orientation (proactive vs. reactive), goals (avoiding/repairing harm vs. capturing benefits), management target (responding to changed variability of environmental events vs. responding to absolute changes in environmental conditions), policy foundation (substantive vs. procedural), capital employed (technological, financial, human, social, & natural), and strategy (reduce vulnerability vs. enhance resilience). *See* Ruhl, *supra* note 12, at 381–85 (discussing the seven parameters in adaptation design).

41. Biesbroek et al., *supra* note 13, at 232.

42. *See, e.g.*, Nguyen Van Khanh Triet, Nguyen Viet Dung, Hideto Fujii, Matti Kummu, Bruno Merz & Heiko Apel, *Has Dyke Development in the Vietnamese Mekong Delta Shifted Flood Hazard Downstream?*, 21 HYDROLOGY & EARTH SYS. SCI. 3991, 3991 (2017) (concluding that "high-dyke development has raised the flood hazard downstream").

43. *See, e.g.*, Climate Change Adaptation Resource Center, *Sea Level Rise*, U.S. EPA, https://www.epa.gov/arc-x/climate-impacts-water-utilities#tab-4 (describing "build[ing] flood barriers to protect infrastructure" and "relocate[ing] facilities to higher elevations" as two strategies to adapt to sea level change).

44. *See* Nguyen Van Khanh Triet et al., *supra* note 42.

internal response to sea level rise.[45] Physical barriers can also have temporal spillovers; for example, if they have to be reassessed or rebuilt in the future to reflect newer projections of sea level rise, future adaptive costs will be higher.

Relocation entails a greater range of environmental, social, and cultural values that might be compromised. Relocating entire communities—for climate or other reasons—creates additional burden for the hosting locale. A hosting locale may face the environmental and socioeconomic burdens of an increasing population in the event that it takes in residents from areas affected by rising sea levels. The additional environmental stress may be manifested in water and food shortage, loss of forestry and biodiversity, and pollution.[46] Depending on the social and cultural proximity of the relocated and hosting locales, there may also be additional conflicts between the two communities.

Furthermore, in many cases, the full range of spillovers and their impact caused by an adaptive strategy cannot be fully assessed. Some strategies bring co-benefits not explicitly comprehended at the planning and implementation stage. In the case of the Vietnamese Mekong Delta dikes, researchers found that although peak flood level may have deepened due to the construction of dikes, high dikes have helped redistribute floodwater and reduce the volume of water.[47] Similarly, relocation has positive policy spillovers when it facilitates knowledge and technology transfer between the hosting and relocated communities.[48] By contrast, even flow-through dams designed for flood control (which are built to allow natural flow and to control floods

45. *See* Pam M. Berry, Sally Brown, Minpeng Chen, Areti Kontogianni, Olwen Rowlands, Gillian Simpson & Michalis Skourtos, *Cross-Sectorial Interactions of Adaptation and Mitigation Measures*, 128 CLIMATE CHANGE 381, 386 (2015) ("[C]oastal hard-engineering could prevent coastal ecosystems migrating inland in response to sea-level rise.").

46. *See, e.g.*, John O. Oucho, *Environmental Impact of Refugees and Internally Displaced Persons in Sub-Saharan Africa* 11 (African Migration Alliance Biennial Workshop on Climate Change Environment and Migration, East London, South Africa, Nov. 15–16, 2007), https://goo.gl/3hNG2E (listing negative and positive environmental impacts of refugees and internally displaced persons).

47. *See* Dung Duc Tran, Gerardo van Halsema, Petra J.G.J. Hellegers, Long Phi Hoang, Tho Quang Tran, Matti Kummu & Fulco Ludwig, *Assessing Impacts of Dike Construction on the Flood Dynamics of the Mekong Delta*, 22 HYDROLOGY & EARTH SYS. SCI. 1875, 1890 (2018) (noting that "continued high dike construction over the period from 2000 is likely to increase the flood risk across the entire LXQ," but "dike construction has produced radical changes in the floodwater balance and distributions . . . [by] reduc[ing] the volumes of floodwater reaching the LXQ").

