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Integrating the Law of the Rio Chama through Institutional Ontologies of The Middle Rio Grande Basin

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INTEGRATING THE LAW OF THE RIO CHAMA THROUGH INSTITUTIONAL ONTOLOGIES OF THE MIDDLE RIO GRANDE BASIN

*Terror is lawfulness, if law is the law of the movement of some suprahuman force, Nature or History. * * * If the essence of government is defined as lawfulness, and if it is understood that laws are the stabilizing forces in the public affairs of men (as indeed it always has been since Plato invoked Zeus, the god of the boundaries, in his Laws), then the problem of movement of the body politic and the actions of its citizens arises. Lawfulness sets limitations to actions, but does not inspire them; the greatness, but also the perplexity of laws in free societies is that they only tell what one should not, but never what one should do. The necessary movement of a body politic can never be found in its essence if only because this essence—again since Plato—has always been defined with a view to its permanence. Duration seemed one of the surest yardsticks for the goodness of government*

—Hannah Arendt^

You want me to land on Earth? Why? ***— Because you're hanging in midair, headed for a crash?*** *— How is it down there? —* ***Pretty tense.*** *— A war zone? —* ***Close: a Critical Zone, a few kilometers thick where everything happens.*** *— Is it habitable? —* ***Depends on your chosen science.*** *— Will I survive down there? —* ***Depends on your politics.***

—Bruno Latour & Peter Wiebel&

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^ HANNAH ARENDT, THE ORIGINS OF TOTALITARIANISM 465, 466–67 (1976 ed. with added prefaces).

& LATOUR & WIEBEL, *infra* note 1, at Cover.

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ABSTRACT

The Law of the River is paradigmatically the legal and policy framework for river basin governance in the largely arid Western United Sates. In parsing this notoriously arcane body of law, complexity theory and jurisprudence, or the philosophy of law, are useful tools. This work develops and applies a conceptual model of the Middle Rio Grande basin as a social–ecological system in an attempt to improve understanding, transparency, and a sense of meaning of the so-called Law of the River. This project confronts the legal ecology of the "Great River" and its principle middle valley tributary, northern New Mexico's Rio Chama, through the lens of what it takes to operationalize instream ecological flows. The overarching "legal mapping" analysis draws on various strands of theory and practice coalescing around the diversity of institutions—or "institutional ontologies"—which, employing techniques of material culture, or new materialism, are constitutive of and indeed construct the Law of the River.

On the question of instream flows, the legal analysis is mainly descriptive, prescriptive, and ethical by nature. It also draws on a significant body of interdisciplinary scholarship and applied research into the coupled legal–operational framework for New Mexico's Rio Grande reservoirs. Especially relevant are the efforts of the Rio Chama Flow Project, a multistakeholder initiative studying and advocating for multi-objective instream flows on the Wild and Scenic-designated reach of the Rio Chama between El Vado and Abiquiu reservoirs. This otherwise largely untouched stream segment is, paradoxically, a highly engineered

system and a core part of the transbasin water transfer under Reclamation's San Juan–Chama Project. Owing to these marked contrasts, the Rio Chama is, therefore, ripe for scientific and institutional analysis, which is where this article joins the relay, with its unpacking of the mechanisms for instream flow innovation there. But the Rio Chama Flow Project's original legal hypothesis—that these instream, ecological flows can be further optimized throughout novel applications of hitherto underutilized "flexibility" in existing legal authorities, requires refining.

As this article asserts, we must urgently and fundamentally reorient ourselves with respect to the Law of River considering: 1) the manifold contingencies and historic processes which it rests upon; 2) the planetary forces and mission-critical exigencies of global climate, as reflected in local social–hydrologic conditions; together with 3) the core attendant issues of justice—including indigenous rights and settler colonialism—all in a fundamentally transboundary, entangled assemblage. To put it more prosaically, a complex, adaptive system. Because the Law of the River is such an apparent lingua franca or boundary object, the ontology of this legal framework is an idoneous starting point, methodologically and substantively, since canonical water law and policy belie that constitutive diversity of this not merely abstract but situated, material, and embodied, body of law.

INTRODUCTION

The Rio Grande is constitutive of a "Critical Zone" undergirding life in many forms.[1] The river flows from Colorado, through New Mexico, then to Texas, and empties into the Gulf of Mexico. It tracks the entirety of the boundary between Texas and Mexico.[2] Like the river itself, the Middle Rio Grande Basin is a complex, adaptive system, especially considering the management and governance of its waters—the Critical Zone's lifeblood. The rules governing such waters, both legally and institutionally, are codified in the so-called *Law of the River*.[3] Such "rules"

1. BRUNO LATOUR AND PETER WIEBEL EDS., CRITICAL ZONES: THE SCIENCE & POLITICS OF LANDING ON EARTH (2020).

2. Mexico's full name is *Estados Unidos Mexicanos*, *i.e.*, the United *Mexican* States.

3. *See generally* Adell Amos, *Developing the Law of the River*, 62 KANS. L. REV. 1092 (2014); James Robison, The Law of the Colorado River: A Contemporary Perspective on its Transformation (2013) (unpublished dissertation, Harvard Law School) (on file with author).

contain multiform infrastructural,[4] institutional,[5] cultural[6] and other such elements.[7] An entangled assemblage,[8] the resultant institutional ontologies require integral heuristics and analytics to properly convey their constitutive diversity, critical to justice and to the continued survival and dignity of human life and that of our more-than-human relations.

While the Law of the River can be quite abstract, grounded notions of climate justice and related matters[9] help to foreground, and thus highlight the Middle Rio Grande system's precarity.[10] As of this writing, the basin is projected to experience the worst spring runoff conditions in nearly 70 years, with much of New Mexico facing "exceptional drought conditions."[11] This precarity highlights threats to human life, culture, and survival and the urgency, stakes, and scope of the policy responses needed. Still, "you can't manage what you don't measure," as the maxim goes. And so, an adequate mapping of these manifold agents, structures, and behaviors—*emergent properties* themselves—must not only be done, but disseminated and deliberated, urgently, and transparently.[12] This exercise, while daunting and slow-moving, would be a step toward addressing the critical, intertwined threats to life and dignity posed by global change and adjacent resource-consuming political economies, such as settler colonialism. These economic systems and attendant human and environmental effects are deeply rooted, historically and racially. They are also, importantly, present realities in the Western United States

4. *Cf.* ANDREA BALLESTERO, A FUTURE HISTORY OF WATER (2019).

5. *Cf.* KATHARINA PISTOR AND OLIVIER DE SCHUTTER EDS., GOVERNING ACCESS TO ESSENTIAL RESOURCES (2015); ELINOR OSTROM, UNDERSTANDING INSTITUTIONAL DIVERSITY (2005).

6. *Cf.* HERMAN GRAY AND MACARENA GÓMEZ–BARRIS EDS., TOWARDS A SOCIOLOGY OF THE TRACE (2010).

7. *Cf.* Robison, *supra* note 3; William K. Jaeger et al., *Finding Water Scarcity Amid Abundance Using Human–Natural Systems Models*, PROCEEDINGS OF THE NAT'L ACADEMIES OF SCIENCE (2017); BALLESTERO, *supra* note 4.

8. *See, e.g.*, IAN HODDER, ENTANGLED: AN ARCHAEOLOGY OF THE RELATIONSHIP BETWEEN HUMANS AND THINGS (2012); MANUEL DELANDA, ASSEMBLAGE THEORY (2016) (drawing on the concepts of "entanglement" and "assemblage [theory]" as developed by such scholars as anthropologist Ian Hodder and philosopher Manuel DeLanda).

9. *See, e.g.*, Darren Modzelwski, *Pueblo Water Rights*, *in* INDIGENOUS JUSTICE: NEW TOOLS, APPROACHES, AND SPACES 53, 53–68 (Jennifer Hendry et al., eds., 2018); Richard Hughes, *Pueblo Indian Water Right: Charting the Unknown*, 57 NAT. RES. J. 219 (2017).

10. *See, e.g.*, LAURA PASKUS, AT THE PRECIPICE: NEW MEXICO'S CHANGING CLIMATE (2020); ELIZABETH KOLBERT, THE SIXTH EXTINCTION: AN UNNATURAL HISTORY; WILLIAM DEBUYS, A GREAT ARIDNESS: CLIMATE CHANGE AND THE FUTURE OF THE AMERICAN SOUTHWEST (2011).

11. *See* Theresa Davis, *NM Water Managers Warn Communities to Prepare for Low Rio Grande*, ALBUQUERQUE J. (Jan. 31, 2021, 10:36 pm), https://www.abqjournal.com/2354734/nm-water-managers-warn-communities-to-prepare-for-low-rio-grande.html (MRGCD chief engineer and CEO forecasting worst "water shortages and storage restrictions . . . since the 1950s"); Hannah Grover, *Amid Drought, Interstate Stream Commissions Seeks Federal Support*, NM Political Rpt. (May 2, 2021), https://nmpoliticalreport.com/2021/05/02/amid-drought-interstate-stream-commission-seeks-federal-support/.

12. *Cf.* Robison, *supra* note 3; *see, e.g.*, Burke W. Griggs, *The Political Cultures of Irrigation and the Proxy Battles of Interstate Water Litigation*, 57 NAT. RES. J. 1, 12 (2017); James Ragsdale, Jr., *Anasazi Jurisprudence*, 22 AMER. INDIAN L. REV. 392; VINE DELORIA, JR., METAPHYSICS OF MODERN EXISTENCE (2012; paperback ed.); BALLESTERO, *supra* note 4; ERIC P. PERRAMOND, UNSETTLED WATERS: RIGHTS, LAW, AND IDENTITY IN THE AMERICAN WEST (2018).

("U.S.") and, in particular, New Mexico. Unpacking and integrating these realities provides a crucial perspective for formulating ethical policy responses to the manifold challenges facing river basin governance in the arid West.

The legal and policy framework for river basin governance is the so-called Law of the River. Complexity theory and jurisprudence are both useful, if seldom used, tools for parsing this notoriously complex, arcane body of law. Towards such a challenging meaning-making exercise, this article develops and applies a conceptual model to make sense of the Middle Rio Grande Basin as a notional social–ecological system in terms of a legal ecology of the Rio Grande and the Rio Chama, its principal tributary north of Mexico. Such a *legal mapping* analytic draws on various strands of theory and praxis coalescing around ontology. The model comprises descriptive and prescriptive elements which, however provisionally integrated, point to and roughly sketch some contours of critical emergent ethical dimensions of water law, policy, and management—and of natural resource use and management more generally. This empirical–theoretical method also draws on new materialism—a transdisciplinary field which proffers "an ontological reconceptualization of the material world"[13] and related approaches, such as legal geography,[14] to think about the problematics imminent in paradigmatic political economy, which no doubt extend into the natural resources' domain.[15]

This article draws on earlier research into legal and operational aspects of reservoir operations in the system, work which has often been carried out under the auspices of the Rio Chama Flow Project, in collaboration with its various stakeholders, and researchers. The Flow Project obtains funding from the U.S. Bureau of Reclamation ("Reclamation"), the de facto *water master* of the rivers Chama and Grande. Flows on the Rio Chama are driven by Reclamation's transbasin San Juan–Chama Project. This transdisciplinary, multistakeholder initiative has been promoting, and operationalizing, ecological, flows on a federally designated "Wild and Scenic"[16] segment of the Rio Chama between El Vado and Abiquiu reservoirs in northern New Mexico. These two reservoirs are operated and managed by Reclamation, and the Army Corps of Engineers ("the Corps"). Unsurprisingly, this

13. Melinda H. Benson, *New Materialism: an Ontology for the Anthropocene*, 59 NAT. RESOURCES J. 251, 253 (2019) [hereinafter M.H. Benson (2019)] (offering, by way of explanation, new materialism's alternative guises: "post-humanism, agential realism, and new or vital materialism," i.e., those field fields representing a "move away from the centrality of the human and toward a more complex and relational perspective" on life, e.g., politics for take but one example).

14. *See, e.g.*, Melinda Morgan, *Rules of Engagement: The Spatiality of Judicial Review*, *in* THE EXPANDING SPACES OF LAW: A TIMELY LEGAL GEOGRAPHY (2014).

15. *See, e.g.*, Sarah Krakoff, *Settler Colonialism and Reclamation: Where American Indian Law and Natural Resources Law Meet*, 24 COLO. NAT. RES., ENERGY & ENVT'L. L. REV. 261, 264–83, 285 (2013) (arguing that "in response to the thorny questions . . . how tribes should be able both to quantify and use their water today, answers should be consistent with the goal of unraveling our settler-colonial past") (internal citation omitted); *cf.* Melinda Morgan, *Mining Sacred Space: Law Enactment of Competing Ontologies in the American West*, 44 ENVT'L & PLANNING A 44: 1443 (2012); *see* Eduardo Galeano, OPEN VEINS OF LATIN AMERICA: FIVE CENTURIES OF THE PILLAGE OF A CONTINENT (Engl. trans. 1997) (giving the classic account of this phenomenon in the Americas but do note that, for what it is worth, the author later disavowed the work; *see* Larry Rohter, *Author Changes His Mind on 70s Manifesto*, N.Y. Times (May 23, 2014), *available at* https://www.nytimes.com/2014/05/24/books/eduardo-galeano-disavows-his-book-the-open-veins.html).

16. Krakoff, *supra* note 15.

otherwise largely untouched Wild and Scenic segment of the Rio Chama is nonetheless a highly engineered system. This apparent paradox results from a large—approximately 100,000 acre-feet per year—transbasin water transfer, from the Colorado River Basin to the Rio Grande Basin. This transfer, by means of the San Juan–Chama Project, primarily serves the City of Albuquerque and the state's largest irrigation district, the Middle Rio Grande Conservancy District ("MRGCD").

The Rio Chama Flow Project's original legal hypothesis, that ecological flows on the river and elsewhere in the Middle Rio Grande Basin can be optimized by underutilized flexibility in existing legal authority, requires refining. History's manifold contingencies, projected climate change-related decrease surface water flows, and core issues of justice—including indigenous rights—are but a sampling of the many reasons why. Whether ecological flows can be improved by way of underutilized flexibility in existing legal authority, and the consequent question of how to effectuate such innovations, requires investigation of what the Law of the River is, exactly. This descriptive task frames the approach taken to water governance in the Middle Rio Grande, particularly complex adaptive system with attendant ontological registers. The jurisprudential, legal, analytical, and ethical issues in such an approach suggest a learning agenda that would pose policy questions whose effective resolution is necessary to maintain the just and dignified habitability of the Critical Zone. These far-from-straight-ahead legal issues implicate paradigm shifts, squarely confronting matters of institutional economics, and complex adaptive systems, for example, harkening to the Bloomington school of political economy[17] and the Santa Fe school of complexity theory,[18] respectively.

Complexity and law, in turn, intersect by way of computational legal analysis,[19] which though quantitative in terms of its use of legal texts as data, nonetheless provides a useful conceptual framework—*legal analytics*, as one of its leading scholars, Kevin Ashley, calls it.[20] As it turns out, legal analytics has been employed as a front-line water management tool going back nearly two decades. Indeed, the flagship Upper Rio Grande Water Operations Model ("URGWOM"), used by all major water managers in the Middle Rio Grande, models water allocation and use through 200 discrete extant law and policy rules.[21] The law and policy rules and concomitant ontologies required to cope with such complex systems in the face of threats to human survival, to take but one example, are far from academic. The relevance of this application of legal analytic has grown, if anything.[22] As this article will show, the assemblage they comprise represents myriad entanglements, from

17. *Cf*. OSTROM, *supra* note 5.

18. WORLDS HIDDEN IN PLAIN SIGHT: THE EVOLVING IDEA OF COMPLEXITY AT THE SANTA FE INSTITUTE 1984–2019 (David Krakauer ed.) (2019) (overviewing the Santa Fe Institute's work in this field, spanning the nearly four decades).

19. *See, e.g.*, LAW AS DATA: COMPUTATION, TEXT AND THE FUTURE OF LEGAL ANALYSIS (Michael A. Livermore and Daniel N. Rockmore, eds., 2019); Eric Williamson, *In New Book, Michael Livermore Delves int Data's Possibilities*, Univ. of Virginia News & Media (June 3, 2019) (containing embedded link to a short interview and a podcast episode featuring Prof. Livermore on this topic).

20. *See* KEVIN D. ASHLEY, ARTIFICIAL INTELLIGENCE AND LEGAL ANALYTICS (2017).

21. Craig Boroughs, Upper Rio Grande Water Operations Model (URGWOM): RiverWare Ruleset Documentation, Version 5.0.2 (Sept. 12, 2013) [hereinafter URGWOM Ruleset].

22. *Id.*

political ecological to geomorphology. Popular, even expert, discourse often falsely distinguishes between the legal and the physical, and between the social–ecological and the phenomenological, etc.

Notwithstanding the urgency of operationalizing legally defensible instream flows and, to this end, refining the Flow Project's legal flexibility, the hypothesis is admirably simple and elegant. This adaptive management-flavored hypothesis appears quite appropriate, if at first blush unremarkable, given the setting's thoroughgoing transboundary architecture.[23] Within this networked, polycentric system of governance, where "colors" of water and attendant legal authorities are multiple and manifest in various social–ecological configurations, their disposition implicates multiple valences and plural fields, which implicate fundamental ontological issues in law and society.[24] This then implicates our fundamental orientation to the material world—and each other.[25] Throughout the West, legal arguments like those implied by a narrow view of the Law of the River or of the legal flexibility hypothesis both belie the constitutive diversity of what the law of the river is, exactly.[26] This article attempts to first describe such complexity and then engage a meaning-making investigation[27] whose coupled empirical and analytical dimensions[28] attempt to address the crucial threats of climate change and concomitant water insecurity vis-à-vis life, dignity, and justice in the Middle Rio Grande Basin.

In the so-called Anthropocene,[29] "past performance" is certainly "no longer" any "guarantee of future returns," as the investment maxim goes.[30] As various scholars and scientists have argued that the Law of the River is ripe for transformational analyses.[31] Their work has, in turn, identified a slew of critically applied research questions.[32] Underscoring this "Anthropocentric" moment, one pair

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23. Water flows in the Middle Rio Grande in a truly liminal setting: ecologically and culturally, but also through more than a half dozen sovereigns.

24. M.H. Benson (2019), *supra* note 13.

25. *Id.*

26. Salt River Water Users' Ass'n v. Kovacovich, 3 Ariz. App. 28, 411 P.2d. 201 (1966).

27. *See, e.g.*, Nicholas Blomley, *The Boundaries of Property: Complexity, Relationality, and Spatiality*, 50 LAW & SOC'Y REV. 224, 224 (2016).

28. *See generally* DAVID GROENFELDT, WATER AND ETHICS: A VALUES APPROACH TO SOLVING THE WATER CRISIS (2013).

29. *See generally*, Kolbert, *supra* note 10 (As our planet faces what may appears to be the sixth-ever mass extinction event, it could be said that such a centering of the human at this critical juncture does more harm than good, as various scholars have argued); *see, e.g.*, KATHRYN YUSOFF, A BILLION BLACK ANTHROPOCENES OR NONE 4 (2019) (this purported geologic epoch, offers a "view from nowhere," which points to, on its face, our "becoming post-racial through Anthropocentric speciation," but really is a "foil of the humanist trickster—one that places an injunction on the recognition of historic modes of geopolitical mattering while maintaining unequal relations of power through continued environmental exposures.") (quoting Toni Morrison's caution against such "metaphoric shortcuts" who language can "evoke and enforce hidden signs of racial superiority, cultural hegemony, and dismissive 'othering' of people and language").

30. *Cf. e.g.*, BALLESTERO, *supra* note 4 (regarding "so-called" Anthropocene); *see also, e.g.,* Jaeger, *supra* note 7.

31. Amos, *supra* note 3.

32. *See* Jaeger, *supra* note 7; *see also* Amos, *supra* note 3, at 1092–93; Robison, *supra* note 3, at 391–404.

of water law scholars have called for the "[e]nd of [s]ustainability" as the paradigmatic political response to the exigencies of global change.[33] This mode eschews traditional environmental governance for a resilience-based adaptive management that draws from complexity theory and emphasizes, for example, a "narrative of connection" and "living a new story."[34] Such a perspective is nothing new.[35] However, it accords with a growing chorus of voices in rejecting the view of humans as separate from nature, which is embedded in doctrinal environmental law.[36] To wit, many indigenous scholars offer convincing rejections of this sort of Cartesian dualism, through narratives that have been present from time immemorial, and continue to resonate.[37] These integrated perspectives provide a powerful lens into the entangled aspects of water, environmental, and natural resources law and policy.[38]

As developed herein, practical–empirical analysis offers insight to water managers and others, although modest contributions to the Law of the River jurisprudence may incidentally result. From the empirical standpoint, this work assembles a first-of-its kind Law of the Rio Chama. This framework was developed to support Reclamation's and other stakeholders' efforts of optimizing the Middle Rio Grande Basin water and reservoir operations for resilience and environmental flows. As a result of the first phase of the Rio Chama Flow Project's legal analysis, which this article articulates and extends, Reclamation has exhibited interest in further refining and documenting this system's legal complexity.