48. *See, e.g.*, Oucho, *supra* note 46 (listing negative and positive environmental impacts of refugees and internally displaced persons).

when the water level rises)[49] are touted for their downstream-locale-friendliness but can have negative geographical spillovers, since they may increase sedimentation in downstream water channels.[50] In most cases, the initial environmental impact assessment of an adaptive project does not fully anticipate the multidimensional spillover effects it may have, and follow-up assessments tend to be sporadic and inconclusive.[51]

The scientific uncertainty of adaptive strategies complicates policymaking. First, uncertainty jeopardizes a project's environmental effectiveness. An adaptive strategy that benefits one locale for 20 years at the expense of other locales' wellbeing or biodiversity is not sustainable. Furthermore, the multiple dimensions of possible spillovers often require local policymakers to balance different policy priorities. Policymakers acting individually cannot be trusted to strike the right balance, given the objective difficulty of balancing incentives, the natural tendency for individual actors to seek personal gain at the sacrifice of the collective good, and their susceptibility to giving in to their constituents' particular political ideologies.[52] Lastly, the uncertainty of adaptive projects may also make them less popular, since the projects might require periodical reassessment in light of new evidence and provide uncertain returns.

Worse yet, absent coordination, the multidimensional and interconnected spillover effects can exacerbate the existing inequality among communities. Developing countries tend to be hit the hardest by climate change due to lack of financial resources, infrastructure, and expertise in responding to those impacts.[53] Compared to developed

49. *See Flow-Through Dam for Flood Control*, CLIMATE TECH. CTR. & NETWORK, https://www.ctc-n.org/technologies/flow-through-dam-flood-control (last visited Apr. 29, 2018) (explaining flow-through dams).

50. *See* TETSUMI SUMI, DESIGNING AND OPERATING FLOOD RETENTION DRY 'DAMS' IN JAPAN AND USA 7, https://www.researchgate.net/publication/266293841 (last visited Sept. 23, 2018) ("Generally, dry dams have also advantage on environmental impacts to downstream river since there may be almost no change in water quality and sediment transport in river with and without dams, . . . [but] relatively coarse sediments such as sand and gravel may be discharged in a low concentration a little delaying from the inflow one. This delay may cause sedimentation in reservoir and sediment deposition in the downstream river channel.").

51. *See, e.g.*, DANIEL A. FARBER, RES. FOR THE FUTURE, A LEGAL FRAMEWORK FOR CLIMATE ADAPTATION ASSESSMENT 6 (Dec. 2009) (observing that ongoing monitoring and follow-up reassessment are absent from many adaption projects).

52. Studies have found that customers' political ideologies even affect their purchase behavior, *see generally* Dena M. Gromet, Howard Kunreuther & Richard P. Larrick, *Political Ideology Affects Energy-Efficiency Attitudes and Choice*s, 110 PROC. NAT'L ACAD. SCI. 9314 (2013), which suggests that political ideology can also be a powerful factor for policymakers.

53. *See, e.g.*, Laukkonen et al., *supra* note 24, at 288–89 (discussing that poor countries are

countries, developing countries are already much less equipped to implement local measures to adapt to climate change. The multidimensional spillovers from uncoordinated adaptive efforts exacerbate this existing inequality. Poorer countries may not be able to defend themselves against the spillovers from upstream rich countries' adaptive strategies, and they may not have the scientific and legal capacity to prove the negative effects of upstream adaptive measures.[54] Lacking access to financing and technology to respond to the now compound climate impact—the impact of climate change itself and the spillovers from upstream countries—developing countries would bear the brunt of the consequences of uncoordinated adaptive actions.

B. The Inadequacy of a Mitigation-Based Coordination Framework

To address the distinct challenges of adaptation, local efforts should be coordinated. Coordinating adaptive strategies can produce myriad benefits across sectors. Coordination can promote climate research by bringing scientists together and reducing unnecessary duplication of research efforts. Knowledge sharing and information transfer can help locales learn from each other and better adapt to similar impacts from climate change. Inter-jurisdictional dialogues can help policymakers better understand the impact of their actions and align different locales' incentives. Existing proposals for coordinating climate actions are largely developed for the mitigation problem. But a mitigation-based coordination analysis is inadequate for designing adaptation coordination because mitigation is conceptually and practically different from adaptation.