This article employs Ruhl and Katz's (2019) "legal mapping" methodology to better represent the complexity of this river, and thus improve Rio Chama water management towards the goal of operationalizing non-zero sum ecological flows.[39] Here, legal mapping will question the systemic complexity of the Law of the River in terms of the system's structure and behavior and with an eye towards—as Ruhl and Katz highlight—the important tasks of measuring and, prospectively, monitoring and stress-testing the system within such complexity regime.[40] The tasks, in the mapping model, incorporate elements of design—for example, routines, protocols, and technical tools. They also implicate management, such as measurement of system and behavior—for example, network analytics and feedback, respectively. Critical, too, is the task gaging system risk whereby, in the "legal mapping" domain one can think in terms of "stress tests," data feeds and "dashboards," and post-

33. MELINDA HARM BENSON & ROBIN CRAIG, THE END OF SUSTAINABILITY: RESILIENCE AND THE FUTURE OF ENVIRONMENTAL GOVERNANCE IN THE ANTHROPOCENE (2017).

34. *See generally id*.

35. *See* JEDEDIAH PURDY, THIS LAND IS OUR LAND: THE STRUGGLE FOR A NEW COMMONWEALTH (2019).

36. *Id*; *see also* JEDEDIAH PURDY, AFTER NATURE: A POLITICS FOR THE ANTHROPOCENE (2017).

37. *See generally* NICK ESTES, OUR HISTORY IN THE FUTURE (2019); ROZANNE DUNBAR– ORTIZ, AN INDIGENOUS PEOPLES' HISTORY OF THE UNITED STATES (2015); Ragsdale, Jr., *supra* note 12.

38. *See generally* Modzelwski, *supra* note 9; *cf.* MARTIN SHELDRAKE, ENTANGLED LIFE: HOW FUNGI MAKE OUR WORLDS, CHANGE OUR MINDS, AND SHAPE OUR FUTURES (2020); YUSOFF, *supra* note 29; JUSSI PAPRIKA, A GEOLOGY OF MEDIA (2015); ANNA TSING, THE MUSHROOM AT THE END OF THE WORLD: ON THE POSSIBILITY OF LIFE IN CAPITALIST RUINS (2014).

39. J.B. Ruhl & Daniel Katz, *Mapping Law's Complexity with "Legal Maps*," *in* COMPLEXITY THEORY AND LAW: MAPPING AN EMERGENT JURISPRUDENCE, ch. 2 (2019).

40. *Id*. at 37–42.

mortem analysis. In this connection, Reclamation and partners have pursued a more sophisticated modelling of complexity and system behavior, through updates to URGWOM.[41] This physical–computational mode is used to manage surface water from Colorado to Texas. The model contains a hierarchy of rules which reflect the taxonomy of legal authorities, from the Rio Grande Compact to the myriad operational—and arguably discretionary—decisions implemented by Reclamation, the Corps, and other water managers, such as the MRGCD. The legal mechanisms—indeed, legal authority—underlying this rule-based, complex (adaptive) system as captured, for example, in URGWOM, would appear amenable to rigorous analysis. Conceivably, the same type of algorithm-assisted decision-making water managers employ by URGWOM could be applied to deconstruct this model towards an improved understanding of the system. One possible framework for such a project is Kevin D. Ashley's "legal analytics," described in, *Artificial Intelligence and Legal Analytics: New Tools for Law Practice in the Digital Age*.[42]

More practically, this article also reports empirical results generated from the overarching exercise, developing a legal analysis appropriately attuned to the exigencies of the Rio Chama Flow Project's ecological flow optimization efforts. Philosophy aside, this article asserts that such empirical work is part and parcel of conceptual model development for a complexity theory-based legal analytics applicable to a real-world Law of the River.

Following that initial reportage, the article proposes a Law of the River-based conceptual model to capture the system's interdependent legal complexities. This conceptual model would comprise code-based legal reasoning which represents the relevant *legal* concepts (rules) in ontological terms (i.*e.*, what *is*). To wit, Reclamation's rule based URGWOM is an idoneous starting point. To extend this framework, the article also considers a case study in reservoir-based water management, a *pulse flow* event on the Rio Chama in 2016. In doing so, it describes and analyzes a flow operation which required the assent of the Rio Grande Compact Commission through an official Resolution of the tri-state authority, called a Resolution Hydrograph. In the same spirit, the article also comes to revisit one canonical interpretation of legal authority underlying a prominent tool for water management flexibility along the Rio Chama, the Heron Waiver, which permits contractors of San Juan–Chama Project water to take delivery of their Project annual water allotments within a certain period.

This work is also intended to be used as an adaptive management tool, helping to parse a complex system, and thus facilitate efficacious responses to water insecurity, which simultaneously indexes other critical issues of human wellbeing.[43]

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41. *Cf.* URGWOM Ruleset, *supra* note 21; *see generally* CRAIG BOROUGHS, USER MANUAL FOR WATER OPERATIONS AND FORECAST A MODULES OF URGWOM FOR PREPARING ANNUAL OPERATING PLANS, WATER OPS MODEL v-4.1.2 [hereinafter URGWOM Model v–4.1.2 User Manual] (2010).

42. ASHLEY, *supra* note 20.

43. *See generally* Kathleen Moore, Optimizing Reservoir Operations to Adapt to 21st Century Expectations of Climate and Social Change in the Willamette River Basin, Oregon, Ph.D. Diss. (Oregon St. Univ., June 2015); Mary Tchamkina, Evaluating the Need for Adaptation for U.S. Army Corps of Engineers Wilmington District Reservoirs, Masters Thesis (Duke Univ., April 2016); *see also* RIO CHAMA FLOW PROJECT, DRAFT PROPOSAL (Nov. 13, 2015) [hereinafter RCFP PROPOSAL] (intended outcomes) (noting goal of legal analysis to "prevent . . . institutional and operational constraints to modifying flows and storage" from becoming "fixed and inflexible"); Melinda Harm Benson, Ryan

Towards such resilience, it contributes to a growing portfolio of applied research showing that institutional and operational constraints on modifying flows and storage need not be treated as fixed and inflexible.[44] Next, it represents a curation of innovative water management responses in the Middle Rio Grande, historic and contemporary, and thus memorializes and transparently documents actual examples of reservoir operations flexibility, notably in the reservoir operations context. Historical bases for many operational constraints are characterized to show how the relevant assumptions may not be invalid.[45] In the end, the investigation underlying this article reveals that discretion is regularly exercised by water managers and recognizes this flexibility paradigm occurs both within and goes beyond existing legal authority. Similarly, it presents a refinement of the legal flexibility hypothesis for in-stream flows. Finally, it presents some options to extend the discretion–flexibility paradigm.

Moving from theoretical inquiries to practical modes, this work responds to stakeholder interest in refining water management decision-support tools for the Rio Grande Basin. Foremost among these tools is URGWOM, which is used by many government agencies, federal, state, and local, and which clearly captures the canonical elements of the Law of the River in stunning detail. Building on and conceptually going beyond URGWOM's rule-based system and dynamic modeling framework and similar approaches,[46] this article thus contributes to a more nuanced understanding of the information processing, feedback, and feedforward mechanisms which produce a structure of interconnected and interdependent agents throughout the system. These components are all the hallmarks of a complex, adaptive system.

Such legal–philosophical exploration of the political economy of water in the arid West, through the more integral dimensions of culture, livelihood, wellbeing, survival, and justice is as timely and relevant as ever. For example, while the Rio Grande and Rio Chama are not subject to active litigation like the San Pedro in Arizona, the Lower Rio Grande is, although stayed pending the resolution of the *Texas v. New Mexico* original action before the U.S. Supreme Court. In that case, as in the active water rights adjudication in Arizona's San Pedro Basin, it could well be

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Morrison, and Mark Stone, *A Classification Framework for Running Adaptive Management Rapids*, 18 ECOLOGY & SOC'Y, No. 3, Art. 30, at [PDF] pp. 3–8, esp. tbls. 2, 3 (2013)) [hereinafter M.H. Benson (2013)] (presenting a conceptual model for adaptive management and river restoration in the context of the Rio Chama).

44. *See, e.g.,* Victor Flatt & Jeremy Tarr, *Adaptation, Legal Resiliency, and the U.S. Army Corps of Engineers: Managing Water Supply in a Climate-Altered World*, 89 N.C. L. REV. 1499 (2011) (analyzing legal authority for Corps' reservoir operations with eye to (a) "preserving flexibility by exercising discretionary authority in inherent in common Corps' decisions" and "recognizing the flexibility paradigm and making it operational").

45. Melinda Harm Benson, et al., *Water Governance Challenges in New Mexico's Middle Rio Grande Valley: A Resilience Assessment*, 51 IDAHO L. REV. 195, 205–18 (2014) [hereinafter M.H. Benson (2014)] (suggesting avenues for "more flexible and adaptive strategies for water storage and delivery," highlighting institutional constraints (including operations restrictions at Heron and El Vado but noting that "changes are possible," giving the example of ca. 2007–10 Cochiti Deviation(s) and historical basis of many constraints, including "many . . . assumptions . . . [which] are now known to be invalid").

46. *See, e.g.*, Ryan Morrison, Managing Complex Water Resource Systems for Ecological Integrity: Evaluating Tradeoffs and Uncertainty (2014) (civil engineering Ph.D. dissertation, Univ. of New Mexico) (on file with author and the University of New Mexico).

said the "human abstractions of the natural world" at issue—namely, the distinction between groundwater and surface water—resultantly lend themselves to infinite debate, as if "to suit one's purposes."[47] While such philosophical musings are surprising, though not dispositive, when uttered by a government attorney in a legal brief, the abstraction was precisely the mark for Deloria's critical analysis[48] in his creative, emergent *Metaphysics*.[49] These "absurd result[s]" of Western water law, that endless recursion, with which Deloria engaged are thus becoming increasingly recognized.[50]

Part I inquires into and describes the premises underlying the article's overarching argument. That core assertion is that ecological precarity and myriad interdependencies of the Middle Rio Grande basin merit—demand, really—an adequate mapping of its variegated components, infrastructure, institutions, culture, and history, among other elements. That background narrative foregrounds the prescriptive issues which Part II pursues and highlights in terms of the Law of the Rio Grande and Rio Chama. This descriptive project builds on preliminary results, both scientific and legal, of the interdisciplinary Rio Chama Flow Project's longtime in-stream, ecological flow science and advocacy work. Building on this legal–operational, adaptive management framework, then, Part III presents contemporary views of the Law of the River, by contrasting it with more orthodox interpretations, and thus evaluating what these respective frames of reference fundamentally constitute, hereby hinting at why the entrenched, reductive, and paradigmatic view is misguided. Traces of important world-making possibilities of alternative interpretations are foreshadowed here as technical water management tools, including powerful physical–mathematical models that are compared with a suite of largely cooperative, negotiated agreements, and water exchanges and transfers.

Part IV, the core of the article, applies the complexity jurisprudence framework thus developed to present more realistic, if not truly integral Law of the River, proceeding in three main steps. First, it explores the legal analysis of a 1983 Department of the Interior Solicitor's legal opinion rejected, then abruptly blessed, a flexibility-generating interpretation of Congressional authorization of the transbasin San Juan–Chama Project diversion. This legal authority for so-called "carryover waivers" for storage San Juan–Chama Project water past year-end may be longest-standing source of reservoir operations and thus water management flexibility on the

47. *In Re: The General Adjudication of All Water Rights to Use Water in the Gila River System and Source*, Contested Case No. W1–103, *In re San Pedro Subflow Technical Report*, U.S. Response Brief 3–4, 4, filed Nov. 13, 2019 (arguing against, in longstanding case which has not yet finally resolved the distinction, *if* any, between surface water and groundwater in an groundwater-fed desert stream system, against premise that "classifications of water exists in nature," highlighting the "logical fallacy of reification" of such a proposition and noting that man-made abstractions as "the map" or "the terrain" are "mere approximation, the accuracy of which one may questions, revisit, and debate *ad infinitum*, to suit one's purposes").

48. DELORIA, *supra* note 12, at 179 (interpreting the prior appropriation case which providing Arizona's rule regarding "salvaged" water, *Salt River Water Users' Ass'n v. Kovacovich*, 3 Ariz. App. 28, 411 P.2d. 201 (1966)) (observing, trenchantly, that if "our legal system reflects our view of reality, [] we believe we exist [] apart from the physical world").

49. *See, e.g.*, DELORIA, *supra* note 12.

50. U.S. Response Brief 4, W1-103, *In re San Pedro Subflow Technical Report* (Nov. 13, 2019) ("absurd result," *i.e.*, parochial debate and thus recursion "*ad infinitum*").

Rio Chama. This case suggests opportunities for creative legal analysis, even as it long preceded technical water resources modeling, which aid current efforts. One venue suggested for such integrated legal analytics if is the case of storage pursuant to the Prior and Paramount water rights of the Six Middle Rio Grande Pueblos, also discussed. Second, it deconstructs the coupled legal–practical underpinnings of the "Resolution Hydrograph" of 2016—an experimental instream ecological "pulse flow" event on the Chama blessed by the eponymous authorizing issued by Rio Grande Compact Commission. Finally, Part IV reflects on this foray into innovative empirical aspects of MRG water governance, offering some potential flexibility mechanisms, highlighting too the political–ecological elements of the conceptual model presented—often overlooked by canonical representation of the Law of the River.

I. BACKGROUND

The geology, history, geography, and ecology of the Rio Grande Basin yields an appropriate—and unique—setting for studying reservoir operations, their legal framework, and the potential adaptive capacity of each in the face of global changes. Diversity produces resilience[51] and the Rio Grande Basin has a rich history that is characterized by geographic and cultural diversity.[52] Geographically, the headwaters of the Rio Grande lie above the tree line in the southern reaches of the Rocky Mountains. From there, the river gains as it flows through the parched Colorado Plateau of northern New Mexico and feeds the Pueblo civilizations, as well as newer Anglo developments in the Middle Rio Grande from roughly Albuquerque to Socorro. Prior to forming the international boundary between Mexico and the U.S., the river provides for extensive irrigated agriculture in the northern reaches of the Chihuahuan Desert; from source to sea, the river flows 1,896 miles.[53]

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51. *See, e.g.*, Thomas Friedman, Interview, LIVING ON EARTH (Dec. 16, 2016), http://www.loe.org/shows/segments.html?programID=16-P13-00051&segmentID=6 Cf.16, 2016), http://www.loe.org/shows/segments.html?programID=16-P13-00051&segmentID=6 (in other words, diversity—of ecology, landscapes, cultures, politics, for example—demands and thus produces resilience); *cf*. M.H. Benson (2014), *supra* note 45, at 198 (noting the contrast, in explaining how under resilience theory, regime shift causes transformation—both ecologically and politically).

52. *See generally* FRED M. PHILLIPS, G. EMLEN HALL, AND MARY E. BLACK, REINING IN THE RIO GRANDE: PEOPLE, LAND, AND WATER (2015) [hereinafter PHILLIPS]; PAUL HORGAN, GREAT RIVER: THE RIO GRANDE IN NORTH AMERICAN HISTORY (1991); IRA G. CLARK, WATER IN NEW MEXICO: A HISTORY OF ITS MANAGEMENT AND USE (1st ed., 2nd printing, 2002); *see also* STEVE HARRIS, LONG RIVER, SHORT WATER: THE RIO GRANDE WATER DEVELOPMENT STORY, in N.M. BUREAU OF GEOLOGY AND MINERAL RESOURCES, Decision-Makers Guide: Water Resources of the Middle Rio Grande: San Acacia to Elephant Butte 7–14 (L. Greer Price, Peggy S. Johnson, and Douglas Bland, eds., 2007); G. Emlen Hall, *The Middle Rio Grande—Short on Water, Long on Legal Uncertainties*, in N.M. BUREAU OF GEOLOGY AND MINERAL RESOURCES, Decision-Makers Guide: Water Resources of the Middle Rio Grande: San Acacia to Elephant Butte at 54–57 (L. Greer Price, Peggy S. Johnson, and Douglas Bland eds., 2007) [hereinafter Hall (2007)]; M.H. Benson (2014), *supra* note 45, at 199–200 (providing an overview of historical background); U.S. BUREAU OF RECLAMATION, WEST-WIDE CLIMATE RISK ASSESSMENT: UPPER RIO GRANDE IMPACT ASSESSMENT (Dec. 2013), at app. A, A-1–A-3 [hereinafter CLIMATE RISK ASSESSMENT] (summarizing basin history).

53. TEXAS PARKS AND WILDLIFE, RIO GRANDE BASIN, available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=25&ved=2ahUKEwi3qIWkperkAhVQoZ4KHdLQDY8QFjAYegQIARAC&url=http%3A%2F%2Ftpwd.texas.gov%2Fbusiness%2Fgr

A. Primer on Rio Grande History, Geography

While this work focuses on the Rio Grande's principal tributary, the Rio Chama, it necessarily involves a treatment of the Rio Grande from Española, in northern New Mexico at its confluence with the Rio Chama, through the middle Rio Grande valley, from Cochiti Reservoir to Elephant Butte. The Rio Grande follows the eponymous, roughly thirty-million-year-old, three-mile-deep Rift Valley from Colorado to Chihuahua, Mexico. Three sub-basins mark the Upper and Middle Rio Grande reaches, from north to south: The San Luis (in southern Colorado), the Española, and the Albuquerque basins, the latter of which exhibits a thickness of up to 1,500 feet. Precambrian rock forms the basement of the Middle Rio Grande, the surface exposure of which can be seen, for example, in the Sandia Mountains overlooking Albuquerque. For comparison, the modern Rio Grande Valley dates from approximately one million years ago, while the Albuquerque volcanoes erupted about 150,000 years ago. The area was first settled 12,000 years ago, with permanent settlement occurring roughly 1,500 years ago.[54]

Along the Rio Grande's path through varied landscapes, ecosystems, and cultures, the river operates as a liminal system. The river's ecological diversity mirrors the cultural diversity along its banks. New Mexico is home to twenty-three Native American tribes, including nineteen Pueblos, nearly all of which are situated alongside the Rio Grande. These tribes have inhabited their lands from time immemorial, through cycles of drought, colonization, and agricultural, socio-cultural, and economic development.[55] With the river's annual spring flooding, the historic floodplain comprised a similarly rich riparian ecosystem, characterized by cottonwood, migratory birds, waterfowl, and a variety of fish.[56] The Rio Grande is known as a "feast or famine" river because natural temporal variation in the river's flow has historically complemented its biological and geographical diversity.[57] A changing climate amplifies these variations, as drought and flood magnitudes increase and snowmelt runoff occurs earlier in the year.[58] This new exigency, along

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ants%2Fwildlife%2Fcwcs%2Fmedia%2Fdocs%2Frivers%2Friogrande1.doc&usg=AOvVaw3YXe9Rd8w7RUi8ta6Wh4bv.

54. Adrian Oglesby, The Colors of Water: Compact, Irrigations, M&A, Ecological, and Recreation (2010) (notes for talk given on Rio Chama rafting trip); *see also* PHILLIPS, *supra* note 52, at 11–23.

55. *See generally* ROXANNE DUNBAR–ORTIZ, ROOTS OF RESISTANCE: A HISTORY OF LAND TENURE IN NEW MEXICO (2007); ASHISH KOTHARI, PLURIVERSE: A POST-DEVELOPMENT DICTIONARY (2019).

56. *See* PHILLIPS, *supra* note 52, at 37–38; *cf.*, HORGAN, *supra* note 52, at 3–7; *see generally* U.S. FISH AND WILDLIFE SERVICE, FINAL BIOLOGICAL AND CONFERENCE OPINION FOR BUREAU OF RECLAMATION, BUREAU OF INDIAN AFFAIRS, AND NON-FEDERAL WATER MANAGEMENT AND MAINTENANCE ACTIVITIES ON THE MIDDLE RIO GRANDE, NEW MEXICO 27, 40, 41 (Dec. 2, 2016) [hereinafter 2016 BIOLOGICAL OPINION].

57. Kara Gillon, *An Environmental Pool for the Rio Grande*, 47 NAT. RES. J. 615, 617, n. 10 (2007) [hereinafter Gillon (2007)]; *See also* HORGAN, *supra* note 52, at 3–7 (describing the rich landscape in which the Rio Grande flows and the low volume of water that is typical of the Rio Grande); *see also* PHILLIPS, *supra* note 52, at Plate 28 (showing the ebb and flow of drought in the southwest); *cf.* DEBUYS, *supra* note 10, at 11 ("The physical landscape of New Mexico is as rich as its culture[.]").