Mitigation is a collective action problem.[55] Since the effects of GHGs are evenly distributed in the atmosphere, individuals only bear a small fraction of the climate impact of their activities. Thus, each locale has every incentive to emit as much as necessary to achieve development goals and no incentive to reduce emissions in a way that sacrifices their other economic priorities. The history of GHG emissions has been a classic case of the "tragedy of the commons." Since no single jurisdiction's emission reduction effort can make a meaningful difference in reducing the aggregate carbon dioxide in the

hit hardest by climate change due to their lack of resources).

54. *Id.*

55. *See, e.g.*, Nicholas Stern, *What is the Economics of Climate Change?*, 7 WORLD ECON. 1, 4 (2006) (noting that climate change is "a problem of intertemporal international collective action with major uncertainty and linked market failures").

atmosphere,[56] regional efforts at mitigation will not work unless the actors that do mitigate constitute a critical mass that meaningfully reduces the global level of GHGs. Global coordination is thus essential. Uncoordinated local efforts may even incentivize other actors to emit *more*: knowing that others are cutting emissions, some actors may feel less urgency about cutting their own emissions and pursue short-term, more carbon-intensive projects instead—a 2.0 version of the tragedy of the commons scenario. The main policy challenge in the mitigation context is therefore incentivizing participation and addressing the free-rider problem.[57]

But adaptation faces the opposite incentive problem: each jurisdiction has every incentive to adapt, since each individual locale reaps all of the benefit of their own adaptation. Each locale has no reason to care about the spillover effect of its actions on nearby locales. Additionally, the locale cares about environmental priorities and adopts a long-term perspective only insofar as its constituents do. In the case of a subnational jurisdiction, spillovers to nearby locales, to other policy priorities, and to future generations may be curbed by domestic law.

Still, the spillover will not be easily remedied—or even recognized—if it happens between countries. A burdened jurisdiction may not be able to seek recourse due to, say, the difficulty of proving causation or the lack of developed international rules and procedures governing such disputes.

Mitigation and adaptation call for different kinds of coordination due to their conceptual differences. The main concern over uncoordinated mitigation is the leakage problem. Leakage refers to the phenomenon that emission reductions in one locale lead to increased emissions in other locales.[58] Scholars and researchers have pointed to two economic reasons why regional mitigation policies lead to carbon leakage. First, one jurisdiction's emission reduction policy may lead carbon-intensive firms to relocate to jurisdictions with more lax

56. Jonathan B. Wiener, *Think Globally, Act Globally: The Limits of Local Climate Policies*, 155 U. PENN. L. REV. 1961, 1966 (2007) ("[N]o state could effectively control its own ambient level of carbon dioxide or other GHGs, because that ambient level is determined by the worldwide concentration of GHGs in the atmosphere.").

57. *See id.* at 1965 (discussing how "[e]ach state (or country) has an incentive to free ride on other states' (or countries') actions, enjoying the global benefits without bearing the local costs," resulting in underinvestment in abatement).

58. *See id.* at 1967 (stating that subglobal action "suffers from cross-border 'leakage' of emissions: subglobal regulatory coverage encourages source activities to shift or 'leak' to unregulated areas over time").

emission regulations, thus leaving the total global carbon emissions unaffected.[59] Secondly, reduction of demand for fossil fuels in one jurisdiction may lead to a global decline of the price of fossil fuels, thereby increasing the demand from other jurisdictions.[60] In addition, leakage can result from moral hazard: knowing that other locales are adopting stringent mitigation policies, non-mitigating locales may feel less urgency to mitigate.[61]

The leakage problem and the arguments against sub-global mitigation efforts developed around it, however, do not apply in the adaptation context. Adaptation is not a collective action problem. Unlike mitigation, which conceptually lends itself to a global, centralized coordination framework, localization is inherent to the concept of adaptation. The assessment of and strategies to cope with climate risks are context specific, as each locale's climate vulnerability is intimately related to its "geophysical, biological, and socio-economic systems"[62] or "the totality of relationships in a given social situation . . . in combination with environmental forces."[63]

Effective adaptation depends to a much lesser extent—if at all, without financing—on the adaptation efforts of other locales. The benefits of each locale's adaptation effort are reaped entirely by that locale; one locale would not "slack off" or delay adaptation efforts just because others are adapting.

Furthermore, instead of driving capital away to non-adapting jurisdictions, adaptation may instead attract capital by reducing the physical and regulatory risks of the investing environment. In sum, relatively independent from each other, regional actors have more incentive to adopt progressive adaptation strategies that benefit

59. *See, e.g.*, Brad Plumer, *A Closer Look at How Rich Countries "Outsource" Their CO2 Emissions to Poorer Ones*, VOX (Apr 18, 2017, 11:00 AM), https://www.vox.com/energy-and-environment/2017/4/18/15331040/emissions-outsourcing-carbon-leakage ("If the US ever got serious about adopting strict limits on CO2 emissions, one thing policymakers might worry about is that many of America's factories and plants would simply move overseas, blunting the plan's effectiveness.").

60. *See* Joshua Elliott, Ian Foster, Sam Kortum, Gita Khun Jush, Todd Munson & David Weisbach, *Unilateral Carbon Taxes, Border Tax Adjustments, and Carbon Leakage* 1 (Univ. of Chicago Inst. for Law & Econ., Working Paper No. 600, 2012) ("[I]f nations with carbon controls use fewer fossil fuels, the price of fossil fuels may go down, resulting in more use in other regions."); *see also* Wiener, *supra* note 56, at 1967–68 (describing these two phenomena as "carbon relocation" and "price effect").

61. *See* Wiener, *supra* note 56, at 1967–68 (referring to the moral hazard problem as the "slack off effect").

62. Laukkonen et al., *supra* note 24, at 288 (citation omitted).

63. *Id.* (citation omitted).

themselves. Thus, instead of leakage, the concern for adaptation is spillover, as detailed in Section A.

Thus, the kind of coordination that adaptation calls for is very different from the kinds of coordination that mitigation requires. Adaptation involves a wider range of actors, multiple areas of policy, and much greater scientific and political uncertainty, thus calling for a different coordination tailored to these distinct challenges. While mitigation demands inclusion and centralization, adaptation coordination fares better under an integrated, network-based model. The following section describes this model.

III. A NETWORK-BASED APPROACH TO COORDINATION

Compared to a centralized governance framework, which concentrates decision-making authority in one institution, a network-based framework distributes authority to various participants in the network and focuses instead on promoting collaboration and exchange.[64] A positive side effect of this organizational flexibility is temporal flexibility—by dispersing decision-making authority, a network-based approach also allows various actors to respond to new problems as they arise. Thus, while a centralized framework "frontloads" decision making both institutionally, by delegating authority to high-level actors, and temporally, by focusing on the initial planning and assessment stage, a network-based approach distributes decision making by empowering all actors and allowing for later-stage, ad hoc responses.[65]

A network-based framework is thus better suited to solve complex problems such as coordinating climate change adaptation,[66] which needs to respond both to intra-system connectivity (e.g., feedback loops within the global climate system and their localized effects) and to inter-system spillovers,[67] often with inadequate information. Its organizational and temporal flexibility can better integrate new

64. *See, e.g.*, GABRIEL A. HUPPÉ & HEATHER CREECH , INT'L INST. FOR SUSTAINABLE DEV., DORIS KNOBLAUCH, THE FRONTIERS OF NETWORKED GOVERNANCE 1 (2012) ("By making use of governance networks that may self-organize within bounds to help support certain policy-making functions, networked governance integrates distributed capacities for problem solving and policy-making.").

65. *Cf. id.* at 7 (comparing "self-organized" governance networks with "acting steering" governance networks).