58. *See, e.g.*, CLIMATE RISK ASSESSMENT, *supra* note 52, at s-iii–iv; *see* PASKUS, *supra* note 10; *see* DEBUYS, *supra* note 10, at 8–9; *see generally* David S. Gutzler, *Climate and Drought in New Mexico*, *in Water Policy in New Mexico: Addressing the challenge of an Uncertain Future* (David S. Brookshire, Hoshin V. Gupta, & Olen Paul Matthews, eds., 2012).

with the effects of human-induced alteration of the river's ecosystem and hydrograph, demands a new form of ecological resilience.

Humans have modified the natural hydrologic regime of the Rio Grande throughout historical and colonial times, but modern efforts altered the river on a vast scale. The river has a high sediment load and historically had a dynamic, braided river channel. Historically, its main water course could reach a half-mile width, and regular flooding would inundate the floodplain and reorient the channel's margins and sand bars.[59] By far the largest effect on the river's hydrograph in the Middle Rio Grande was occasioned within the past hundred years. In the nineteenth century, large-scale water storage and flood control projects were constructed from the Heron, El Vado, and Abiquiu reservoirs on the Rio Chama, to Cochiti and Elephant Butte on the main-stem Rio Grande.[60] The big dams of this area drastically affect a river's flow regime. In general, peak flows were dampened and stored by dams and released over time. This process also traps large quantities of sediment in each reservoir, which in turn causes river aggradation upstream and degradation downstream. Today, the Middle Rio Grande reach has largely been channelized through flood control structures like levees, resulting in a more homogenous, deeper, and swifter river with less—if any—hydraulic connection to its historic floodplain.[61]

Human settlement along the river is nonetheless a foundational aspect of current governance structure on the Rio Grande, which comprises elements both rooted and superimposed. The Middle Rio Grande basin is, in fact, home to one of the oldest, most developed hydraulic societies in the world. Native American Pueblo water use and governance dates back at least a thousand years. Historian Roxanne Dunbar-Ortiz notes that indigenous peoples in the Western Hemisphere had economies and institutions which supported populations on the same level as those of Europe at the time.[62] To wit, New Mexico was one of the most successful, and its complex irrigation systems date from pre-colonial times.[63] Because the past is often prologue, this vast history likely contain clues for "new" ecological resilience.

During the most recent 500-year period, the waters of the Rio Grande Basin have been governed by many sovereigns: multiple Native American pueblos; the Spanish crown; Mexico; the territory and then state of New Mexico; and the United States.[64] Spanish influence on water management in these areas dates to the

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59. *See, e.g.*, Teresa Rice, *The Middle Rio Grande Basin, New Mexico* (Ch.6), NAT. RES. L. CTR., VOL 2, 6-1-6-7 (1996) (narrating water supply development, geographic setting, as well as customary water management regimes).

60. Bruce Thompson, *Water Resources in New Mexico* 28–33, *in Water Policy in New Mexico: Addressing the challenge of an Uncertain Future* (David S. Brookshire, Hoshin V. Gupta, & Olen Paul Matthews, eds., 2012); *See, e.g.*, PHILLIPS, *supra* note 52, at 103–26.

61. *See, e.g.,* 2016 BIOLOGICAL OPINION, *supra* note 56, at 15–36, 42, 66; *Cf*. PHILLIPS, *supra* note 52, at 67–80, 144.

62. Audiotape: Roxanne Dunbar-Ortiz, Lecture, An Indigenous Economic Model, held by Alternative Radio (Feb. 2, 2017) (transcript on file with author).

63. *Id.*

64. *See* Modzelwski, *supra* note 9, at 53–65; *see generally* PERRAMOND, *supra* note 12; *see generally* DUNBAR–ORTIZ, *supra* note 55, at 3–17 (explaining the history of land sovereignty in New Mexico); *see generally* Malcolm Ebright & Rick Hendricks, *Pueblo Sovereignty: Indian Land and Water in New Mexico and Texas* 3–27 (2019) (explaining the history of the various tribes and pueblos that inhabited the area and transfers of power).

beginnings of European colonialism in the mid-1500s, including Spanish royal "granting" tracts of land, concomitant agricultural development, and the community-oriented governance of surface water irrigation known as acequias.[65] In 1848, these Pueblo and Hispanic lands formally passed from Mexico to the U.S. through the Treaty of Guadalupe Hidalgo.[66] Complex, competing claims among these groups—and other, more newly arrived groups such as Anglo settlers—persisted, and would multiply and continue to the present.[67]

After initial settlement by the ancestors of the modern-day Indian Pueblos, and the first wave of colonization by Hispanic citizens of Spain and Mexico, widespread human intervention in and development of the Rio Grande began in the mid-nineteenth century in the San Luis Valley of southern Colorado.[68] At this time, agriculture expanded significantly, facilitated by the construction of large-scale irrigation works and levees. The resultant increase in sediment load, along with river dewatering, channelization and narrowing, contributed to a newly aggrading river. In fact, increasingly frequent flooding and elevated water tables meant the river's nature, extent, and flow were becoming divorced from its historic, natural rhythms.[69]

The U.S. federal presence on the Rio Grande dates to the end of the nineteenth century, as the federal government became involved as a water developer, owing to the repeated failure of private irrigation enterprises.[70] Initially, the federal government imposed an embargo on non-federal development on the Upper Rio Grande from 1895 to 1925, as it investigated and then built the roughly 1 million acre-foot impoundment of water at Elephant Butte Dam and Reservoir.[71] In the mid-1920s, the MRGCD was founded to drain the swamplands that had developed along the newly aggrading Rio Grande.[72] While the MRGCD would come to be the core water supplier in the Middle Rio Grande—having consolidated dozens of individual acequias, including those from what came to be known as the Six Middle Rio Grande

65. *See, e.g.,* DUNBAR–ORTIZ, *supra* note 55, at 8, 31–45 (land grants), 10–11, 18–24 (irrigation and *acequias*), 58–60, 100–18 (irrigation, agriculture and land capitalization); PHILLIPS, *supra* note 52, at 10–11, 12, 11–23, 39–48, 61, 65 (explaining social institutions of water governance, Spanish influence, and acequias), 65–66 ("a plague of cattle").

66. Treaty of Peace, Friendship, Limits, and Settlement with the Republic of Mexico, Mex.-U.S., Feb. 2, 1848, 9 Stat. 922 [hereinafter Treaty of Guadalupe Hidalgo]; CLARK, *supra* note 52, at 24, 33, 35; *see generally* Hughes, *supra* note 9.

67. *See also* Hughes, *supra* note 9, at , 222 n. 7 (2017) (providing an overview of the nature of Pueblo land holdings in New Mexico, including by Spanish "grant"), 253–54 (noting impact of Spanish and Mexican law on Pueblo water rights); *see generally* PHILLIPS, *supra* note 52, at 24–33 (explaining the varies settlements along the Rio Grande and different irrigation techniques used); *see generally* MALCOLM EBRIGHT, ET AL., FOUR SQUARE LEAGUES: PUEBLO INDIAN LAND IN NEW MEXICO (UNM Press, 2014).

68. Griggs, *supra* note 12; Andrew Gulliford, *Aldo Leopold, Estella Bergere, Mia Casita and Sheepherding in New Mexico and Colorado*, 57 NAT. RES. J. 395, 397, 403 (2017), https://digitalrepository.unm.edu/nrj/vol57/iss2/6.

69. Oglesby, *supra* note 54; *see also* Gulliford, *supra* note 68, at 401–403; PHILLIPS, *supra* note 52, at 70–72.

70. *See, e.g.,* DOUGLAS LITTLEFIELD, CONFLICT ON THE RIO GRANDE: WATER AND THE LAW, 3–15, 16–165 (Univ. of Okla. Press, 2008); *See generally* CLARK, *supra* note 46, at 55–82.

71. *See, e.g.,* LITTLEFIELD, *supra* note 70, at 52–55, 147–65, 170–18, 186.

72. Middle Rio Grande Conservancy Dist., Senate Memorial 21 Task Force Studying the Electoral Process of the Middle Rio Grande Conservancy District: Findings and Recommendation, http://mrgcd.com/uploads/FileLinks/d001dbb5f28d48999cbeef85e264ce76/SM21_Final_Report.pdf

Pueblos—it was so unsuccessful at its original drainage project that it required a bailout by the federal government.[73] As Reclamation bolstered its water development and supply presence in the West, it cemented its presence in the Middle Rio Grande.[74] The bailed-out MRGCD, and its existing acequia infrastructure, became the cornerstone of Reclamation's Middle Rio Grande Project.[75]

B. Past Flex Points

This article describes several past water management actions that have illustrated the ability of water managers to find flexibility within their existing operating environment.[76] Historically these flex points have been identified in response to floods, droughts, infrastructure failure, and concerns for the environment.[77]

The degradation for the Rio Grande watershed, incited by the rapid development of land and water in the San Luis Valley during the late 1800s, served as the catalyst for major changes in the existing water management regime.[78] Within forty years the development of the Rio Grande in Colorado resulted in sever water shortages and increased flood risks in New Mexico, Texas and Mexico.[79] Only a couple decades later an international convention was negotiated to share water between the U.S. and Mexico.[80] Contemporaneously the U.S government created the Reclamation Service, imposed the prior appropriation doctrine on New Mexico water law, and began development of the Rio Grande Project.[81]

The aggradation of mainstem river beds in the Middle Rio Grande Valley, also caused in no small part by the development in the San Luis Valley, resulted in water-logged lands and increased flood threats.[82] By the 1920's, New Mexico's urban leaders were busy creating the MRGCD to drain the lands, build levees, and create irrigation water storage on the Rio Chama.[83] The real possibility of expanded irrigation in the Middle Rio Grande in an already water-short basin motivated the negotiation of the Rio Grande Compact. The inadequacy of the MRGCD to control floods and groundwater levels resulted in federal intervention through the creation of the federal Middle Rio Grande Project in 1948.[84] The need to provide Albuquerque

73. *See, e.g.,* PHILLIPS, *supra* note 52, at 112–22.

74. *See, e.g.,* PHILLIPS, *supra* note 52, at 103–115; *see also* Flood Control Act of 1948, Pub. L. 80-771, 62 Stat. 1175, 1179 (1948); BUREAU OF RECLAMATION, JOINT BIOLOGICAL ASSESSMENT: BUREAU OF RECLAMATION, BUREAU OF INDIAN AFFAIRS, AND NON-FEDERAL WATER MANAGEMENT AND MAINTENANCE ACTIVITIES ON THE MIDDLE RIO GRANDE, NEW MEXICO, at I-5 to I-7 (August 2015) [hereinafter 2015 JOINT BIOLOGICAL ASSESSMENT].

75. *See* PHILLIPS, note 52, at 102–122, 130–32.

76. *See infra* Section III.B(2).

77. *See infra* Section I.A.

78. *Id.*

79. *See id*.

80. *See* App. A(1) (citing Paddock, *supra* note 178) (forthcoming 2021) (on file with author).

81. *Infra* Section II.B(1); *see generally infra* Section III.A; *cf.* App. A(2) *passim*.

82. *See, e.g.*, *infra* Section III.A.

83. *See id.*

84. *Id;* App. A(2)(ii)(a) (detailing Middle Rio Grande Project and its development).

with additional flood control resulted in the authorization and construction of Cochiti Reservoir and the creation of the Reservoir Regulation Plan in 1960.[85]

The imposition of the Endangered Species Act ("ESA") and the attendant requirements for protecting the Rio Grande silvery minnow created several less dramatic but critically important moments of management flexibility in the Middle Rio Grande.[86] These responses have been predominantly a matter of soft law rather than instituting a dramatic change to federal or state law.

In the early 2000's, there was a flurry of management changes related to the Rio Grande silvery minnow that were motivated by ESA litigation.[87] New management agreements and collaborations were employed. Reclamation created the Supplemental Water Program to source water supplies for the minnow.[88] The Middle Rio Grande Endangered Species Collaborative Program, a new organization of multiple stakeholders, was established to protect the silvery minnow while allowing existing and future water use to continue.[89]

The 2001 Conservation Water Agreement was a remarkable new tool negotiated by parties to the silvery minnow litigation as a way to utilize New Mexico's Rio Grande Compact credits in new and creative ways for the benefit of the minnow.[90] It required the consent, which was granted, of the Rio Grande Compact Commission to deviate from normal operations. This served as the basis for the 2003, 2008, and 2016 Emergency Drought Water Agreement ("EDWA").[91] All of these agreements allow for flexible water management within the constraints of ESA Biological Opinions, New Mexico water law, and the Rio Grande Compact.

II. SETTING: THE CRITICAL ZONE

The Rio Chama Flow Project's overarching effort is really a trust-building exercise amongst stakeholders.[92] Building this trust requires at a minimum that environmental flow operations be perceived to have no negative impacts to water users at large, from acequia *parciantes* on the Rio Chama to the MRGCD and the Six Middle Rio Grande Pueblos. In short, this requires demonstrating that such flows benefit multiple sectors, harm no actors, and offer robust, quantifiable ecological results. To get there, in-stream flow operations must be evidence-based and legally defensible, as well as framed in terms of adaptive management, which is widely recognized as a best practice in management of natural resources. Such a proof-of-concept, successfully demonstrated on the Rio Chama, could lead to a fresh take of

85. *See* App. A(2)(ii)(a) at 85–87 nn. 521–23, 529–38.

86. *Cf. infra* Section III.B(2); App. B, at tbls. 1, 2, 5, 6, & 7.

87. App. B, at tbls. 1, 2.

88. *See infra* Section III.B(2).

89. *Cf.* Gillon (2007), *supra* note 57; App. B, at tbls. 1, 2, & 8 *passim.*

90. App. B, at tbls. 1 & 2.

91. *Cf. infra* notes 435–48 and accompanying text; App. B, at tbls. 1 & 2.

92. *Cf.* Charles Heckscher, TRUST IN A COMPLEX WORLD: ENRICHING COMMUNITY (2016), at chs. 1, 3, 4, 6–7 (exploring, *inter alia*, emergent futures as the "rich" community characterized by "interactive sensitivity," notwithstanding the "contest for legitimacy" as the benefits of collaboration intersect the present paradigmatic decline of the community in modern era), chapter level abstracts available at https://global.oup.com/academic/product/trust-in-a-complex-world-9780198708551?cc=us&lang=en&# (click on link in right hand column, "Also Available In: Oxford Scholarship Online").

the myriad "hard law" constraints which govern not just the Rio Chama but also the Rio Grande proper, such as Congressionally mandated flood control limits to reservoir operations, and in the case of the mainstem Rio, ESA requirements. Indeed, people bring lawsuits after all and, perhaps like the midwifery model, a fresh view that includes collaborative and evidenced-based but still traditional methods, could be brought to decrease litigation risk and increase the positive outcomes. Here, to rebirth an ecosystem.[93]

In support of this ongoing effort to midwife in-stream flows in the Middle Rio Grande, the following section develops the core of a Critical Zone- and complexity theory-informed Law of the River for the Rio Chama–Middle Rio Grande system.[94] What emerges from this initial legal mapping exercise[95] is a sketch of the ambiguities inherent in this physically embodied, body of law. This mapping can be thought of simply as characterizing the hypothesized underutilized existing legal authority in support of optimized ecological flows on the Rio Chama. While these foundational elements of water governance on the Rio Chama and mainstem Rio Grande are far from novel, in other ways, the empirical results presented and summarized here are new contributions. Together they represent a decision–support tool, a map of the law and society matrix of any Law of the River—especially important in such a fundamentally transboundary system as the Middle Rio Grande.

A. Water and Governance of the Middle Rio Grande

Following the work of Benson, et. al. (2013),[96] and many others,[97] this article analyzes the legal constraints and opportunities for flexibility in reservoir operations on the Rio Chama. In doing so, it does not focus on individual conflicts but instead attempts to treat the system as a whole. To that end, both real and perceived limitations are mapped and evaluated. These limitations include prevailing federal reservoir authorizing legislation and state water law, along with regulation, management, policy, and operations. This work further intends to facilitate transparency, clarify decision-making and accurately inform water users, managers, and citizens.[98] The law of the Rio Chama is a collection of treaties, interstate compacts, statutes, court decisions, regulations, and contracts generated over more than 100 years of conflict regarding the allocation of the Rio Grande and its tributaries. While there is not necessarily a definitive version of the Law of the River

93. *See, e.g.*, Rob Fishman, Working Paper Presented Univ. of Arizona College of Law, *Collaborative Governance Under the Endangered Species Act: An Empirical Analysis of Protective Regulations* 63–65 or 101–103 (Mar. 29, 2021) (abstract containing Fishman's empirical results on file with author).

94. SECURE Water Act of 2009, Pub. L. No. 111–11, 123 Stat. 1329 (codified as 42 U.S.C. 109B) (as a requirement of the SECURE Water Act, this Law of the River for the Rio Chama, which underlies the legal analysis in this article, will be made available through the Bureau of Reclamation).

95. *Cf.* Ruhl & Katz, *supra* note 39.

96. M.H. Benson (2013), *supra* note 43.

97. *See* LITTLEFIELD, *supra* note 70, at 1879–1939 (The source of international and interstate conflict going back at least 120 years, the Rio Grande basin is well characterized).

98. *See generally* ALIDA CANTOR ET. AL., DATA FOR WATER DECISION MAKING: INFORMING THE IMPLEMENTATION OF CALIFORNIA'S OPEN AND TRANSPARENT WATER DATA ACT THROUGH RESEARCH AND ENGAGEMENT, AB 1755 STAKEHOLDER WORKING GROUP SYNTHESIS REPORT (2018).

for the Rio Grande or the Rio Chama, this compilation may be the first Law of the Rio Chama compiled in database form, complete with explanatory annotations and relevant gray literature that assists in understanding the law.[99]

Material institutions bearing on reservoir operations are foundational for this article's analytical framework. Here, material is meant in a tripartite literal, metaphorical, and legal sense. Once developed, the analytic will be applied to the Law of the River, generally, to the Law of the Rios Chama and Grande, and most specifically, the nexus of ecological flows and reservoir operations in the Middle Rio Grande Basin. This overview is presented at the outset and builds largely on the pioneering work of perhaps a dozen leading Middle Rio Grande water-wonks, managers, and scholars in science, law, and policy praxis from geomorphology, engineering, and water operations to complexity theory and adaptive management.[100]

This article adopts the core premise that the Middle Rio Grande is a complex, socio–ecological system that must adapt. The issue is that achieving water supply resilience to climate change implicates ways of being and knowing, in other words, ontology and epistemology.[101] This *specified resilience* must address "climate stress, over [the] appropriated basin." The former is a path dependency, and the latter is *the* salient future trajectory.[102] Furthermore, it must address decreased functional diversity owing to, *inter alia*, massive infrastructure for water storage and flood control. All of this points to adaptive governance innovation needs in the realm of reservoir operations flexibility and water management innovations, including storage and allocation mechanisms.[103] The related ontological and epistemological issues deal with what we value and protect.[104]

1. The Great River and Thumbnail Complexity Sketch

Simple hydrographs showing flow over time indicate the current reality.[105] That is that over the course of the twentieth century the federal government led a massive water development scheme in the arid West, thus creating a highly managed

99. *See, e.g.,* App. B, at tbls. 3, 4, 6, & 7 (database on file with author).

100. *See e.g.*, HARRIS, *supra* note 52; Mark Stone, CF Byrne, RR Morrison, *Evaluating the impacts of hydrologic and geomorphic alterations on floodplain connectivity*, Ecohydrology, 2017 (investigating floodplain inundation and interface dynamics on two New Mexico Rivers, including the Rio Grande); Morgan, *supra* note 14; Oglesby, *supra* note 54; Mike Harvey, RIO CHAMA FLOW [OPTIMIZATION] PROJECT, 2016 Pulse Flow: "Resolution Hydrograph" (Oct. 12, 2016); Oglesby, *supra* note 54.

101. Melinda Harm Benson et al., *Governing the Rio Grande: Challenges and Opportunities for New Mexico's Water Supply*, in PRACTICAL PANARCHY FOR ADAPTIVE WATER GOVERNANCE, Barbara Cosens and Lance Gunderson eds. (2018), https://doi.org/10.1007/978-3-319-72472-0_7 [hereinafter M.H. Benson (2018)].

102. *See, e.g.*, *Id*.

103. *Id*.

104. *Cf*. Ragsdale, Jr., *supra* note 12 (What we value and protect can be explored by way of culture and (diverse) narratives as well as metaphor—*i.e.*, infrastructure, conversation, relationship, and (making) kin.); PURDY, *supra* note 36 (regarding the overwhelming literal weight of infrastructure, globally); Jane Baron, *The Contested Commitments of Property*, 62 HASTINGS L. J. 917 (2010) (proposing "conversation" metaphor as alternative to the paradigmatic property law metaphor, "machine"); ESTES, *supra* note 37 (relations and "making kin," in the context of activism of "water protectors" at Standing Rock in 2016).