66. *See id.* at 4 ("Problems of higher complexity require governance networks that are more heterogeneous.").

67. *See supra* notes 49–53 and accompanying text (discussing multidimensional spillover effects).

scientific evidence, multiple dimensions of policy priorities, and different kinds of actors. Better still, the existing bottom-up model of climate adaptation already provides the institutional foundation needed for a network-based coordination framework.

The remainder of Part III discusses the existing structure of global coordination of adaptive strategies and highlights some features and institutions that might develop to facilitate a network-based framework.

A. Current State of Adaptation Coordination

Currently, regional adaptive strategies lack a coherent organizing policy. The fragmented landscape of adaptation makes adaptation much less efficient than it would be with coordination. Jurisdictions facing similar problems could have learned from each other and avoided starting from scratch. For example, a major barrier to local adaptation planning is access to scientific information. In many instances, scientific data do exist, but the public and policymakers are not equipped to interpret the information and translate it into actionable strategies.[68] Absent coordination, each community has to reinvent the wheel and invests in technical consultancy to translate raw scientific data to comprehensible policy recommendations, even though the same challenge might have been addressed by other similarly situated communities.

Furthermore, uncoordinated adaptive strategies undermine other policy priorities, especially mitigation. Adaptation competes directly with mitigation for limited levels of extant climate finance. In 2016, over $112 billion was dedicated to mitigation financing and $23 billion to adaptation financing,[69] although adaptation is estimated to require at least $70 billion every year.[70] Certain adaptive strategies can undermine mitigation goals. For example, adapting to sea level rise by

68. *See* Linda Shi, Eric Chu & Jessica Debats, *Explaining Progress in Climate Adaptation Planning Across 156 U.S. Municipalities*, 81 J. AM. PLAN. ASS'N 191, 194 (2015) (noting that cities in the U.S. rely on technical consultants to interpret climate data and have difficulty communicating them to the public); BARNETT ET AL., *supra* note 33, at 30 (noting that many respondents lacked "tools and techniques to translate information into informed decisions at the local level").

69. *See The Global Landscape of Climate Finance 2017*, CLIMATE POLICY INITIATIVE 12 fig.9 (2017) (reporting "[p]ublic climate finance by use").

70. *See UNEP Report: Cost of Adapting to Climate Change Couse Hit $500B Per Year by 2050*, U.N. SUSTAINABLE DEV. GOALS (May 10, 2016), https://www.un.org/sustainabledevelopment/blog/2016/05/unep-report-cost-of-adapting-to-climate-change-could-hit-500b-per-year-by-2050 ("Previous estimates place the cost of adapting to climate change at between $70 to $100 billion annually for the period 2010-2050.").

building dikes can disrupt the coastal ecosystem by eliminating wetlands,[71] which are excellent sources of carbon sequestration,[72] and vice versa: high-density urban planning can "provide . . . common energy schemes that . . . reduce emissions," but it also makes the area more vulnerable to climate-related impact by increasing the risk of urban flooding.[73]

A further consequence of the lack of coordination is the political abuse of the adaptation label. Given the complexity and interconnectivity of the global environmental, social, and political ecosystem, the term "adaptation" can refer to anything conceivably related to climate change. For example, a 2016 article argues that many of Singapore's climate adaptation policies were in fact little more than conventional vital systems security policies such as food and water security.[74] Instead of recognizing the complex, interconnected, or "pluripotent" nature of climate change, the island nation has largely viewed the environment as just one variable in its engineering toolkit to stage artificial, anthropogenic transformations to achieve other policy goals.[75] Its "climate initiative" was just a plan to achieve policy

71. *See Up to Four-Fifths of Wetlands Worldwide Could Be at Risk for Sea Level Rise*, UNIV. OF CAMBRIDGE (Feb. 24, 2016), http://www.cam.ac.uk/research/news/up-to-four-fifths-of-wetlands-worldwide-could-be-at-risk-from-sea-level-rise (reporting on research showing the impact of sea level rise on wetlands and pointing out that "[a] main reason for the high vulnerability of coastal wetlands to sea level rise is coastal 'squeeze,' a consequence of long-term coastal protection strategies, such as dikes"); *see also* Louise W. Bedsworth & Ellen Hanak, *Adaptation to Climate Change: A Review of Challenges and Tradeoffs in Six Areas*, 76 J. AM. PLAN. ASS'N 477, 479 (2010) ("Sea-level rise will . . . accentuate the existing tradeoffs between coastal development and coastal ecosystem conservation.").