105. *See, e.g.,* App. B, at tbls. 3, 4, 6, & 7 (showing water operations on Rio Chama A stocks and flows of water over time, i.e., storage, releases, and flows of water between Heron Dam and Reservoir and the river's confluence with the mainstem Rio Grande at the Ottowi Gage).

hydrological system controlled by a vast built infrastructure.[106] The combined effects notably include earlier peaks of snowmelt-driven runoff in the spring and disconnection of the rivers' historic floodplain—a liminal zone rich in biodiversity—from increasingly channelized and sediment-starved water courses. This resulted in significantly degraded riverine and riparian ecosystem health, including impacts on an endangered Rio Grande silvery minnow, acting as a proxy for overall river health. Most importantly, what reasonably might be considered a rapidly approaching ecological threshold in the Middle Rio Grande watershed certainly looks like it has already arrived.[107]

Water law and legal geography scholar, Melinda Harm Benson, and colleagues recently offered an exceptional articulation of aspired-to and necessary "specific resilience" of the Middle Rio Grande, treating the basin as a complex, adaptive social–ecological system that must adapt successfully to the system shocks and regime shifts already underway. The authors describe the system structure, including its social and ecological elements as well as key exogenous drivers in this water governance space.[108] Based on this empirical work, they propose a theory of change for Middle Rio Grande water governance that would consider the system's current trajectory and resistance to perturbations from non-linear, complex processes such as climate change and attendant reverberations in water security in terms of both quality and quantity.[109]

Accordingly, water policy and governance issues are part and parcel of the system's adaptive capacity. In other words, this is the system's amenability to change as water managers consider alternative scenarios and operational innovations under pressure to make water available to people and ecosystems.[110] These considerations all relate to the adaptive capacity required for a system approaching its ecological threshold, *i.e.*, a regime change–transformation.[111] Climate change indeed "[c]hanges [e]verything."[112] Not least of such changes are the assumptions underlying global political economy. In turn, the character and relationality of the emergent interdependencies are governed by the elements that comprise the system's social and ecological structure.[113] Apart from climate, other key structural components include regimes of water supply and allocation, *i.e.*, governance structures, as well as social elements which, after lifeways extant from time immemorial, would subsequently include two waves of colonization, *at least* three sovereign nations, and landscape modifications on various scales.[114]

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106. *See generally* Marc Reisner, CADILLAC DESERT: THE AMERICAN WEST AND ITS DISAPPEARING WATER (1993) (landmark journalistic investigation, surface water domain); CHARLES BOWDEN, KILLING THE HIDDEN WATERS (1985) (investigating concomitant groundwater issues from anthropologically oriented journalistic perspective focusing on 20th century revolution in groundwater pumping and attendant effects and implication).

107. *Id*; *accord* PASKUS, *supra* note 10.

108. M.H. Benson (2018), *supra* note 101.

109. *Id.*

110. *Id*.

111. *Id.*

112. Naomi Klein, THIS CHANGES EVERYTHING: CAPITALISM VS. THE CLIMATE (2014).

113. M.H. Benson (2018), *supra* note 101.

114. *Id*.

Key drivers in the Middle Rio Grande water governance space, as described by Benson and others, include the orthodox elements of this complex adaptive system.[115] These include: 1) a multistate water allocation contract, the Rio Grande Compact, which divides the river between New Mexico and its neighboring states and traditionally represents, hierarchically, the core and highest discrete legal authority for water management in the state; 2) federal water management infrastructure; 3) an overlay of environmental law, like the ESA; 4) a large irrigation district, the MRGCD; 5) six sovereign, native nations, whose water is incidentally delivered by the MRGCD; and 6) environmental advocacy groups.[116] Far from comprehensive, this enumeration nonetheless provides building blocks or "enabling constrains" for generating adaptive innovations, including addressing historic inequities and injustices.[117]

Water supply resilience to climate change requires effective and *adaptive* management of natural resources in response to climate's manifold threats.[118] In this way, Benson et al. are among those water-wonks and other diverse voices holding space for the conversation surrounding the now well-established premise: *resilience theory helps recognize the need for adaptive capacity*.[119] Here, the river—Rio Grande, Rio Chama or otherwise—is the system's lifeblood, a leading indicator of major, interrelated regime change drivers such as climate and fire.[120]

2. Adaptive Management in the Middle Rio Grande

Global climate change-type drought is driving water management innovation in New Mexico. In the winter of 2017–2018, for example, snowpack in the Rio Grande Basin was at a historic low, and the Rio Grande at Albuquerque dried in parts as early as April.[121] As of September 20, 2018, Elephant Butte storage was

115. *Id*.

116. Robison, *supra* note 7 at 19–89, 169–207, 231–243, 245–58, 268–314, 315–354, and 356–397 (describing environmental law "overlay" on the Law of the River) (theorizing changing property law; articulating a "transformation" in such jurisprudence through the Law of the River [LoTR] lens, in terms of "[s]ystematic [n]ature of [a]mbiguities" inherent in, *inter alia,* the LoTR's "environmental law overlay" and their contemporaneous materiality," along with concomitant lessons and reflections on the LoTR's "adaptability" in the face of the multiple registers of challenges associated with climate change and characteristic "interstitially," as well as associated "administrability" issues facing the Colorado River Compact and, more generally, water governance in the Colorado River Basin); *cf. infra* Section II–IV; App. § A, *passim* ("Law and Policy for Reservoir Operations").

117. *See, e.g.,* M.H. Benson (2014), *supra* note 45, at 218–221 (regarding institutional constraints); Krakoff*, supra* note 15 (regarding historic and extant issues of justice and rights in context of Reclamation water projects vis-a-vis settler colonialism and natural resources law); *see generally* OSTROM, *supra* note 5.

118. M.H. Benson (2018), *supra* note 101 (for example, fire-risk to upland forests in the Rio Grande's headwaters—having certain watershed degradation as well as concomitant water supply and governance effects and implications—has mobilized roughly $240 million in Nature Conservancy administered funding for restoration efforts.).

119. *Id*.

120. *Id*.

121. Laura Paskus, *It's Only April and a Stretch of the Rio Grande Has Already Dried*, N.M. POLITICAL REP'T (Apr. 8, 2018), http://nmpoliticalreport.com/822352/its-only-april-and-a-stretch-of-the-rio-grande-has-already-dried-en/;

roughly three percent of total capacity, approximately 60,000 acre-feet.[122] Spurred by these ongoing exceptional conditions, a historic partnership comprised of the Audubon Society, Pueblos, and municipalities collaborated the following summer to release nearly 1,000 acre-feet of water to keep a stretch of the Middle Rio Grande from drying.[123] Later in the summer irrigation season, the collaboration leased roughly 20,000 acre-feet of water from the Albuquerque Bernalillo County Water Utility ("ABCWUA") to maintain Rio Grande flows at a cost of about $2 million.[124] Guiding and constraining such innovative responses to the exigent hydrologic circumstances is the Law of the River, the legal and policy infrastructure which governs water operations.

At its core, the Rio Grande Basin is a complex, interconnected system. Three reservoirs of system-wide import, Heron, El Vado, and Abiquiu, are located on the Rio Chama. Of note, flows on the stretch of the Rio Chama between El Vado and Abiquiu are particularly amenable to an analysis of reservoir operations because the river operates, at this reach, as a relatively simplified system. The analysis of and constraints to operationalizing experimental flows—in large part a function of legal authority and management flexibility bearing on relevant reservoir operations—is greatly simplified there, for two primary reasons. First, and primarily, there are no endangered species that would otherwise trigger the application of the ESA and, thus, heightened scrutiny and political sensitivity, across the board. Second, there is a near paucity of consumptive uses on the stretch of river, so a water-rights impairment analysis, theoretically but also practically, is significantly streamlined, if not altogether avoided.

This federally designated "Wild and Scenic" reach of the Rio Chama has been the object of study for the Rio Chama Flow Project, an interdisciplinary collaborative conservation program engaged in an adaptive management-based investigation of the synergies of environmental flows, recreational opportunities, and economic development surrounding the Rio Chama.[125] Taking these efforts as a starting point, this article focuses on this unique stretch of the Rio Chama. Should the Rio Chama Flow Project's evidence-based multi-stakeholder exercise bear fruit, it may offer a scalable model for optimizing water management on the main-stem Rio Grande, which has yet to be adjudicated and is subject to the considerable

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Henry Fountain, *In a Warming West, The Rio Grande is Drying Up*, N.Y. TIMES (May 24, 2018), https://www.nytimes.com/interactive/2018/05/24/climate/dry-rio-grande.html.

122. Laura Paskus, *As New Mexico Reservoirs Hit Bottom, Worries Grow Over the Future,* WATER DEEPLY (Sept. 25, 2018), https://www.newsdeeply.com/water/articles/2018/09/25/as-new-mexico-reservoirs-hit-bottom-worries-grow-over-the-future.

123. *See* Press Release, *In Historic Partnership Audubon and New Mexico Municipalities Release Water to Recharge Vital Habitat Along the Rio Grande,* AUDUBON NEW MEXICO, (July 17, 2018), http://nm.audubon.org/press-release/historic-partnership-audubon-and-new-mexico-municipalities-release-water-recharge [hereinafter Audubon Soc'y, Historic Partnership]; see also Press Release, *Audubon Announces Historic Water Release to the Middle Rio Grande,* AUDUBON NEW MEXICO (Sept. 7, 2016), http://nm.audubon.org/press-release/audubon-announces-historic-water-release-middle-rio-grande.

124. U.S. BUREAU OF RECLAMATION, WATER MANAGERS PARTNER TO PRESERVE MIDDLE RIO GRANDE FLOWS (Aug. 22, 2018), https://www.usbr.gov/newsroom/newsrelease/detail.cfm?RecordID=63104.

125. *See id*.

constraints of the ESA. The interdependence of the Rio Chama and Rio Grande goes further than this analytical matter.

Indeed, neither the Rio Chama nor any legal analysis of reservoir operations exist in a vacuum. In compiling the Law of the River for the Rio Chama, this work thus draws from the interconnected elements of the Law of the River for the Rio Grande and the *original* Law of the River, that of the Colorado River. The case study of the Rio Chama offers insights into the operations of a "novel [eco]system" as well as man's attempts to optimize it, a common occurrence on rivers across the West.[126] Indeed, the tributary Rio Chama mirrors many features of the mainstem Rio Grande. For example, in its short course, the Rio Chama is dammed three times. This infrastructure provides water and flood control for the Albuquerque metro area, including the MRGCD, one of the largest suppliers of irrigation water in New Mexico. The Rio Chama also conveys water imported across the Continental Divide from the Colorado River Basin, as part of Reclamation's San Juan-Chama Project. This Project's water is destined primarily for ABCWUA and MRGCD. The Rio Chama regularly flows at greater-than-historical levels by a large margin. This occurrence is both unique in the arid West and orthodox—in that transbasin water transfer projects are common. In this sense, the San Juan-Chama Project's annual average project "firm-yield" of nearly 100,000 acre-feet is conveyed by the Rio Chama from Reclamation's Heron Reservoir, through MRGCD's El Vado Reservoir, and then through the Middle Rio Grande Project's Abiquiu Reservoir, before finally being released for use in the Middle Rio Grande valley near Albuquerque.

Taking a step back to reorient, it is worth recalling that the Rio Chama is a principal tributary and thus part of the Middle Rio Grande Basin, which is itself a complex[127] socio–ecological[128] system where geography, hydrology, law, economics, policy, and management decisions control the flow and allocation of water. In fact, a physical–mathematical modeling of the Middle Rio Grande system requires no less than 180 discrete law-driven rules.[129] The legal, policy, and management framework of the Rio Grande Basin's New Mexico reservoirs—three of the five are located on the Rio Chama—was laid out in a special issue of this Journal.[130] Not surprisingly, uncertainty abounds in this complex system, as in any

126. Mike Harvey, *supra* note 100 (PowerPoint presentation, given at Rio Chama Flow Project Advisory Council Meeting) (on file with author) (characterizing the Rio Chama as a "novel system" that has been triply dammed, but receives an influx of "new" San Juan-Chama Project water diverted from the Colorado River Basin).

127. *See, e.g.*, Hall (2007), *supra* note 52, at 54, 54–62 (providing an overview of the "many basic facts about legal claims to the Middle Rio Grande [that] we [don't] know"); *see generally* Jaeger, *supra* note 7, at 2, fig. 1 (diagram components and linkages for model of Willamette River hydrological/economic/legal system, which contains multiple reservoirs and water uses).

128. *See, e.g.*, M.H. Benson (2014), *supra* note 45 (analyzing key interactions as thresholds of social and ecological elements of the Middle Rio Grande, including their associated "drivers and disturbances").

129. URGWOM Ruleset, supra note 21, at 4–5 (noting policy for operating water storage and diversion facilities along the Rio Grande and Rio Chama represented in URGWOM in 46 different policy groups and 180 specifically coded rules).

130. Klein, *supra* note 112.

system of water rights or uses.[131] Within this complex system, reservoir operations[132] may be ripe for more flexible, optimized configurations.[133] In the face of continued water-short conditions, such configurations should offer both resiliency and adaptive capacity.

Despite the importation of water from the Colorado River Basin, the Middle Rio Grande remains perennially water short and water management collaboration has progressed haltingly. The sum of various individual legal uncertainties, such as the nature and extent of Pueblo and MRGCD water rights, has superimposed a "legal scarcity" on top of natural water scarcity.[134] Despite a narrative of collaboration gaining traction,[135] in the years following commencement of the silvery minnow litigation and issuance of the 2003 Biological Opinion, major stakeholders could not even agree on which *scenarios* of reservoir operations to model.[136] In contrast to the lack of consensus regarding the desirability, feasibility, and legal underpinnings of alternative reservoir operations in the Middle and Upper Rio Grande, there is scientific consensus on the need to manage this surface water system for keystone ecological processes.[137] Aquatic biology and riparian ecology, as it turns out, cannot be separated from the *human* ecology of the river.

Water resources management, as well as concomitant efforts in agriculture, conservation, and climate adaptation, can at one level be viewed a neutrally governed by our inherited geography. Under this view, the Rio Grande silvery minnow that has spawned prodigious litigation efforts, but also collaborative efforts, is a blessing, not a curse.[138] It is a prescient indicator of the system's vulnerability, namely insufficient adaptive capacity to buffer such shocks to the species as decreased surface water supplies and droughts which have become increasingly sever, and frequent. The minnow's existence is a function of its unique, arid geography. It has been a disruptive force incentivizing needed climate adaptation, water management

131. *See, e.g.,* William deBuys, *Navigating the River of our Future: The Rio Poco-Grande*, 41 NAT. RESOURCES J. 265, 277 (2001), https://digitalrepository.unm.edu/nrj/vol41/iss2/2/ ("uncertainty abounds" in "any cluster or water rights and uses").

132. *See generally* Susan Kelly and Diego Urbina, *New Mexico Major Reservoirs: An Overview*, UTTON CTR., WATER MATTERS!, at 20-1–20-18 (2011) [hereinafter Kelly & Urbina].

133. *See, e.g*., Amos, *supra* note 3, at 1132 ("Once these flexibilities are represented, they will facilitate the investigation of the resiliency and adaptive capacity inherent within the current legal system and identify where changes to law and policy might be most effective."); DEBUYS, *supra* note 10, at 277 (" . . . there is flex in the system").

134. Hall, *supra* note 72, at 57 ("The sum of all of these uncertainties—the nature and extent of pueblo and MRGCD rights, the source of rights for increasing municipal demand, the unintended consequences of changes to policies—is even greater uncertainty"); DEBUYS, *supra* note 10, at 277 ("Every system leaks. Most systems operate as much on assumptions as hard data, and only rarely are those assumptions entirely correct.").

135. *See generally* JOHN FLECK, WATER IS FOR FIGHTING OVER: AND OTHER MYTHS ABOUT WATER IN THE WEST (2016).

136. Susan Kelly, *Modeling Reservoir Storage Scenarios by Consensus*, 47 NAT. RES. J. 651, 663–71 (2007) [hereinafter Kelly (2007b)].

137. DEBUYS, *supra* note 10, at 268, 270–71, 274 (describing "keystone processes" and their ecological significance and arguing that environmental river management should manage for keystone processes by, inter alia, providing flows which mimic the natural hydrograph); *see also* Morrison, *supra* note 46.

138. *Id*. at 280.

resilience, and cooperation.[139] The premise of this work is that optimized reservoir operations, like protecting the minnow, need not be a zero-sum game.

According to author and conservationist William deBuys, the biggest challenge in effectively managing the waters of the Rio Grande is political ecology.[140] Notwithstanding the tremendous technical work done on the Rio Grande, there will likely never be full agreement regarding operational models of this system.[141] These models, such as the URGWOM, used by agencies such as Reclamation and the Corps, represent powerful and sophisticated planning, predictive, and accounting capabilities. They are based on current knowledge, scientific and otherwise. One major underpinning of such a model is the legal infrastructure that dictates many operational rules. But while many legal mandates, such as provisions of the Rio Grande Compact or the various dams' and reservoirs' authorizing legislation, translate neatly into operational requirements and water accounting schemes, assumptions may be built into the model's representation of other legal authorities. Further, water management and reservoir operations take place within a decision-making continuum ranging from professional judgment to multi-stakeholder negotiation and collaboration.[142] Within this discretionary space, where water managers and regulators may differ in the particulars, taking different approaches may not violate the Law of the Rio Chama.

Following a similar effort in the Pacific Northwest, this article and corresponding interdisciplinary efforts of the Rio Chama Flow Project attempt a refined integration of law and policy into collaborative efforts[143] of stakeholders to optimize flows on the Rio Chama.[144] Accordingly, it is intended as a fresh look at the well-trodden components of the Law of the River—such as the legislative underpinnings of water storage and release at Abiquiu, El Vado, and Heron Reservoirs.[145] It is also intended to be an innovative mapping exercise, incorporating those "soft law" components of the Law of the River, like policy, management, and operations, which have largely escaped detailed analysis.[146] The most salient

139. *See infra* Section II.A(1), III.A, and III.B(2), nn. 430–44 and accompanying text, *passim*; App. A(4) *passim* (treating ESA developments and litigation history in MRG Basin).

140. DEBUYS, *supra* note 10, at 277–78.

141. *Id*. at 279 (arguing this situation "effectively throws decision making into the political and economic sphere").

142. *See infra* Section III.A–B *passim*; App. B, at tbls. 1, 2, 3, & 4 (Excerpts from Engineer Advisers' Report in Rio Grande Compact Commission Annual Reports, 2000 to present; Excerpts from Reclamation's Annual Reports to the Rio Grande Compact Commission, 2000 to present; Heron–El Vado–Abiquiu Operations (Flows); San Juan–Chama at Otowi).

143. *See generally* Amos, supra note 3 (giving an example of similar work in Oregon); *see also* Jaeger, *supra* note 7.

144. Ranging from, for example, acequia interests downstream of Abiquiu Reservoir to the Corps of Engineers whose flood control management decisions could affect the integrity of acequia diversion structures.

145. *See generally* Flatt & Tarr, *supra* note 44 (taking a "fresh look" at legal authority for Corps' dam management).

146. *Cf.* Robison, *supra* note 3; Jaeger *supra* note 7; BALLESTERO, *supra* note 4; Griggs, *supra* note 12; Ragsdale, Jr., *supra* note 12; *infra* Section III.A–B *passim*; App. B, at tbls. 1, 2, 3, 4, 5, 6, 7, & 8 *passim* (Excerpts from Engineer Advisers' Report in Rio Grande Compact Commission Annual Reports, 2000 to present; Excerpts from Reclamation's Annual Reports to the Rio Grande Compact Commission, 2000 to present; Heron–El Vado–Abiquiu Operations (Flows); San Juan–Chama at Otowi; Bureau of

conclusions will be incorporated into the Rio Chama Flow Project's modeling efforts, led by Professor Mark Stone at the University of New Mexico. Such modeling efforts go beyond those of the Upper Rio Grande Water Operations Review, which, for example, has yet to consider water ownership in its modeling reservoir operations flexibility on the Rio Chama.[147]

3. Rio Chama Flow Project: Legal Complexity and Analytical Methodology

Broadly speaking, the Rio Chama Flow Project seeks to achieve environmental and recreational improvement on the roughly 35-mile-long stretch of the Rio Chama between El Vado and Abiquiu reservoirs. To do so, the Project set out to identify feasible changes in the operations of the Heron and El Vado reservoirs that do not affect downstream water users. Between Heron and Abiquiu, the Rio Chama conveys roughly 400,000 acre-feet of water per year,[148] including 96,000 acre-feet of imported San Juan-Chama Project water,[149] with negligible consumptive usage. This setting provides a unique opportunity to develop optimized hydrographs in the form of "multi-objective flow optimizations schedules" depending on water availability, which is the most critical among many constraints. Ultimately, the Rio Chama Flow Project intends to foster a collaborative determination of water operations based on multi-disciplinary science and sustainable policy. Building on baseline studies (*e.g.*, hydrology, geomorphology, system dynamics modeling), the Rio Chama Flow Project currently shoulders modeling efforts to incorporate an enhanced understanding of the operational, legal, and institutional constraints on optimization of reservoir operations.[150]

In support of these modeling efforts, the Flow Project's research regarding the legal flexibility hypothesis commenced with a literature review. The broad initial orientation was to interstate compact law, including an overview of the Rio Grande Compact's provisions accounting for debits and credits, as well as the relinquishment of accrued credits in certain situations that prevents storage in reservoirs such as El Vado, despite standing restrictions.[151] The review next canvassed the literature on

Reclamation, Art. VII-Relinquishment Credits; Middle Rio Grande Project; San Juan–Chama at Azotea, Heron, and Abiquiu; ESA Middle Rio Grande Project).

147. *See* URGWOM Ruleset, *supra* note 21.

148. *See, e.g.,* N.M. OFFICE OF THE STATE ENG'R, RIO CHAMA REGIONAL WATER PLAN, at 68, 72–72 (Tbl. 5-4b and Figs. 5-9a, -b., respectively) (2016), ("Description of the Planning Region" and "Legal Issues Unique to the Region and Local Conflicts Needing resolution," respectively) http://www.ose.state.nm.us/Planning/RWP/Regions/14_RioChama/2016/Reg%2014_Rio%20Chama%20Regional%20Water%20Plan%202016_July%202016_with%20appendices.pdf.

149. *See* App. A(1)(ii)(b) ("In general terms, the San Juan–Chama [Diversion] Project is the vehicle for New Mexico utilization of a large share of its allotment as an Upper Basin state within the Colorado River Basin. In this scheme, New Mexico is statutorily permitted to divert an average, 'firm yield' of 96,200 acre-feet from the San Juan River basin by tunnel through the continental divide and into the Rio Grande Basin.").

150. RCFP Proposal, *supra* note 43, at 1 (intended outcomes), 4 (noting goal of legal analysis to "prevent . . . institutional and operational constraints to modifying flows and storage" from becoming "fixed and inflexible").

151. Memorandum from Colin McKenzie on Interstate Compact Law to Adrian Oglesby, UTTON CTR. (June 29, 2015); Memorandum from Colin McKenzie on Relinquishment Credit Water Allocation to Adrian Oglesby, UTTON CTR. (Sept. 1, 2015)..

reservoir operations, using this Journal's 2007 symposium on New Mexico Reservoirs as a starting point.[152] That symposium resulted in articles covering a range of reservoir operations issues, including: the legal framework; legislative and litigation history; conservation storage at Abiquiu; modeling reservoir storage; silvery minnow litigation; carryover storage and Indian pueblo water rights; and Prior and Paramount water.[153]

As the literature review progressed, it oriented progressively to primary authorities like Congressional authorizations of the reservoirs and interpretive tools like legislative histories,[154] a database of the resulting Law of the River took shape.[155] The primary provisions of the Law of the River captured by this database encompass legal regimes that correspond to multiple sovereigns: the U.S. and Mexico; Colorado, New Mexico, and Texas; and at least six Middle Rio Grande Pueblos.[156] Thus, this Law of the River captures elements of international law and U.S. federal law, as well as contracts—federal, state and private—between these various government and other private entities.[157] Substantively, the Law of the River encompasses, *inter alia*, water law, environmental law, and federal Indian law.[158]

In addition to these primary authorities, sundry regulations, agreements, and other provisions drive the storage and release of water from reservoirs on the Rio Chama and Rio Grande. This physical water storage and delivery infrastructure is primarily managed by Reclamation and the Corps, along with the MRGCD.[159] These water management agencies, therefore, figure prominently in the operational aspects of the Law of the River. Accordingly, the Law of the River database, as with the analysis proper, can be conceptually divided into two parts: 1) "hard law," *i.e.*,

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152. *See* Symposium, *Symposium on New Mexico's Rio Grande Rivers*, 47 NAT. RESOURCES J., NO. 3 (2007), https://digitalrepository.unm.edu/nrj/vol47/iss3/.

153. *Id*.

154. *See* Amos, *supra* note 3, at 1137–38 (noting that an approach to investigating reservoir operations flexibility would [1] "build a description of the statutory and regulatory authorities that govern the operation of the federal reservoirs managed on the Willamette River and the non-reservoir statutory and regulatory frameworks that impact the reservoir operations"; [2] "catalog and describe the relevant federal court decisions that impact the exercise of discretionary legal authority on the part of the relevant federal agencies on the Willamette River"; and [3] involve "interviews to better understand the process used by the relevant agencies to determine how and when to exercise available discretionary authority.") (A broad view of these legal authorities would include, inter alia: project authorizing statutes, programmatic statutes, applicable federal environmental law, and regulatory authority such as Corps' water control manuals and water control plans; Reclamation water supply Contracts, as well as state water law); *see also* Reed Benson, *Reviewing Reservoir Operations: Can Federal Water Projects Adapt to Change?*, 42 COLUMBIA J. ENVT'L L. 353, 368–84 (2017) (providing an overview of legal factors affecting dam operations in the West) [hereinafter R. Benson (2017)].

155. *See* UTTON CTR., Law of the River Database: Sources (last updated Sept. 7, 2018) (on file with Utton Center); UTTON CTR., Law of the River: Annotated Bibliography (Sept. 10, 2018) (selected grey literature) (on file with Utton Center) (In its current form, this database is housed in: one hierarchical database containing sources; an annotated outline and compilation of primary provisions of the Law of the River; and an annotated bibliography that serves as a "guide" to the Law of the River).

156. *See infra* Section II.A(1)–(3) and III.A.

157. *See infra* Section II.A; *see* App. A(1)–(4) (Reference Sections pertaining to 1906 Treaty; Federal Water Projects; Water Supply, Storage, Appropriation, and Conservation: OSE Permits, Reclamation Contracts, and Conservancy Law—State and Federal Water Law Nexus; and Endangered Species Act).

158. *See* App. A(1)–(4).

159. *See, e.g.*, *infra* Section III.B(1)

treaties, statutes, and case law;[160] and 2) "soft law," *i.e.*, regulation, policy, management, and operations.[161] A summary of these soft law provisions is presented in Tables 1–8 (found in the Appendices). It contains excerpts of key water management decisions from 2000 to present—which was a dry period that may roughly correspond with the new climatological normal—and legal conditions in the Rio Grande Basin, comprising extended drought and legal scarcity driven by ESA compliance.

The legal analysis developed in this article represents both a synthesis of the Law of the River and a response to the first order question: What authorities, statutory and regulatory, govern reservoir operations in the form of storage and release of water? The compiled database mentioned above forms a conceptual understanding of the system, comprising mainly hard law along with policy and operations. Thus situated, the project team contextualized key regulatory, water management, and reservoir operations decisions—such as Rio Grande Compact Commission Resolutions, which have authorized deviations from the congressionally mandated Reservoir Regulation Plan for the Middle Rio Grande Project reservoir.[162] This sort of operational and historical contextualization also extended to the technical realm. For example, it helped to identify precisely which priority Reclamation treats as its key policy rules in their modeling efforts. These policy rules are grounded in legal authority, but their application takes place in a discretionary technical space. Thus, a key component of the analysis process included transparency regarding this sort of law in action, through a process of unpacking and memorializing.

Unpacking the different layers of reservoir operations and related law, policy, and management decisions, the project team identified key threshold interactions[163] that define the behavior of complex socio–ecological systems such as the Rio Chama. Having identified these "boundary conditions,"[164] the investigation

160. Colin McKenzie, *Law of the River: Outline and Compilation*, UTTON CTR. (July 4, 2018) ("hard law").

161. *See e.g.*, *Law of the River: Policy and Operations*, UTTON CTR. (May 23, 2018) ("soft law" comprising tabular presentation of experts from (1) Engineer Advisors' Reports from the Rio Grande Compact Commission's Annual Report, 2000–16, and (2) Bureau of Reclamation's Annual Reports to the Rio Grande Compact Commission; UTTON CTR., Law of the River: URGWOM Annotated Ruleset (Sept. 2018) (on file with Utton Center) (summary presentation of operative policy rules from 2013 RiverWare ruleset documentation, including explanatory annotations and citations to relevant legal authority) [hereinafter URGWOM Annotated Ruleset]; UTTON CTR., Law of the River: Policy and Operations (May 23, 2018) (tabular presentation of experts from (1) Engineer Advisors' Reports from the Rio Grande Compact Commission's Annual Report, 2000–16, and (2) Bureau of Reclamation's Annual Reports to the Rio Grande Compact Commission).

162. *See* M.H. Benson (2018), *supra* note 101; *infra* Section IV.A–C.

163. *See* M.H. Benson (2014), *supra* note 45, at 215–18 (characterizing "key interaction and thresholds" in Middle Rio Grande socio-ecological system such as river channelization and changes in the natural hydrograph, including an earlier peak runoff).

164. *See* Barbara Cosens, *Panel Comments on Crisis, Resilience, and the Reformation of the International Law on Sustainable Development*, CANADIAN COUNCIL ON INT'L LAW CONFERENCE, (Nov. 2012), http://lawprofessors.typepad.com/environmental_law/2013/02/perspectives-on-crisis-resilience-and-the-reformation-of-the-international-law-on-sustainable-develo.html (noting importance of boundary conditions—i.e., how the behavior of interconnected systems is defined by how they interact—in analyzing complex systems, from geochemistry to geomorphology); *see also* Roberto Mangabeira Unger,

next focused on key relationships and agreements, creating workarounds for management. It became apparent that water allocation in the West is as much determined by these workarounds as it is by the Law of the Rivers' black letter law.[165] This understanding permits the evaluation and characterization of operational flexibility within the existing legal infrastructure.

The premise of this approach is that there is inherent flexibility within the water management system. This type of flexibility, however, is non-linear, involves multiple "colors" of water, tends to be transactional, and often occurs "off balance sheet."[166] Sometimes this flexibility is the result of private negotiations and thus not a binding precedent, while other times it is the result of "horse trading." Regularly, it occurs as a function of ground-level water managers diligent and daily operations coordination, which involves multiple water users and government agencies. This sort of flexibility has not lent itself to description and exploration, and results in individual laws and conflicts which dominate water law.[167] Nonetheless, the flexibility embodies the most important and dynamic boundary conditions that govern the Rio Chama as a system.

Oriented with the flexibility hypothesis, specific research questions were generated. For example, what is the nature and extent of discretionary authorities given to water managers in this system? What processes govern agency application of discretionary authority to manage flow? To what extent is discretion controlled by legal requirements as opposed to professional judgment? Finally, what is the magnitude of variability in flows derived from existing (or past) discretionary authority.[168] This stepwise approach led to consideration of some of the key liminal relationships, agreements, and legal parameters, which govern the importation, flow, storage, release, and subsequent diversion of water on the Rio Chama. In turn, these working research questions guided, as well as narrowed, the resultant legal analysis.

Water law and policy scholars have consistently argued that reservoir operations are ripe for a fresh look, taken with the goal of identifying management flexibility and discretionary operations. Benson (2007) contends that Reclamation's operation of water projects is an "[i]nherently [d]iscretionary [a]ctivity."[169] Flatt and Tarr (2011) claim, similarly, that there is discretionary authority inherent in the Corps' decisions.[170] Amos (2014) proposes that "there is inherent discretionary authority in the existing structure of water law" that "has not been fully explored or implemented" and that "may provide the adaptive capacity to address changed future

Legal Analysis as Institutional Imagination, 59 MOD. L. REV 1, 7 (noting impact of reforms in the "institutional and ideological context of political and economic life" —e.g., social democracy in Europe; the New Deal in America; and Keynesianism—on setting the "boundary conditions" within which society organizes and "understands and defends their interests.").

165. *See generally* FLECK, *supra* note 135.

166. *Cf.* Robison, *supra* note 3; Jaeger *supra* note 7; BALLESTERO, *supra* note 4; Griggs, *supra* note 12; Ragsdale, Jr., *supra* note 12 (regarding "non-linear"); *see infra* Section III.B(1)–(2) (regarding "transactional" and multiple "colors" of water and "off balance sheet," *i.e.*, requires substantial investigation to piece together narrative and other details).

167. Amos, *supra* note 3, at 1095–96.

168. *See id.* at 1137 (raising these questions in the context of the Willamette Basin in Oregon).

169. Reed Benson, *Dams, Duties, and Discretion: Bureau of Reclamation Water Project Operations and the Endangered Species Act*, 33 COLUMBIA J. ENVT'L L. 1, 40–43 (2007).

170. Flatt & Tarr, *supra* note 44, at 1535–47.

circumstances."[171] This article furthers those arguments, presenting empirical evidence, through operational examples of this flexibility paradigm, mapping the operational aspects and legal underpinnings of such water management and reservoir operations innovations as: 1) drought agreements for "conservation storage" of water; 2) voluntary water transfers and sophisticated water management; and 3) temporary re-operation of flood-control reservoirs for spring pulse flows on the Rio Chama and Rio Grande.[172]

In these case studies, one can view changes to the ostensibly ossified law of reservoir operations as possible. They highlight where there is a historical basis for certain assumptions, or where assumptions are either known to be—or may be—invalid. Finally, with an eye to coupling law and modeling efforts, this work identifies areas ripe for future investigation in terms of the physical, infrastructural, institutional, and climatological variables at play in existing and prospective sources of discretionary authority.

What emerges is, unsurprisingly, a complex multi-jurisdictional space, a case study in a complex, adaptive system, and polycentric governance. Western water law—even without the overlay of, for example, environmental law and the sovereignty, livelihood, and economic development needs of native American tribes and Pueblos—is a fragmented jurisdictional space.[173] Combined with the new exigency of ESA requirements amidst prolonged drought, the resulting political and economic risk is significant. This risk has manifested recently in the protracted litigation over the endangered Rio Grande silvery minnow and a pending U.S. Supreme Court suit between Texas and New Mexico over interstate allocation of river water.[174] The Rio Grande Basin in New Mexico is, therefore, an *important* venue for this type of research.

B. Institutional Ontologies

Situated with this brief sketch of the historical, political–economic, legal–ecological framework of water governance in the Middle Rio Grande, it is difficult to accept at face value what the Law of River is. What this space signifies is contestable, to paraphrase Henri Lefebvre,[175] it no doubt has meaning. A coupled

171. Amos, *supra* note 3, at n. 18 and accompanying text (citing J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems—with Applications to Climate Change Adaptation*, 89 N.C. L. REV. 1373, 1388–93 (2011)); *cf.* Barbara Cosens, *Transboundary River Governance in the Face of Uncertainty: Resilience Theory and the Columbia River Treaty*, 30 J. LAND RES. & ENVT'L. L. 229 (2010).

172. *See, e.g., infra* Section III.B(1)–(2); IV.A–C; App. A *passim;* App. B, at tbls. 1–8; *see* M.H. Benson (2013), *supra* note 43.

173. See, *e.g.*, Kundis Craig, *Climate Change, Regulatory Fragmentation, and Water Triage*, 79 U. COLO. L. REV. 825 (2008); Amos, *supra* note 3, at n. 6.

174. *See* U.S. BUREAU OF RECLAMATION, COMMISSIONERS OF RECLAMATION (Mar. 1, 2018) https://www.usbr.gov/history/commiss.html (perhaps a tacit acknowledgment of this reality, New Mexicans have in recent years often been tapped as Commissioner for the Bureau of Reclamation, the agency's top position) (listing all Reclamation Commissioners, including New Mexicans Eluid Martinez, Michael Connor, and Estevan López—three of the last six, since 1995).

175. Rob Shields, *Henri Lefebvre: Philosopher of Everyday Life* (2002) (Henri Lefebvre was a Marxist and Existentialist philosopher, a sociologist of urban and rural life and a theorist of the State, of international flows of capital and of social space).

spatial–pragmatic analysis, as developed by legal geographer David Delaney,[176] of what the Rio Grande's Critical Zone signifies leads straight to the law. Not so abstractly, law is a function of a diversity of human experience. These innumerable social spaces are constitutive of the Law of the River. Space and experience are thus interwoven in the manifold processes by which the Rio Grande is governed. There is agency in the dimensionalities of this hydro–bio–geology, human and legal ecology, and material culture; this assemblage of institutions. The perennial political question, how to live in a place together, is thus yoked to a similar definitional—if philosophical—matter: what is the law? Ontology, or the study of what there is, serves as a first approximation by which to address the threshold question of what the Law of the Rio Chama *is*. In this connection, law is treated as a diversity of institutions, namely structured human–ecological interactions. Applying the lens of ontology to the rules emergent in this complex system is a useful step in parsing these rules and their underlying grammar, towards an improved understanding of the underlying experiences. An investigation into what those Middle Rio Grande water institutions are today, what exists in such spaces, and how they interact, is the inquiry pursued in the following sections.

1. Institutional Diversity on the Rio Chama

History and geography have always shaped water management and allocation decisions in the basin, and still does to the present day. Various forms of governance have attached to different forms of advanced agriculture in the Middle Rio Grande Basin, including the Rio Chama watershed. Today, the major legal regimes reflect these historical water governance institutions as well as add news ones.[177] They focus on, inter alia: aboriginal rights (Pueblo water rights); community governance (acequias); public lands reclamation, flood control, environmental law (federal claims); and municipal and irrigation needs (imported transbasin water). At the highest level, three institutions are woven throughout nearly all water law, policy, and management decisions in the Middle Rio Grande Basin: 1) international treaties; 2) interstate compacts; and 3) federal regulation and agency mandates.[178]

Federal intervention on the Rio Grande was catalyzed by the international and interstate nature of the river, which is legally allocated between four sovereigns and facilitated by a fifth. These four sovereigns include three states, Colorado, New Mexico and Texas, and a country, Mexico with the U.S. acting as facilitator. In the 1890s, a dispute arose between Mexico and the U.S. over excessive upstream

176. DAVID DELANEY, NICHOLAS BLOMLEY & RICHARD FORD, THE LEGAL GEOGRAPHIES READER (2001).

177. *See* M.H. Benson (2014), *supra* note 45, at 199–205 (providing a useful overview of governance structure and key actors); *see generally* Susan Kelly, et al., OVERVIEW OF WATER LAW APPLICABLE TO THE MIDDLE RIO GRANDE WATER PLANNING REGION, STATE OF N.M. INTERSTATE STREAM COMM'N & OFFICE OF THE STATE ENG'R, MIDDLE RIO GRANDE REGIONAL WATER PLAN (2004), [hereinafter Kelly (2004)] Supporting Document H-6 (providing an overview of New Mexico water law, pueblo water rights, relevant Endangered Species Act considerations, the San Juan-Chama project, and interstate compacts); *see generally* CLIMATE RISK ASSESSMENT, *supra* note 52 (providing comprehensive overview of Upper Rio Grande Water Operations).

178. *See generally* William A. Paddock, *The Rio Grande Convention of 1906: A Brief History of an International and Interstate Apportionment of the Rio Grande*, 77 DENV. U. L. REV. 287 (1999) (touching on treaties, compacts, and federal action in a discussion of water allocation).

American diversions of the river.[179] This dispute and resultant diplomatic pressure caused a federal embargo on the use of public lands for diversion and storage of water in both Colorado and New Mexico that would last until 1925.[180] The 1906 convention between Mexico and the U.S. resolved the conflict with a provision that gave Mexico a legal entitlement to 60,000 acre-feet per year of Rio Grande water.[181] To help in part with the resulting obligation to deliver water to Mexico and also to facilitate effective, large scale surface water irrigation, the federal Rio Grande Project commenced in 1907.[182] In 1935, in a further bid to avoid transboundary conflict on the river, now between Colorado, New Mexico, and Texas, the U.S. implemented another embargo on water development to pressure a binding, interstate agreement to share the river.[183]

After Colorado, New Mexico, and Texas agreed to a temporary compact in 1929, the extant Rio Grande Compact was agreed upon and then ratified by the respective states in 1938.[184] In general terms, the Compact intended to protect contemporaneous water uses and newer, upstream uses like development facilitated by the construction of new reservoirs were circumscribed.[185] Thus, the waters of the river were allocated between these sovereigns, while also paying lip service to sovereign native nations' senior Prior and Paramount rights to Rio Grande's surface flows.

Just as the Rio Grande Compact influences the timing and magnitude of water storage, so do the mandates of federal agencies—primarily Reclamation, the Corps, and the U.S. Fish and Wildlife Service ("Service").[186] Reclamation and the Corps both manage the built infrastructure along the river, including dams and reservoirs, but their missions are different. Since the Reclamation Act of 1902, Reclamation—and its predecessor, the Reclamation Service—has been charged with reclaiming the arid lands of the West, that is land west of the 100th meridian.[187] The newest addition to Reclamation's portfolio of water supply projects in New Mexico is the San Juan-Chama Project, which diverts 96,000 acre-feet of water from the Colorado River Basin to be used primarily by the City of Albuquerque and the MRGCD. The Corps, in contrast, was deputized in the 1930s and '40s to lead flood control efforts around the country.[188] In the Middle Rio Grande Basin, the City of Albuquerque and MRGCD irrigators have benefitted from the resulting

179. *See* LITTLEFIELD, *supra* note 70, at 16–32; *see also* PHILLIPS, *supra* note 52, at 87–88.