72. *See generally, e.g.*, A. M. Nahlik & M. S. Fennessy, *Carbon Storage in US Wetlands*, 7 NATURE COMM. 13835: 1 (2016) (highlighting the role of wetlands in storing carbon).

73. Laukkonen et al., *supra* note 24, at 289.

74. *See* Jerome Whitington, *Modernist Infrastructure and the Vital Systems Security of Water: Singapore's Pluripotent Climate Futures*, 28 PUB. CULTURE 415, 417, 420 (2016) (noting that Singapore's adaptation policy is grounded in its vital systems security policies and pointing out that Singapore's adaptation focuses more on environmental engineering and planning rather than assessing uncertainty and allowing flexibility); *see also* Eric Klinenberg, *Climate Change: Adaptation, Mitigation, and Critical Infrastructures*, 28 PUB. CULTURE 187, 191 (2016) (summarizing Whitington's argument that "government officials [in Singapore] have framed conventional population security policies as climate change adaptation strategies"). Vital systems are interlinked systems that a society depends on to function property. *See generally* Stephen J. Collier & Andrew Lakoff, *Vital Systems Security: Reflexive Biopolitics and the Government of Emergency*, 32 THEORY, CULTURE & SOC'Y 19 (2015) (describing "the historical emergence of vital systems security").

75. *See* Whitington, *supra* note 74, at 420 ("[Singapore] is far too confident that it knows what climate change holds in store, with the result of limiting its apprehension of the future to a small number of constrained variables.").

goals under a linear projection of global warming[76] and would in fact increase its carbon emissions by as much as 60 percent.[77] Absent a consistent understanding of what adaptation entails, multiple actors would be operating under different climate paradigms using the same "adaptation" label, which can exacerbate the existing fragmentation of the climate landscape.

B. Features of a Network-Based Approach

A network-based approach has multiple advantages and can effectively mitigate these existing and potential consequences of the fragmented adaptation landscape. In recent years, subnational initiatives in the U.S. have become more connected with each other, and their success illustrates some of these advantages.

One of the major advantages of a network-based approach is knowledge sharing. Communities facing similar climate challenges can share knowledge and experience, thus reducing the cost of adaptation design and promoting the development of better adaptive strategies. Furthermore, communities can better identify synergies and tradeoffs through collaboration, thus better integrating adaptation and mitigation.[78] Knowledge sharing can also reduce the inequality in adaptive capacities by enabling vulnerable communities to strategically allocate limited resources.

In the United States, for example, a major platform for adaptation knowledge sharing is the Adaptation Clearinghouse operated by Georgetown University.[79] Launched in 2011, the Clearinghouse contains over 2,000 adaptation resources[80] to assist state and local policymakers and academics to share information and build

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76. *See id.* at 417 (citations omitted) ("Singapore's planners assume that forecasted climate changes will be limited to small, quantitative increases in set variables . . . [and] fail to consider the likelihood of potentially nonlinear or chaotic impacts on vital systems security.").

77. *Id.* at 431 ("The national policy advertises an 11–16 percent decrease in carbon intensity by 2020, while real greenhouse gas emissions will increase by at least 60 percent, to sixty-five metric tons, by 2020.").

78. *See* IPCC FIFTH ASSESSMENT REPORT, *supra* note 23, at 1117 (noting that "combined adaptation and mitigation policy designs" should "avoid[] trade-offs, . . . identify[] synergies, . . . enhanc[e] responsible capacity, . . . [and] develop[] institutional links between adaptation and mitigation").

79. ADAPTATION CLEARINGHOUSE, https://www.adaptationclearinghouse.org/ (last visited Apr. 29, 2018).

80. *Adaptation Clearinghouse 2.0 Launches with Powerful New Tools for Adaptation Professionals*, GEORGETOWN CLIMATE CTR. (July 14, 2016), https://www.georgetownclimate.org/articles/adaptation-clearinghouse-2-0-launches-with-powerful-new-tools-for-adaptation-professionals.html.

partnerships.[81] Resources include legal and policy developments in different jurisdictions, updates of scientific development, and spatial planning strategies. The resources can be sorted by state or by sector, and the Clearinghouse tracks each states' adaptation progress. Visitors can also register and manage their adaptation networks through the platform, an especially useful feature for adaptation officials.[82] This model can feasibly be implemented internationally, with academic institutions, non-governmental organizations, and local communities participating in knowledge sharing platforms and partnerships.

In addition, regional coordination in designing and implementing adaptation infrastructure will be especially useful as jurisdictions in close geographic proximity also face similar climate challenges. Regional coordination can take place at different levels of governance and among different kinds of actors. For example, in the U.S., a few counties in southeast Florida entered the Southeast Florida Regional Climate Compact to respond to the region's particular vulnerabilities to sea level rise by "reshap[ing] facilities for managing storm water, wastewater, and drinking water in anticipation of hydrology reshaped by higher sea levels."[83] Such subnational inter-jurisdictional partnerships allow members to better leverage their federal and state funding sources and coordinate adaptive policies in a manner that is mindful of nearby jurisdictions' needs and capacities.

To encourage local innovation and partnership, domestic legal reform is necessary. Currently, in the U.S., the ability of state and local governments to establish innovative programs and inter-jurisdictional alliances is limited. For example, states hoping to build resilience in food security by promoting domestic agriculture may be barred from doing so by the Dormant Commerce Clause, which prohibits states from discriminating against out-of-state products.[84] Some states even voluntarily restrict their ability to adopt more progressive forms of climate action. In North Carolina, for example, the state legislature

81. *See generally About the Adaptation Clearinghouse*, ADAPTATION CLEARINGHOUSE, http://www.adaptationclearinghouse.org/about.html (last visited April 28, 2018).

82. ADAPTATION CLEARINGHOUSE, *supra* note 79.

83. RICHARD H. MAYS, ENVIRONMENTAL LAW FORMS GUIDE § 29:10 (3d ed. 2018); *see also What Is the Compact?*, SE. FLA. REG'L CLIMATE CHANGE COMPACT, www.southeastfloridaclimatecompact.org/about-us/what-is-the-compact (last visited Apr. 29, 2018) (providing an overview of the Compact).

84. *See* Michael Barsa, *Rethinking the Dormant Commerce Clause?: Climate Change and Food Security*, 13 NW. J. L. & SOC. POL'Y 40, 56 (2018) (discussing how the uneven geographic concentration of food production in the U.S. makes crops especially vulnerable to climate events and noting that distributing food production in different states must overcome barriers imposed by the Dormant Commerce Clause).

passed a "federal ceiling" provision in its Administrative Procedure Act that significantly limits the state's ability to adopt more stringent environmental standards than existing federal standards.[85] Local governments are similarly bound by laws that prohibit them from pursuing creative adaptive strategies. In so-called "Dillon's rule states," local governments may not pursue initiatives unless explicitly sanctioned by the state legislature.[86] A 2010 survey showed that at least 36 states in the U.S. are Dillon's rule states.[87] In other words, in most states, local governments lack the legal infrastructure to adopt innovative adaptation policies. Dillon's rule centralizes decision making power in the state and limits local governments to *ex ante* policy tools on the books, but the complexity and uncertainty of climate change mandate flexible and customized arrangement in the delegation of political power. Thus, domestic legal reforms that empower state and local governments are necessary to effectively unleash the resources and partnerships of local adaptive strategies.