180. *See* LITTLEFIELD, *supra* note 70.

181. Paddock, *supra* note 178 at 292.

182. *See* LITTLEFIELD, *supra* note 70, at 146.

183. Susan Kelly, et. al., *History of the Rio Grande Reservoirs in New Mexico: Legislation and Litigation*, 47 NAT. RES. J. 525 (2007) (containing an excellent history of interstate water litigation on the Rio Grande, building on previous work by Al Utton) [hereinafter Kelly (2007a)].

184. *See generally* LITTLEFIELD, *supra* note 70, at 166–216.

185. Rio Grande Compact, N.M. STAT. § 72-15-23 (1938); *see generally* LITTLEFIELD, *supra* note 70, at 194–216.

186. *See generally* M.H. Benson (2013), *supra* note 43, at Table 2 (summarizing key constituencies and managers).

187. *See generally* PHILLIPS, *supra* note 52.

188. Flood Control Act of 1936, Pub. L. No. 74-738 (enacted June 22, 1936); *see also* Flood Control Act of 1944, Pub. L. No. 78-534, 58 Stat. 887, ch. 665 (1944).

infrastructure of dams and levees.[189] In turn, the Service is charged with the implementation of key aspects of the ESA. In its Biological Opinions, the Service determines whether federal agency actions, such as actions by Reclamation or the Corps, will "jeopardize" listed endangered species. Because such a Biological Opinion may require actions like maintaining minimum flows in a river to avoid jeopardy to an endangered species, it operates as a key water management constraint in a water-short environment like New Mexico.[190]

Two other federal institutions affect water allocation in the Middle Rio Grande: The Middle Rio Grande Endangered Species Collaborative Program ("Collaborative Program") and the Bureau of Indian Affairs ("BIA"). The Collaborative Program is a multi-stakeholder group that supports and coordinates efforts to achieve compliance with the ESA.[191] To this end, the federal funds it receives and then matches in part are directed to research and other efforts to achieve ESA compliance.[192] The BIA has the obligation to ensure the Six Middle Rio Grande Pueblos receive their water entitlements, even when Compact Article VII restrictions would otherwise prevent water from being stored at El Vado.[193] A foundational fact is that these Pueblos are sovereign Native American nations whose water use dates from time immemorial.[194] They hold the most senior water rights in the Middle Rio

189. *See* PHILLIPS, *supra* note 52, at 138–133.

190. *See* Consolidated Appropriations Act, 2005, Pub. L. No. 108-447, § 205(a)–(b), 118 Stat. 2949 (2004); *see also* App. (A)(4) at note 270 (WildEarth Guardians v. United States Bureau of Reclamation, No. 1:14-cv-00666 (D.N.M. filed July 24, 2014)); App. A(4) at note 271 (Lara Katz, *History of the Minnow Litigation and Its Implications for the Future of Reservoir Operations on the Rio Grande*, 47, 675 (2007)); *see also* App. (A)(4) at note 275 (Energy and Water Development Appropriations Act, 2004, Pub. L. No. 108-137, § 208, 117 Stat. 1827, 1849–50 (2003) (passed by Jeff Bingaman and Pete Domenici, providing that no federal funds would be applied to the San Juan-Chama Project for the benefit of the Silvery Minnow unless such water purchased from a willing seller pursuant to relevant Office of the State Engineer [OSE] permitting, and deeming that compliance with the 2003 BiOp would comprise compliance with Endangered Species Act requirements for a ten-year period)); *see also* App. A(4) at note 276 (Dry year flow targets under the 2003 BiOp, applicable to the Rio Grande from the outlet of Cochiti Dam and Reservoir through San Marcial, comprise a "continuous flow" requirement in the winter and spawning season, from November 16 through June 15, and a minimum 100 cubic feet per second ("cfs") during the post-spawning and summer months; *see, e.g.* BUREAU OF RECLAMATION, RIO GRANDE PROJECT ANNUAL OPERATING PLAN: WATER OPERATIONS MODELING 26 (2016), https://www.usbr.gov/uc/albuq/rm/RGP/pdfs/2016-AOP.pdf); *see* App. A(4) at note 741 (2003), http://www.fws.gov/southwest/es/NewMexico/documents/BO/2003-0129%20Middle%20Rio%20Grande%20Water%20Ops%20BO.pdf).

191. *See, e.g.,* BUREAU OF RECLAMATION *et al.*, *Memorandum of Understanding, Middle Rio Grande Endangered Species Collaborative Program* (April 23, 2002); Gillon (2007), *supra* note 57.

192. *See* COLIN MCKENZIE, UTTON CTR., *Federal Advisory Committee Act/Middle Rio Grande Endangered Species Collaborative Program* 1–2, at n. 2–4, 12–13 (Apr. 16, 2017) (copy on file with Bureau of Reclamation, Albuquerque Area office).

193. MEMORANDUM, U.S. DEP'T OF THE INTERIOR [DOI], ASS'T SEC'Y FOR INDIAN AFFAIRS—LAND AND WATER RESOURCES, TO DOI SEC'Y (Dec. 1, 1981), with attached copy of "AGREEMENT FOR PROCEDURES FOR THE STORAGE AND RELEASE OF INDIAN WATER ENTITLEMENTS OF THE SIX MIDDLE RIO GRANDE [MRG] PUEBLOS," signed Oct. 28–Nov. 2 by, *inter alia*, SIX MRG PUEBLOS' IRRIGATION COMMITTEE, SECRETARY OF INTERIOR'S DESIGNATED ENGINEER, BUREAU OF INDIAN AFFAIRS AREA DIRECTOR, AND BUREAU OF RECLAMATION (attachment approved Dec. 28, 1981 by DOI Secretary James Watt) (on file with author) [hereinafter 1981 P&P Agreement].

194. *See, e.g.*, Modzelwski, *supra* note 9; *see also* Hughes, *supra* note 9, at, 240–41 (discussing the inherent water rights of Pueblos).

Grande, sufficient to irrigate 8,847 acre-feet of water per year.[195] Because they are superior to all other irrigation water rights in the region, they are referred to as Prior and Paramount water rights.[196]

The institutional framework of the particular reach of the Rio Chama that this article focuses on—from the El Vado dam downstream to the Abiquiu Reservoir upstream—is dominated by contrasting elements. Flows are largely controlled by three dams, an interbasin water transfer, and municipal and agricultural water allocations, yet the waters are largely inaccessible, primitive, and contain a blue-ribbon fishery.[197] With the Rio Chama's hydrologic regime fundamentally altered owing to the El Vado dam and reservoir (which dates from the 1930s), and the importation of significant amounts of imported San Juan–Chama Project water,[198] it has seen a forty percent increase over its pre San Juan–Chama Project, solely native Rio Grande Basin flows. Nonetheless, operations at El Vado occasionally de-water the river. Post-El Vado, high flows have been recorded on the order of 6,000 cubic feet per second.[199] Transbasin diversion flows are coupled with the unique absence of non-negligible diversions. This circumstance, paired with the fact that flows from El Vado may be stored at Abiquiu, indicates a ripe possibility for reservoir operation and experimentation.[200]

This reach of the Rio Chama from El Vado to Abiquiu has also been designated as a Wild and Scenic River.[201] Parts of the Rio Chama are "wild" designated, which means its shores and watershed are essentially "primitive."[202] This federal designation recognizes the unique natural, cultural, and recreational values

195. *See, e.g.*, 1981 P&P Agreement, *supra* note 193, at 1.

196. *See generally* N.M. OFFICE OF THE STATE ENG'R, REGIONAL WATER PLAN: RIO CHAMA WATERSHED, 1–10 (2006), http://www.ose.state.nm.us/Planning/RWP/Regions/14_RioChama/2006/3-Legal-Issues.pdf; *see also* RIO CHAMA RWP (2016), *supra* note 148 ("Description of the Planning Region" and "Legal Issues Unique to the Region and Local Conflicts Needing resolution," respectively).

197. *See* Thompson, *supra* note 60.

198. *See id.*; *see also* RCFP Proposal, *supra* note 43, at 1 (citing Wohl et al., 2015); *see also* Funding Proposal from Rio Grande Restoration to the US Bureau of Reclamation, WaterSMART Cooperative Watershed Management Program Proposal: Rio Chama Watershed Partnership (June 5, 2014) [hereinafter 2014 RGR WaterSMART Proposal].

199. U.S. GEOLOGICAL SURVEY, RIO CHAMA DISCHARGE DATA BELOW EL VADO DAM, N.M., (2021) (showing logarithm plot of peak flows to nearly 6,000 cfs, and occasionally near-zero flows, on the order of 1–10 cfs) [hereinafter USGS Stream Gage Below El Vado Dam]; https://nwis.waterdata.usgs.gov/nm/nwis/uv/?cb_00060=on&format=gif_default&site_no=08285500&period=&begin_date=1991-05-01&end_date=2021-03-22; *cf.* Harvey, *supra* note 100, at 2, 33 (Chama peak flows, below El Vado).

200. *See* M.H. Benson (2013), *supra* note 43, at 3–7 (providing an overview of Rio Chama system, including: [1] the river's "Wild and Scenic" designation; [2] its altered hydrologic regime; [3] the San Juan-Chama Project; and [4] recent experimental flows); Morrison, *supra* note 46, at §§ 2.2.1, 2.2.2 (basin description and environmental flow study); *see also* M.H. Benson (2014), *supra* note 45, at 206–17 (detailing elements of social and ecological system(s) in Middle Rio Grande).

201. *See* App. A(5) ("While the Endangered Species Act does not apply to the Rio Chama since the silvery minnow has been extirpated from that river, a remote stretch of the river between El Vado and Abiquiu Reservoirs has been afforded environmental protections for its unique aesthetic and natural values."); *see also* App. A(5) at n. 821 (N.M. Game & Fish Dep't, Wildlife Notes: Silvery Minnow (no date), http://www.wildlife.state.nm.us/download/education/conservation/wildlife-notes/aquatic/Rio-Grande-silvery-minnow.pdf).

202. *Id*. (nothing this as a legal term of art in the Wild and Scenic Rivers legislation).

of free-flowing rivers. While dams on this and other rivers confine flow, the Wild and Scenic Rivers Act aimed to complement existing dams with a policy of protecting other selected rivers and reaches "in their free-flowing condition to protect the water quality of such rivers and to fulfill other vital national conservation purposes."[203]

Even as a Wild and Scenic River, downstream diversions control flow on the Rio Chama, since the MRGCD stores water at El Vado reservoir.[204] When MRGCD is not calling for irrigation water, flows on the Rio Chama primarily comprise the ABCWUA's San Juan-Chama allocation. The ABCWUA tends to move water when the MRGCD does not. For example, it has released water during the winter to support brown trout spawning.[205] Indeed, the cold, tailwater releases below El Vado have also generated a world-class trout fishery. At the macro level, this institutional mix has resulted in dampening spring peaks in the hydrograph while MRGCD stores native water at El Vado, and augmenting summer flows when irrigation water is released.[206]

2. Adaptive Capacity and Reservoir Operations

The unique institutional nature and hydrologic regime of the Rio Chama between El Vado and Abiquiu has generated interest in experimental flows. Specific interest in such flows, which would conceptually be released from El Vado and later stored at Abiquiu reservoir, roughly 25 miles downstream, appears to date from 2009.[207] That year, unique runoff conditions required a controlled release of 5,600 cubic feet per second from El Vado.[208] This release equaled a two-year return period flow event in the pre-El Vado Dam era, which was not terribly large. Still, it was the biggest release from El Vado since 1985. At this time, scientists observed that such flows could pass safely through El Vado to Abiquiu reach.[209] Of more immediate scientific—as opposed to engineering—interest, however, were the geomorphologic

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203. Wild and Scenic Rivers Act, Pub. L. No. 90-542, 82 Stat. 906 (1968), codified at 16 U.S.C.A. § 1274 et seq.

204. *See* M.H. Benson (2014), *supra* note 45, at 207, tbl. 2 (summarizing El Vado water management authorizations); *cf.* Luke Piermont, *Muddying the Waters: The Fight Over Relinquishment Credit*, VISTA: NAT. RES., ENERGY & ENVT'L L. SECTION, (Winter 2012) (providing an overview of Article VII credit relinquishment water and related legal issues, including ownership of this water) (noting MRGCD/BOR contract with third party for "relinquishment credit" water storage at El Vado).

205. *See* E-mail exchange between Rich Barrios and Karl Martin (Sept. 15, 1998) (on file with author) [hereinafter Barrios & Martin].

206. *See, e.g.*, CLIMATE RISK ASSESSMENT, *supra* note 52, at App. A, A-12–A-14 (noting reservoir storage and changes to the size and duration of peak flows).

207. Rio Chama Flow Project [RCFP], *The Chama Flow Report*, Vol. 1, No. 3 (Winter 2012), at 2 (note, "This Project Has History," highlighting confluence of relevant factors ca. 2008, -09); *see* App. note 324 (citing WildEarth Guardians v. United States Army Corps of Engineers, 314 F.Supp.3d 1178, 1203–04 (D.N.M. 2018, as amended) (The year was also when, among other related events, Congress authorized Cochiti reservoir operation deviations on a temporary, particularized basis—for environmental flow operations).

208. *cf*. Harvey, *supra* note 100 (citing associated PowerPoint presentation; USGS Stream Gage Below El Vado Dam, *supra* note 199; Presentation Remarks of Mike Harvey given at Rio Chama Flow Project Advisory Council Meeting (Oct. 12, 2016)).

209. Harvey, *supra* note 100 (towards Abiquiu, there are only Forest Service roads and a Benedictine Monastery near the river).

changes resulting from a pulse flow event of this magnitude, which reestablished some pre-damn era ecological functions of the Rio Chama.[210]

To further investigate the possibility of (re)creating ecological flows on the Rio Chama, scholars have set out conceptual models for categorizing and analyzing the relevant constraints and related opportunities for more flexible reservoir operations. In this domain, it bears highlighting that many reservoir operations of the Rio Grande affect or apply to the Rio Chama, as well.[211] Although this is not surprising, it is relevant. While there are no endangered species and no significant water users on the Rio Chama's river's Wild and Scenic reach, flows in this stretch of river are nonetheless characteristically driven in function of the basin-wide reservoir operations. Lessons that are gleaned from the case of the Rio Chama could be extended, therefore, more broadly.

With a particular eye to the Wild and Scenic reach of the Rio Chama, Benson, et. al. (2013), propose a classification system for thinking about the "institutional and physical capacity" issues generally relevant to more flexible operations. In doing so they apply an adaptive management framework.[212] Prospects for operationalizing instream flows—ad hoc and experimental or otherwise—are significantly influenced by a "complex set of legal requirements, physical constraints, and both social and ecological enhancement opportunities."[213] The classification framework put forward thus affords a navigational aid for charting these complex waters, in order to improve and facilitate stakeholder involvement, prevent ossification of perceived limitations, and investigate capacity issues.[214] Further, Benson, et. al., argue that certain "legal and institutional uncertainties" should be incorporated into such a mapping framework.[215] In the near decade that has passed since this framework was first presented, the physical, institutional, and

210. *Id*.

211. *See, e.g.,* Jennifer Faler, Reservoir Operation Constraints and Opportunities, from the Perspective of the Bureau of Reclamation, Presentation at "Institutional Constraints to Water Management in New Mexico, Albuquerque, NM (May 20, 2016), at 9–10, 12–15 (comments and analysis from Reclamation's current area director regarding reservoir operations discussing, inter alia, opportunities and examples of operations flexibility) (on file with Utton Center); John R. D'Antonio Jr., Challenges and Opportunities for Federal Reservoir Management, Presentation at "Institutional Constraints to Water Management in New Mexico, Albuquerque, NM (May 20, 2016) (presentation by former New Mexico State Engineer providing, inter alia, overview of law and management of federal reservoirs and discussing relevant authorities) (on file with Utton Center); Rolf Schmidt-Petersen, Managing the Surface Water of the Upper Rio Grande, in N.M. BUREAU OF GEOLOGY AND MINERAL RESOURCES, Decision-Makers Guide: Water Resources of the Middle Rio Grande: San Acacia to Elephant Butte, Chap. 1, at 27, 30 (L. Greer Price, Peggy S. Johnson, and Douglas Bland eds., 2007) (detailing how water management decisions are made); *see also* Brad Hudgens, U.S. Army Corps of Engineers Institute for Water Resources, Corps Water Supply Storage 101 (2016).

212. M.H. Benson (2013), *supra* note 43, at tbl. 2, 3.

213. *Id.* at 8.

214. *Id.*

215. M.H. Benson (2013), *supra* note 43, at Conclusion; *cf.* M.H. Benson, *supra* note 45, at 218–23; M.H. Benson (2018), *supra* note 101, at 99–101, 103, 112–13; Hannah Gosnell et al., *Transforming (Perceived) Rigidity in Environmental Law Throughout Adaptive Governance: A Case of Endangered Species Act Implementation*, 22 ECOL'Y & SOC'Y (No. 4, online) (2017), at 42–45; 48–52, 53–54; Tbl. 1; Figs. 1–3, https://doi.org/10.5751/ES-09887-220442; *see generally* COSENS ET AL., LEGAL PATHWAYS TO ADAPTIVE GOVERNANCE IN WATER BASINS IN NORTH AMERICA AND AUSTRALIA (Barbara Cosens and Lance Gunderson eds. 2018), https://doi.org/10.1007/978-3-319-72472-0_10.

capacity issues—and uncertainties—have been mapped with increasing sophistication. The Rio Chama Flow Project is now attempting to leverage these and subsequent legal mapping efforts into a numerical modeling tool by incorporating legal complexity. The usefulness of its result would be in function of a more transparent treatment (and modeling) of uncertainty, regardless of the source—scientific or legal.

In this vein, three major high-level constraints tend to dominate water management on both the Rio Chama and Rio Grande. First, a complex accounting of native Rio Grande Basin flows, and non-native flows is required for New Mexico to achieve both legal—and physical—compliance with the Rio Grande Compact.[216] Such accounting is carried out by complex physical–mathematical models. URGWOM, for example, contain rules regarding the physical assumptions and legal requirements underlying how such accounting operates. Modification of reservoir operations would need to be represented in the accounting model, and the effects to components of the water balance provided to the different stakeholders. In general, these effects are difficult to predict or conceptualize, given the complex, non-linear nature of the whole system.[217]

Second, the Abiquiu reservoir—through which native and non-native flows pass—is operated primarily for flood control purposes. Any deviation from these normal operations requires approval from the Rio Grande Compact Commission.[218] The Texas Commissioner, at a minimum, will scrutinize such operation for implications to their allocation, as delivered to Elephant Butte.

Third, any perceived or actual shortage to their allocation through altered reservoir operations could injure the water rights of irrigators. This is a matter of livelihood for irrigators; and for Pueblos, a matter of livelihood and sovereignty.[219] In this way, the 35-mile Wild and Scenic section of the Rio Chama clearly does not exist in a vacuum. New Mexico's water managers, especially federal dam operators (*e.g.*, the Corps) and water project managers (*e.g.*, Reclamation) are sensitive to these wide-ranging implications of modified reservoir operations on the Rio Chama.[220]

For its part, Reclamation's general policy perspective on reservoir operations is informed by the agency's water management responsibilities on the Rio

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216. *See* M.H. Benson (2013), *supra* note 43 at Tbls. 1–4 (laying out useful tabular summaries of these major (and related) constraints); M.H. Benson (2014), *supra* note 45, at 206–07, Tbl. 1; M.H. Benson (2018), *supra* note 101, at 104, Tbl. 7.1.

217. *See* Amos, *supra* note 3, at 1099, n. 16 and accompanying text (describing sophisticated, agent-based simulations tools used to model complex, socio-ecological systems for purposes of optimizing water management), 1131–32 (describing application of agent-based modeling to evaluate water scarcity outcome vis-a-vis the dynamics of legal flexibility, in a project that involves the "integration of biophysical parameters and social science data by legal research regarding the interaction of state and federal water law, on issues like instream flow and water quality").

218. *See* Flood Control Act of 1960, Pub. L. No. 86-645, 74 Stat. 480, 488; *see also* accompanying text ("Congressional authorizations of the MRG Project, which joined the purposes of flood and sediment control with re-development of agricultural lands in the Rio Grande's Middle Valley, occurred over a nearly 20-year period. In 1941, Congress authorized preliminary flood control studies and not until 1960 was the 'reservoir regulation plan' for the Project's component reservoirs defined by statute."); *cf.* M.H. Benson, *supra* note 45, at nn. 166–67 and accompanying text; Gillon (2007), *supra* note 57, at n. 102 and accompanying text, 635 (explaining constraints to such a deviation).

219. *See generally* DUNBAR–ORTIZ, *supra* note 55; Modzelwski, *supra* note 9.

220. *Cf.* 2014 RGR WaterSMART Proposal, *supra* note 198.