The most important aspect of a network-based approach is ensuring all actors' access to resources. Compared to a centralized governance framework, a network-based one can incur significantly higher transaction costs in assessing the scientific and social implications of the compound impact of climate change,[88] in coordinating inter-jurisdictional negotiations, and in establishing new institutions that facilitate learning and regional partnerships.[89] The

85. *See* N.C. GEN. STAT. § 150B-19.3(a) (2018) ("An agency authorized to implement and enforce State and federal environmental laws may not adopt a rule for the protection of the environment or natural resources that imposes a more restrictive standard, limitation, or requirement than those imposed by federal law or rule, if a federal law or rule pertaining to the same subject matter has been adopted, unless adoption of the rule is required by one of the subdivisions of this subsection.").

86. *Cities 101 – Delegation of Power*, NAT'L LEAGUE OF CITIES (Dec. 13, 2016), https://www.nlc.org/resource/cities-101-delegation-of-power (describing that Dillon's rule is a "narrow interpretation of a local government's authority" that allows "a substate government . . . [to] engage in an activity only if it is specifically sanctioned by the state government"). The rule originated from an opinion by Iowa Supreme Court Chief Justice John F. Dillon, in which he declared: "Municipal corporations owe their origin to, and derive their powers and rights wholly from, the legislature. It breathes into them the breath of life, without which they cannot exist." City of Clinton v. Cedar Rapids & Mo. River R.R. Co., 24 Iowa 455, 475 (1868).

87. MATTHEW SELLERS UNDER THE DIRECTION OF JACQUELINE BYERS, NAT'L ASS'N OF CTYS., COUNTY AUTHORITY: A STATE BY STATE REPORT 204–05 (Dec. 2010).

88. *See supra* notes 64–68 and accompanying text (noting the need to assess and respond to not just the impact of climate change itself, but also the impact of adaptive strategies responding to climate change).

89. *See* SUSAN KINNEAR, KYM PATISON, JULIE MANN, ELIZABETH MALONE & VICKI ROSS, NAT'L CLIMATE CHANGE ADAPTATION RESEARCH FACILITY, NETWORK GOVERNANCE AND CLIMATE CHANGE ADAPTATION: COLLABORATIVE RESPONSES TO THE QUEENSLAND

existing vulnerability and resource gap among jurisdictions is already putting poor jurisdictions at a significant disadvantage in adapting to climate change, and a network-based approach oblivious to this inequality would undermine its effectiveness by excluding poorer countries from sharing and contributing to the network. As private capital plays a bigger role in adaptation financing, less developed countries are at a greater disadvantage. Institutional investors are less aware of investment opportunities for climate adaptation; even those that are aware tend to perceive those investments as having less developed financial systems and more volatile markets.[90] Yet, these countries potentially provide better investment opportunities given their greater need for adaptation. A successful network-based framework, therefore, must ensure information and financial inclusivity.

IV. CONCLUSION

Cities and local communities are developing ambitious, innovative strategies to adapt to climate change, but there has not been adequate discussion over the necessity for and approaches to coordinating these efforts. This neglect can significantly impair the effectiveness of climate action due to the distinct challenges of climate adaptation. This paper draws attention to the perils of uncoordinated adaptation and argues that a network-based approach is better suited for adaptation coordination. While the foregoing discussion focuses on adaptation in particular, the network-based approach it proposes is not meant to isolate adaptation from other policy priorities. Rather, adopting a fresh paradigm to analyzing adaptation coordination can promote other policy priorities[91] and facilitate the development of an integrated framework for climate action.

FLOODS 9 (2013) (citations omitted) (noting "a prerequisite for [the] formation and effective function [of network governance frameworks] is that sufficient human, social and economic resources are available to outweigh the transaction costs").

90. *See* Geoffrey Heal, *Funding Climate Adaptation*, *in* THE PARIS AGREEMENT AND BEYOND: INTERNATIONAL CLIMATE CHANGE POLICY POST-2020, at 92 (Robert N. Stavis & Robert C. Stowe eds., 2016) (noting challenges to private adaptation investments in less developed countries).

91. *See supra* notes 65–67 and accompanying text (discussing how a network-based approach can identify synergies between policyd priorities and address existing inequalities).