Grande and Rio Chama from Colorado to Texas. Reclamation manages Heron for imported San Juan-Chama Project water, and El Vado primarily for MRGCD supplies, which include both water native to the Rio Chama and some San Juan-Chama flows.[221] Storage is sometimes restricted under the Rio Grande Compact. El Vado may be used to store water pursuant to New Mexico's credit water relinquishment under the Rio Grande Compact.[222] Reclamation also manages the Rio Grande Project's Elephant Butte Reservoir, which is New Mexico's delivery point to Texas under the Rio Grande Compact.[223] In addition to this matrix of legal requirements and management responsibilities, Reclamation must also meet ESA-mandated flow requirements on the Rio Grande, as determined by the hydrologic objectives enumerated in the relevant Biological Opinion.[224]

Thus, Reclamation views reservoir operations flexibility as a tool to meet these various obligations, including ESA requirements, while enhancing ecological resilience, including meeting or even enhancing its water delivery capabilities during drought.[225] To that end, Reclamation has noted that reservoir storage flexibility may be needed to address water scarcity, earlier peaks of spring snowmelt runoff, as well as more intense floods and more prolonged drought.[226] With these exigencies in

221. *See* M.H. Benson (2014), *supra* note 45, at 206–07, Tbl. 1; M.H. Benson (2018), *supra* note 101, at 104, Tbl. 7.1.

222. *Cf.* Piermont, *supra* note 204.

223. *See, e.g.*, M.H. Benson (2014), *supra* note 45, at 206–07, Tbl. 1; M.H. Benson (2018), *supra* note 101, at 104, Tbl. 7.1.

224. *Cf.* App. A(4) at n. 277 (U.S. FISH AND WILDLIFE SERVICE, BIOLOGICAL AND CONFERENCE OPINION ON THE EFFECTS OF ACTIONS ASSOCIATES WITH THE PROGRAMMATIC BIOLOGICAL ASSESSMENT OF THE BUREAU OF RECLAMATION'S WATER AND RIVER MAINTENANCE OPERATIONS, ARMY CORPS OF ENGINEERS' FLOOD CONTROL OPERATION, AND RELATED NON-FEDERAL ACTIONS ON THE MIDDLE RIO GRANDE, NEW MEXICO (2003), http://www.fws.gov/southwest/es/NewMexico/documents/BO/2003-0129%20Middle%20Rio%20Grande%20Water%20Ops%20BO.pdf); *see also* App. A(4) at n. 282 (U.S. FISH AND WILDLIFE SERVICE, FINAL BIOLOGICAL AND CONFERENCE OPINION FOR BUREAU OF RECLAMATION, BUREAU OF INDIAN AFFAIRS, AND NON-FEDERAL WATER MANAGEMENT AND MAINTENANCE ACTIVITIES ON THE MIDDLE RIO GRANDE, NEW MEXICO 102 (2016), https://www.fws.gov/southwest/es/NewMexico/BO_MRG.cfm); *see* U.S. FISH AND WILDLIFE SERVICE, FINAL BIOLOGICAL AND CONFERENCE OPINION ON THE EFFECTS OF ACTIONS ASSOCIATED WITH THE PROGRAMMATIC BIOLOGICAL ASSESSMENT OF BUREAU OF RECLAMATION'S WATER AND RIVER MAINTENANCE OPERATIONS, ARMY CORPS OF ENGINEERS' FLOOD CONTROL OPERATION, AND RELATED NON-FEDERAL ACTIONS ON THE MIDDLE RIO GRANDE, NEW MEXICO at § VII 87–99 (detailing flow targets as "reasonable and prudent alternatives"), 109 (subject to the Biological Opinion's enumerated "terms and conditions," in concert with Federal and state agencies' discretionary "conservation recommendation"), 1176–18 (Mar. 17, 2003) [hereinafter 2003 BIOLOGICAL OPINION]; *see* 2016 BIOLOGICAL OPINION, *supra* note 56, at 18–24 (showing analogous requirements in the form of concomitant "Conservation Measures" and implementing regulations/programs/partners, corresponding to ESA-required "reasonable and prudent measures."), 13 (regarding draft Hydrologic Objectives for seasonal water needs for silvery minnow support), 19 (noting "Part One of the Silvery Minnow [Survival and Recovery Strategy, or SRS] contains strategies and decision points for silvery minnow production and survival known at the Hydrobiological Objectives"); *see also* App. A, detailing Hydrobiological Objectives.

225. *See* Faler, *supra* note 211, at 9, 10–15; *cf.* 2016 BIOLOGICAL OPINION, *supra* note 56, at Tbl. 1, pp. 149–150, 157–59 at Conservation Measures Nos. 1–4, 6, 31–34, 39; *see generally* 2015 JOINT BIOLOGICAL ASSESSMENT, *supra* note 74.

226. Faler, *supra* note 211, at 9.

mind, Reclamation's 2015 Biological Assessment, prepared in support of the new Rio Grande Biological Opinion, suggested ways towards water management flexibility.[227] These suggestions included alternative El Vado operations that Reclamation indicated were "within current [reservoir] authorizations."[228] These offsetting and conservation measures for El Vado included: 1) "modific[ation] of operations to better meet species needs[;]" 2) "adjustment to storage timing" during the spring peak flows; and 3) "facilitat[ing] exchanges of San Juan-Chama Project water from downstream to upstream to improve water management flexibility."[229] Beyond the types of flexible reservoir operations that Reclamation has been exploring for some time, such as waivers for carryover storage of San Juan–Chama Project water contractor allotments at year end,[230] Reclamation has also suggested pursuing modification to reservoir operations that go beyond existing authorization. For example, adjusting the timing of storage and creating conservation pools in upstream reservoirs.[231]

Jennifer Faler, Reclamation's Albuquerque Area District manager, highlighted some of the agency's "outside the box" thinking in 2017, probing some boundaries of current legal authority and existing authorizations.[232] Focusing on reservoir operations, she cited four recent examples of collaboration with key water users, managers, and regulators. First, Faler highlighted its coordination with the Rio Grande Compact Commission to enact Commission Resolutions which permitted storage at El Vado during Compact Article VII restriction and subsequent releases to support peak pulse-flows on the Middle Rio Grande.[233] Next, she pointed to altered timing for the release of unused Prior and Paramount water stored for the Six Middle Rio Grande Pueblos at El Vado, which "facilitate[d] a more natural hydrograph without affecting [downstream] water use[s] or deliveries under the Rio Grande Compact."[234] Faler also referenced two exchanges of San Juan-Chama Project water from Elephant Butte to upstream storage for the ABCWUA in 2013 and for the City of Santa Fe in 2014.[235] Finally, Ms. Faler cited Reclamation's ongoing "support [for] Albuquerque in its quest for storage of native waters in Abiquiu Reservoir" as another example of creative water management in the Middle Rio Grande.[236]

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227. *See* 2015 JOINT BIOLOGICAL ASSESSMENT, *supra* note 74; 2016 BIOLOGICAL OPINION, *supra* note 56, at Cover Ltr. 1–2; pp. 10, 13; App. A, *passim* (Reclamation Conservation Measures and related Hydrobiological Objectives, as developed initially in 2015 JOINT BIOLOGICAL ASSESSMENT [Hydrological Objectives].

228. *Id.* at 12.

229. *Id.*

230. U.S. ARMY CORPS OF ENGINEERS, U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, AND NEW MEXICO INTERSTATE STREAM COMM'N, UPPER RIO GRANDE WATER OPERATIONS REVIEW, Vol. II, at App. I (Water Operations), I-11 (Apr. 20, 2007) [hereinafter URG WATER OPERATIONS REVIEW] (citing Emmett Rice, Reclamation Field Solicitor Opinion (Nov. 3, 1983)) (providing legal rationale for carryover storage where benefit "inures" to the federal government, not any individual San Juan Chama Project water contractor).

231. Faler, *supra* note 211, at 9.

232. *Id*. at 14.

233. *Id*.

234. *Id*.

235. *Id*.

236. *Id.* at 14.

For its part, the Corps has a naturally narrower view of reservoir operations flexibility, in large part due to safety and engineering considerations underlying its primary mission of flood control.[237] While the Corps often operates reservoirs within its purview for multiple authorized purposes (such as municipal water supply, fish and wildlife, and recreation), flood control is its primary authorized purpose in the case of Abiquiu and Cochiti, as part of the Middle Rio Grande Project. As a threshold matter, the Water Supply Act of 1958 requires Congressional approval for any "major . . . operational changes" to Abiquiu or Cochiti, or for any "modification . . . which would seriously affect the purposes for which the project was authorized."[238]

Within this primary constraint to its operations, recent litigation highlights the Corps' current dim view on at least one aspect of reservoir operations discretion. In *WildEarth Guardians v. U.S. Army Corps of Engineers*, the issue was whether the Corps had, as a matter of law, insufficient discretion in its operations of Abiquiu to exempt it from the requirement that it consult with the Service under the ESA.[239] The Corps expressed the view that temporary, Congressionally authorized deviations from normal operations at the Corps-managed Cochiti Dam and Reservoir were an "unreliable tool for the purpose of silvery minnow spawning."[240] Further, the Corps expressed that it currently has "no authority" for further Cochiti deviation, in part because the Corps "does not own water or have water rights" and that the Corps "does not own the land."[241] In more general terms, the Corps similarly claimed it has "no discretion in [its] normal [daily] operations," which allow for the "free flow" of native Rio Grande and San Juan-Chama Project water through its dams to contractors.[242] In the same vein, the Corps categorically indicated that it has "no authority to acquire or release any added volume of water" and "no real property interests required to store water."[243]

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237. *See, e.g.*, D'Antonio, *supra* note 211, *passim*.

238. *See* App. A(2)(c) ("As broad as Reclamation's and the Corps' water management mandates may be, the Water Supply Act of 1958 ("1958 Act") limits the degree to which both agencies can unilaterally re-purpose or re-operate water projects. The 1958 Act required that Congress approve '[m]odifications of a reservoir project heretofore authorized, surveyed, planned, or constructed to include storage" if such modifications "would seriously affect the purposes for which the project was authorized, surveyed, planned, or constructed, or which would involve major structural or operational changes.' It has been argued that while this provision limits agencies' ability to unilaterally alter project purposes, it implicitly permits non-major changes to project operations, thus affording Reclamation and the Corps a degree of discretion in operating their projects."); *see also* App. A(2)(c) (citing Pub. L. No. 85-500, Stat. 297, § 301 (1958) ("major" changes); *see generally* Flatt & Tarr, *supra* note 44, at 1522 nn. 133–34 and accompanying text ("The WSA of 1958 requires congressional approval for a major allocation change to a previously authorized project that stores water. Section 301 of the Act, which requires congressional approval of modifications to a reservoir project that 'would seriously affect the purposes for which the project was authorized,' has not been the subject of much litigation."), 1529 nn. 190–91 and accompanying text (Act "[r]equires congressional approval of a 'major structural or operational change' and modifications that 'seriously affect' authorized purposes.")*; see* App. A(2)(c) 29; R. Benson (2017), *supra* note 154, at 370–71 nn. 81–83.

239. WildEarth Guardians vs. U.S. Army Corps of Eng'rs, 314 F.Supp.3d 1178, 1183 (D.N.M., June 6, 2018, *amended* Aug. 8, 2014); *see also* WildEarth Guardians v. United States Army Corps of Eng'rs, 2018 U.S. Dist. LEXIS 137112 (Aug. 14, 2018) [hereinafter WEG v. Corps].

240. D'Antonio, *supra* note 211, at 17.

241. *Id.*

242. *Id.*

243. *Id.*

Congress stepped in to address the Corps' concerns regarding a perceived lack of sufficient, *legal* authority to deviate from its primary mission to operate Cochiti Reservoir only for flood control. In the 2018 Water Resources and Development Act, Congress authorized the Corps to reinitiate temporary deviations in its operations of both the Cochiti and Jemez Reservoirs for a period of five years.[244] The Corps must consult with the Pueblos of Cochiti and Santa Ana before restarting temporary deviations and will continue to evaluate the effectiveness of the deviations.[245] Lest the Corps be attacked for its unyielding outlook, it indicated that, had the *WildEarth Guardians* litigation settled, it would have been "happy to facilitate stakeholder discussions to address:

1) "sources of water[;]"
2) "permits to store water[;]"
3) "real property interest required to store water[;]"
4) "Rio Grande Compact Commission approval[; and]"
5) "Congressional authorization[.]"[246]

That said, *WildEarth Guardians* did not settle as the Corps prevailed in court. Corps personnel have recently expressed the view that the agency has been less solicitous in seeking reservoir operations flexibility due to increased scrutiny of its water operations, presumably in terms of the threat of environmental litigation.[247] The Corps also notes it has completed "comprehensive data collection" for Cochiti Dam and Lake, which "would serve as baseline information" for a new, system-wide study.[248] Such a study would presumably form the basis for operating Corps reservoirs on the foundation of up-to-date data. This process could have the effect of rendering previous assumptions invalid and result in an optimized system. If, as a result, the Corps obtained a more accurate estimate for open-water evaporation,[249]

244. *See* America's Water Infrastructure Act of 2018, Pub. L. No. 115-270, § 1175, 132 Stat. 3766 (2018) [hereinafter AWIA (2018)].

245. *Id*. (containing current Congressional authorization of Cochiti Deviations); *cf.* App. at § B (citing the Letter from Antoinette Grant, U.S. Army Corps of Engineers, to Estevan Lopez and Brent Rhees (Nov. 12, 2013) (regarding expiration of the Cochiti Deviation) (on file with author); *see also* D'Antonio, *supra* note 211, at 17 (noting the Corps' that such deviations were "unreliable tool[s]" for Silvery Minnow spawning).

246. AWIA (2018), *supra* note 244.

247. Anjali Bean, Opportunities to Enhance Environmental Flows on the Rio Chama 6–7 (Aug. 2018) (Master of Water Resources Professional Project) (on file with the University of New Mexico Digital Repository) (contending, based on interviews with Corps personnel, that "[g]reater scrutiny of [Corps'] operations . . . has made the agency less able to find flexibility in their operations" and noting that the federal district court's June 2018 decision in favor of the Corps in *WildEarth Guardians* owed, in large, to the Corps' strict adherence to black letter law of, inter alia, Middle Rio Grande Project authorizing legislation).

248. D'Antonio, *supra* note 211, at 19.

249. Open water evaporation is seen as reservoir evaporation, which currently comprises a high percent of water use in the Middle Rio Grande. *See* U.S. ARMY CORPS OF ENG'RS, RIO GRANDE BASIN MASTER WATER CONTROL MANUAL, APP. A, ABIQUIU DAM AND RESERVOIR, RIO CHAMA NEW MEXICO, WATER CONTROL MANUAL 4–5 (1995) [hereinafter Abiquiu WCM] (noting 80-inch estimate of average annual evaporation at Abiquiu Dam).

project operations and policy could be altered to store water more efficiently without impairment to the Corps' acceptable margin of risk for its flood control operations.

Achieving some measure of reservoir operations flexibility is a necessary, but insufficient, condition for adapting to climate change induced drought, which early-21st century Rio Grande Basin conditions have previewed.[250] Still, the process of studying reservoir operations may be as important as specific results. As a laboratory, the Wild and Scenic reach of the Rio Chama offers an opportunity to focus on the process of consensus and trust-building. Complicating factors such as the ESA and impairment to water rights are not at issue as there are no endangered fish or substantial diversions on this reach of the Rio Chama.[251]

In the case of Rio Chama ecological flow operations—recent and prospective—legal defensibility and practicability considerations would benefit from answers to three significant outstanding questions. First, there is an arguably outstanding legal question as to authority for carryover storage at Heron Reservoir.[252] Such storage allows a flexible source of water for downstream release. Second, despite general consensus about the need for more flexible storage at Abiquiu, stakeholders are split on feasibility.[253] The MRGCD, for one, is concerned with how such storage could affect their rights in El Vado.[254] Third, as water moves downstream to Abiquiu, where it would be stored (if temporarily), evaporative losses increase, thus necessitating proper accounting for what amounts to a consumptive use. Still, one can imagine these three issues having technical solutions that would leave all water users—and the environment—whole.[255] Such technical solutions, together with the legal analysis needed to assure the operations are legally defensible, are precisely the terrain of the Rio Chama Flow Project. These issues are significantly less intractable than those related to the maelstrom on the mainstem Rio Grande such as: 1) complex water rights impairment analysis; 2) high-priority—and high-profile—ESA requirements; and 3) bottom-line Compact delivery obligations.[256]

III. MAPPING: LAW OF THE RIVER, OPERATING RULES, AND RESERVOIR OPS

Within this variegated international, interstate, intrastate and generally multi-jurisdictional, transboundary, and inter-sovereign water governance regime, there are varying colors of water. The Law of the River for the Rio Chama and Rio

250. *See, e.g.,* R. Benson (2017), *supra* note 154, at 356–57 ("[R]eservoirs operate in dramatically changing context. . . . [C]limate change has serious implications for dam operating plans.").

251. Personal Communication, Mike Harvey, RCFP Technical Team, Fall 2016.

252. *See infra* Section IV.A.

253. *See, e.g.*, Bean, *supra* note 247, at 7 (noting conceptual agreement among Reclamation, the Corps, MRGCD, and ABCWUA regarding the benefits likely to inure to the Flow Project's goals; highlighting generalized support of the concept from the Corps and ABCWUA; but explaining that the MRGCD is "not particularly interested in risking harm to their own rights").

254. *Id*.

255. *Cf*. DEBUYS, *supra* note 10, at 268, 270–71, 274 (noting, *inter alia*, the most critical challenges in MRG water management domains dealing "political ecology," not technical feasibility).

256. Bean, *supra* note 247, at 8 (noting that "large portion of the water used [for] . . . Silvery Minnow endangered species compliance is stored and released first [on] the Chama").

Grande nonetheless requires an accounting of multidimensional coloring and shading of water, given the coupled physical–legal aspect of water allocation and use under prior appropriation. Accounting for such legal and physical dimensions of embodiment of water thus forms a basis of the legal framework. The Law of the River is the framework by which surface water is managed, and therefore by which reservoirs are operated.

A. Précis for a Law of the River: Treaties, Compact, and Indigenous Rights

Amidst protracted drought and the sometimes-zero-sum mentality of water stakeholders, federal action—and therefore federal law—in the Rio Grande Basin is one axis on which all water management turns.[257] The three bases of federal action in the basin are largely international treaties and an interstate compact, together with federal water projects. Reclamation, which is generally in charge of water supply and the Corps, responsible for flood control, along with an environmental law overlay fall under the prior appropriation regime.[258] All represent explicit Congressional authorizations, approvals, or mandates. The 1906 treaty with Mexico allocates a portion of the Rio Grande's flow to Mexico,[259] while the Rio Grande Compact of 1938 represents Colorado, New Mexico, and Texas's attempt to divide these international and interstate waters among the three states.[260] Next, the MRGCD attempted, but failed, to harness the river.[261] The federal government authorized its bailout as part of the Middle Rio Grande Project, which directed the Corps to provide flood control through a network of dams and levees on the Rio Grande and its tributaries.[262] Subsequently, Congress authorized the San Juan-Chama [Diversion] Project, whereby Reclamation would import water from the Colorado River Basin to supply, primarily, the City of Albuquerque and the MRGCD.[263] Pursuant to authorizing legislation, neither project could operate to interfere with New Mexico's delivery obligations to Texas under the Rio Grande Compact.[264] Further, the ESA obligates water delivery for endangered species.[265]

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257. *See* App. § A(2) *passim*.

258. *Id*. at § A(2)(ii).

259. *Id*. at § A(1).

260. *See generally infra* notes 282–291 and accompanying text.

261. *See* PHILLIPS, *supra* note 52, at 102–122, 130–32 and accompanying text; *see also* 2015 JOINT BIOLOGICAL ASSESSMENT, *supra* note 74, at I-5 to I-7 and accompanying text.

262. *See* App. A(3)(iii) (Conservancy Law); App. A(2)(ii)(a) (MRGCD re-development as part of MRG Project).

263. App. A(2)(ii)(b) at n. 538 (For concise overviews, *see* Abiquiu WCM, *supra* note 249, at 9-2, ¶ 90-1(b)) ("Bureau of Reclamation"); Craig Boroughs, Marc Sidlow, and Steven Bowser, Representing Policy for Operations in the Upper Rio Grande Water Operations Models, Presented *at* 2ND JOINT FED. INTERAGENCY CONF., June 27-July 1, 2010 at 2, 5 [hereinafter Boroughs (2010)]; *see generally* Gillon (2007), *supra* note 57, at 617–19; 2015 JOINT BIOLOGICAL ASSESSMENT, *supra* note 74, at Pt. I, I-3–I-5 ("The San Juan-Chama Project."); Kevin G. Flanigan & Amy I. Haas, *The Impact of Full Beneficial Use of San Juan-Chama Project Water by the City of Albuquerque on New Mexico's Rio Grande Compact Obligations*, 48 N. Res. J. 371, 374–79. (2008).

264. *See generally infra* notes 282–291 and accompanying text.

265. *See* M.H. Benson (2014), *supra* note 45, at 200–05 (providing an overview of interstate compacts, San Juan-Chama Project, tribal agreements, and federal agencies); Oglesby, *supra* note 54 (discussing various "colors of water"); Kevin Flanigan, *Bringing Accountability to Water Planning: Does it take a*

Uncertainty regarding the nature and extent of Pueblo water rights necessarily informs any discussion of water law and policy in the Rio Grande Basin,[266] which is further complicated by the federal-tribal relationship.[267] As scholar and water lawyer Em Hall has pointed out, although "[w]e are accustomed to say that the 1938 Rio Grande Compact limits New Mexico's access to [water] in the Rio Grande generally[,] the *Pueblo claims come before the compact*, which exempts them from its terms."[268] Practically speaking, the priority and magnitude of these rights has the potential to replace nearly all non-native water users. Further, aboriginal or reserved rights, which are governed under federal law, are not subject to state rules on beneficial use and abandonment or forfeiture.[269] To add to this complexity, the nature and extent of Indian water rights is judicially evolving, and in New Mexico, contains a wrinkle. Here, the water rights of Pueblos do not fall squarely within the well-established *Winters* doctrine of federal reserved rights for tribes.[270] Instead, Pueblos may in part have "aboriginal rights," which are unlike federal reserved rights that attached to Indian reservations. These rights were generally created in the latter half of the nineteenth century, recognized by prior sovereigns, Spain and Mexico, and subsequently preserved by the U.S. in 1848 in the Treaty of Guadalupe Hidalgo.[271]

On so-called grant lands, Pueblo water rights are "immemorial, aboriginal, or first priority" because, as the Utton Center has explained, those lands 1) "have been occupied and the water used since before Europeans entered the territory[;]" 2) "were recognized by prior sovereigns[;]" 3) "came into the United States protected by the Treaty of Guadalupe Hidalgo[;]" and 4) "were never relinquished to the federal government."[272] Quantification of Pueblo rights is, nonetheless, still an open legal question. While the "historically irrigated acreage" standard—as opposed to *Winters*' "practicably irrigated acreage" standard—was applied in the *Aamodt* adjudication, that judicial decision carries no precedential value since the case was

Crisis?, New Mexico Water Dialogue Meeting, (The N.M. Water Dialogue) (setting out legal framework for surface water management); Kelly (2007a), *supra* note 176, at 612; Kelly (2007b), *supra* note 183, at 653; Kelly & Urbina, *supra* note 132; Hall (2007), *supra* note 52, at 54 (describing Middle Rio Grande surface flows "subject to different legal claims"); Kara Gillon, *Watershed Down?: The Ups and Downs of Watershed Management in the Southwest*, 5 U. DENV. WATER L. REV. 395, 408–11 (2002) ("The Law of the Rio Grande"); *see generally*, Amos, *supra* note 3, at Pt. III.

266. *See, e.g.*, Kelly 2004, *supra* note 177, at 36 (titled "Pueblos' [and Tribal] Reserved Water Rights"), 37 (titled "Reserved Rights for Other Federal Purposes").

267. *See, e.g.*, UTTON CENTER, *American Indian Water Rights*, *in* WATER MATTERS! 5-1–5-4, 5-6–5-7 (2015) (providing an overview, basis, quantification, and priority of tribal and Pueblo water rights, as well as notes on government-to-government relations); Hall (2007), *supra* note 52, at 54–55; Kelly 2004, *supra* note 177, at 31–36.

268. Hall (2007), *supra* note 52, at 54.

269. *See* App. A(3)(ii)(a)–(b), A(3)(iii) (providing a summation of permits and categories of rights along the MRGCD as well as Conservancy Laws relevant to the MRGCD).

270. *See* Modzelwski, *supra* note 9.

271. *See* Treaty of Guadalupe Hidalgo, *supra* note 66; CLARK, *supra* note 52, at 24, 33, 35; *see generally* Hughes, *supra* note 9; *see generally* Modzelwski, *supra* note 9.

272. UTTON CENTER, *supra* note 267, at 5-2.

subsequently settled.[273] In this legal grey area, out of which arise many injustices in terms of violation of native sovereignty, it is worth recalling the obvious: Federal water rights in New Mexico were not developed with regard to the historical and practical realities of native water rights. As a result, watersheds were over-appropriated, including through the federal Reclamation program.[274]

A final, judicial definition of the nature and extent of Pueblo rights may never occur. Instead, recent Indian water rights settlements in New Mexico, such as *Aamodt* and *Abeyta* (Taos), may provide the next-best answer. Such litigation highlights the magnitude of fiscal and multi-stakeholder collaboration required, through the settlement process, to resolve this complication of Indian water rights.[275] For example, the *Aamodt* and *Abeyta* settlements required federal contributions of $174 and $124 million, respectively, and state contributions of $50 and $19 million, respectively.[276] *Aamodt* required an extensive process to implement the Regional Water System attendant to the case's settlement.[277] Thus, along the path to full implementation of the *Aamodt* settlement were numerous milestones. The Pueblos of Jemez, Santa Ana, and Zia have returned to litigation in the *Abouselman* adjudication and so a judicial determination of the nature and extent of Pueblo water rights in the Middle Rio Grande remains a possibility.[278]

Other than the Pueblos' water rights, tribal rights most relevant to the Rio Chama Flow Project are the rights of the Jicarilla Apache nation, which owns riparian lands on the Rio Chama.[279] In March of 2013, the State of New Mexico and the Jicarilla Apache Nation successfully concluded years of negotiation and collaborative technical work in the *State of New Mexico v. Aragon* adjudication with the entry of a Consent Order recognizing the Nation's water rights on lands acquired since the entry of the 1998 Jicarilla Apache Nation decree,[280] including riparian land it subsequently purchased along the Rio Chama.[281]

Notwithstanding these critical issues regarding the sovereign rights of various native nations in the basin, the Rio Grande Compact remains the canonical—orthodox, as it were—cornerstone of the Law of th[is] River.[282] As noted above, the Compact intended to protect contemporaneous water uses and newer, upstream uses,

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273. Modzelwski, *supra* note 9, at 59–62; Hughes, *supra* note 9, 223–228 (discussing New Mexico ex rel. State Engineer v. Aamodt, 11 N.M. 4, 800 P.2d 1061 (N.M. 1990), which is not binding since this litigation was ultimately settled out of court).

274. *See, e.g.*, Krakoff, *supra* note 15, at 262–63, 265–66, 270–76, 284–86 (2013); UTTON CENTER, *supra* note 267, at 5-3 (discussing reclamation projects and tribal water claims).

275. UTTON CENTER, *supra* note 267, at 5-1–5-7.

276. *Id*. at 5-4.

277. *Id.*

278. *See id*. at 5-5 ("returned to litigation"). *But see* Matthew Fletcher, *Tenth Circuit Denies En Banc Petition in Pueblo Water Rights Matter,* TURTLE TALK (Dec. 21, 2020), https://turtletalk.blog/tag/united-states-v-abousleman/ (citing *Order Denying Petition,* TURTLE TALK (Dec. 18, 2020), https://turtletalk.files.wordpress.com/2020/12/order-denying-petition-for-rehearing.pdf).

279. UTTON CTR. Sources, *supra* note 155, at 5-2.

280. *Id*. at 5-5.

281. *Id.*

282. While the "law of the river" usually refers to the Colorado River, "laws of the rivers" exist around the West. *See* COLO. RIVER COMM'N OF NEV., "LAWS OF THE RIVERS": THE LEGAL REGIMES OF MAJOR INTERSTATE SYSTEMS OF THE UNITED STATES (OCT. 2006).

like development facilitated by the construction of new reservoirs that were circumscribed. For example, Article VII dictates that no water may be stored in upstream, "post-1929" reservoirs when "usable project water" in storage at Elephant Butte falls below 400,000 acre-feet.[283] Accordingly, new uses upstream of Elephant Butte must occur through either imported water from the Colorado River Basin or as a function of water stored above the volumes Rio Grande Project users are entitled to divert.[284]

Under the Rio Grande Compact, water delivery requirements are indexed based on current flows, and New Mexico makes delivery to Texas, not at the political boundary of the two states, but into Elephant Butte Reservoir.[285] Despite these annual, indexed delivery obligations, the Compact allows for a degree of management flexibility. For example, Article VI of the Compact provides the upstream states an accounting system of credits and debits with regards to annual interstate delivery obligations.[286] The accrued debits and credits, however, are limited to 200,000 acre-feet "at any time," with no more than 150,000 acre-feet charged in any given year.[287] These credits and debits are cancelled entirely in those years when Elephant Butte Reservoir is full and thus "spills,"[288] thereby releasing water downstream. Further, Article VII provides that New Mexico or Colorado "may relinquish accrued credits at any time, and Texas may accept such relinquished water."[289] In that case, the upstream state is entitled to store the amount relinquished.[290] New Mexico would accordingly store the water in such post-1929 reservoirs as El Vado.[291]

To put the Compact into perspective, instruments of interstate cooperation[292] like the Compact have become the preferred method of interstate allocation of water.[293] Under the Compact Clause of the U.S. Constitution, interstate

283. Rio Grande Compact, N.M. STAT. ANN. § 72-15-23 (VII) (1938).

284. *Cf. Id*. at §§ 72-15-23(IV), (V).

285. *Id*. at § 72-15-23(IV).

286. *Id*. at § 72-15-23(VI).

287. *Id.*

288. *Id.*

289. *Id*. at § 72-15-23(VII).

290. *Id.*

291. *See generally* Piermont, *supra* note 204 (noting that while the Rio Grande Compact, article VII provisions on relinquishment credits allow New Mexico to store water in post-1929 reservoirs, New Mexico's Interstate Stream Comm'n [ISC] has undertaken to convert "paper" relinquishment credits to "wet" relinquishment water by contracting with MRGCD and the U.S. Bureau of Reclamation for such storage in El Vado).

292. Matthew S. Tripolitsiotis, *Bridge Over Troubled Waters: The Applications of State Law to Compact Clause Entities*, 23 YALE L. & POL'Y REV. 163, 179 (2005) (describing common issues addressed by interstate compacts: bridges and port facilities, economic development, and prisoner exchange—all require collaboration) (internal citation omitted) ("Much of the law applicable to compact entities is determined by the compact itself and contract law . . . Contract law affects compacts no differently than other instruments of agreement that are classifiable as contract. Thus, compact law is contract law.").

293. *See* DOUGLAS KEENEY, NAT. RES. L. CTR., UNIV. OF COLO. SCH. OF L., WATER ALLOCATION COMPACTS IN THE WEST: AN OVERVIEW 8 (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 2002), http://scholar.law.colorado.edu/cgi/viewcontent.cgi?article=1132&context=books_reports_studies; *see also* Edella Schlager & T. Heikkila, *Resolving Water Conflicts: A Comparative Analysis of Interstate*

compacts require Congressional consent, which has the effect of transforming an interstate compact into federal law.[294] Compact law has also historically been coextensive with contract law,[295] yet a compact's meaning may not be defined unilaterally by one state for parochial concerns such as intrastate water allocation.[296] Correspondingly, "no court may order relief inconsistent with its express terms," absent a finding that the compact is unconstitutional.[297] Nonetheless, intrastate allocation issues are potentially troublesome as a function of states' unwillingness to relinquish control of water resources in water-short years or basins.[298] The U.S. Supreme Court adjudicates compact disputes as a matter of course—and original jurisdiction—and may dictate remedies for their breach.[299]

The Rio Grande Compact is codified as state law[300] and forms the backbone of water law in New Mexico, alongside 1) the doctrine of prior appropriation;[301] 2) federal law governing water resources including Reclamation law,[302] Congressional

River Compacts, 37 POL'Y STUDIES J. 367, 369 (2009) (citing comments made by Jerome Muys, at The Western States' Experience With Interstate Water Issues Panel: Lessons From the West, Sponsored by American Bar Association Section of Environment, Energy, and Resources, at the conference Eastern Water Resources: Law, Policy and Technology, in Hollywood, Fla. (May 2004)).

294. U.S. CONST. art. I, §10, cl. 3.

295. *See* Green v. Biddle, 21 U.S. 1 (1823) (deciding the first case to interpret an interstate compact as a contract); *see also* Tarrant Regional Water Dist. v. Herrmann, 133 S. Ct. 2120, 2130 (2013) ("[I]nterstate compacts are construed as contracts under the principles of contract law . . . . So, as with any contract, we begin by examining the express terms of the Compact as the best indication of the intent of the parties."); Petty v. Tenn.-Mo. Bridge Comm'n, 359 U.S. 275, 285 (1985) (Frankfurter, J., dissenting) ("[A] compact is, after all, a contract"); Montana v. Wyoming, 131 S. Ct. 1765 at n.4 (2011) ("As with all contracts, we interpret the Compact according to the intent of the parties [. . .] We this look primarily to the doctrine of appropriation in Wyoming and Montana, but . . . we also look to Western water law more generally."); *see also* U.S. CONST. art. I, §10, cl. 1 (precluding states' impairing obligation of contracts).

296. *See, e.g.*, State ex rel. Dyer v. Sims, 341 U.S. 22, 28 (1951); Nebraska v. Iowa, 406 U.S. 117, 124 (1972).

297. Texas v. New Mexico I, 462 U.S. 554, 564 (1983).

298. Schlager & Heikkila, *supra* note 293, at 371–72.

299. Texas v. New Mexico, 482 U.S. 124 (1987), No. 65, Org. (internal citation omitted) (explaining that, as function of States' ratification of the US Constitution, "the States gave this Court complete judicial power to adjudicate disputes among them . . . and this power includes the capacity to provide one state a remedy for the breach of another."); *see also* U.S. CONST. art. 3, § 2, cl. 1 et seq.; Kansas v. Nebraska, 135 S. Ct. 1042, 1052 (2015) (noting more than one hundred years of the court's recognition of its "inherent authority, as part of the Constitution's grant of original jurisdiction, to equitably apportion interstates streams.") (citing Kansas v. Colorado, 185 U.S. 125, 145 (1902)). Federalism and separation-of-power concerns have rendered the Supreme Court particularly hesitant to "read absent terms into" compacts. *See* Alabama v. North Carolina, x U.S. x, 130 S. Ct. 2295, 2312–2313, 176 L.Ed.2d 1070 (2010) (a low-level radioactivity case citing in pertinent part, the interstate water compact case, Texas v. New Mexico I, 462 U.S. 554, 564 (1983)).

300. *See, e.g.,* Rio Grande Compact, N.M. STAT. ANN. § 72-15-23 (1938) (showing New Mexico's codification of the Rio Grande Compact).

301. Edella Schlager, *Governing Boundaries: Exclusion, Essential Resources, and Sustainability*, *in* GOVERNING ACCESS TO ESSENTIAL RESOURCES 79 n.7 (Olivier De Schutter & Katharina Pistor eds., 2015) ("State officials are bound by compacts[.]") (citing the landmark interstate water compact case, Hinderlider v. La Plata and Cherry Creek Ditch Co., 304 U.S. 91).

302. *See* App. A(2)(i)(a) (programmatic statutes relevant to Bureau of Reclamation operations).

authorizations of dams and reservoirs operated by Reclamation and the Corps;[303] and, most recently, 3) the overlay of environmental law, like the ESA.[304] Throughout this complex assemblage of a legal regime, the Compact is a foundational element that is referenced often and explicitly. The 1948 Flood Control Act,[305] for example, requires that the Middle Rio Grande Project be operated in conformity with the Compact as water is stored, released, and delivered to the MRGCD.[306]

B. Mapping Flow Operations

More than a decade ago, Kara Gillon provided a framework for utilizing a portion of the City of Albuquerque's San Juan–Chama Project water storage space at Abiquiu, the so-called Environmental Pool, to operationalize in-stream flows on the Rio Grande.[307] This special water storage right was the product of the City's 2006 settlement with environmental groups stemming from the eponymous silvery minnow litigation.[308] Gillon mapped out prospective steps, sources of water, and the collaboration needed to operationalize this storage, to be leveraged towards ecological flows dedicated to the river's ecosystem.[309] Following a robust empirical investigation and framework development, Gillon explains the strategy thus: 1) *subleasing storage* with the ABCWUA pursuant to the Settlement Agreement—which was considered at the time by the Corps to be a deviation from normal reservoir operations and thus require approval of the Compact Commission;[310] 2) *sourcing water*—as from Reclamation's Supplemental Water Program—through leases of San Juan–Chama Project water—or in partnership with the State's Strategic Water Reserve; and 3) *obtaining regulatory compliance*, including an assessment of

303. *See* App. A(2)(i)–(iii) (giving an overview of Federal water projects, including programmatic statutes, project-specific authority, and subsequent developments).

304. *See* App. A(4) *passim* (giving an overview of the ESA's role in the Law of the River).

305. *See* App. A(2)(ii)(a) *passim* (giving an overview of project-specific authority for the Middle Rio Grande Project); *see also* App. A(2)(ii)(a) (citing the Flood Control Act of 1941, Pub. L. No. 77-228, § 4, 55 Stat. 638 (YEAR) (authorizing "preliminary examinations and surveys for flood control" in, *inter alia*, "Rio Grande and tributaries, New Mexico")); *see also* App. A(2)(ii)(a) at note 493 (Flood Control Act of 1960, Pub. L. No. 86-645, 74 Stat 480, 488 (1941, 1960)).

306. *Id*.

307. *See generally* Gillon (2007), *supra* note 57, at 629–638.

308. *Id*. at 629–30.

309. Gillon (2007), *supra* note 57, at 636–37 (detailing "Options for an Environmental Pool").

310. *Id*. at 631 n.110 and accompanying text (citing the 2005 version of URGWOM Ruleset). This would appear, by now, to be an academic point since San Juan–Chama Project and native Rio Grande basin waters are regularly co-mingled, both physically and—perhaps more importantly, for present purposes—in URGWOM's accounting framework. According to Audubon's press release regarding its historic first utilization of this Environmental Pool at Abiquiu for the storage and subsequent release of ecological flow, the Pueblos of Sandia, Santa Ana, Cochiti, Sandia, and Isleta each "supplied 100 acre-feet of San Juan–Chama water" to Audubon for the effort. However, these Pueblos do not have San Juan–Chama Project water contracts with the Bureau of Reclamation. This means that the Pueblos may have entered into an exchange of their native Rio Grande basin, Prior and Paramount water for a certain amount of imported, San Juan–Chama water. Such a maneuver would have the benefit of getting around the Corps' reluctance to consider storage of native water in the Environmental Pool *not* to be a deviation from normal reservoir operations").

environmental effects pursuant to the National Environmental Policy Act ("NEPA").[311]

It took nearly a decade before Gillon's framework was operationalized. The National Audubon Society's would come to spearhead the efforts of this innovative use of Abiquiu's Environmental Pool, first in 2016 in partnership with the Middle Rio Grande Pueblos Sandia, Isleta, Santa Ana, and Cochiti, who contributed approximately 400 acre-feet of "wet" water, and the MRGCD, who provided technical assistance and managed the District's water delivery and drainage infrastructure—its irrigation ditches, as well as operational prowess.[312] That operation was planned, as announced by Audubon, to "increase flow in the river channel for a 35-mile stretch for nearly 24 days."[313] Amidst harsh drought conditions, similar operations were repeated in 2018[314] and, most recently, in 2020.[315] In 2020, "530 acre-feet of [] water [was released] . . . near Los Lunas," in an operation that was, Audubon reported, "tightly coordinated with water managers and biologists to ensure effective and efficient use."[316] The legally dispositive fact appears to be that in order to avoid the Corps' determination that the operation was a "deviation" from normal reservoir operations, which would trigger the Compact Commission's advice and consent, the Pueblos exchanged Prior and Paramount water for San Juan–Chama Project water, which would not occasion the same requirement—notwithstanding Congress has authorized that both "colors" of water be stored at Abiquiu.

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311. *Id.* at 637–38 nn. 143–49 and accompanying text.

312. *See* Nat'l Audubon Soc'y, Press Release, *Audubon Announces Historic Water Release to the Middle Rio Grande,* NAT'L AUDUBON SOC'Y (Sept. 7, 2016), https://www.audubon.org/news/audubon-announces-historic-water-release-middle-rio-grande (describing the historic first Rio Grande in-stream flow operation made possible by the Environmental Pool at Abiquiu reservoir) (noting also the contribution of nearly 400 acre-feet of water leased by a Santa Fe golf club from the Jicarilla Apache Nation) (describing historic first Rio Grande in-stream flow operation made possible by the Environmental Pool at Abiquiu reservoir, whereby four Pueblos, Sandia, Isleta, Santa Ana, and Cochiti, partnered with the non-profit to supply nearly 400 acre-feet of San Juan–Chama Project water for the operation, along with the same amount of water leased by a Santa Fe golf club from the Jicarilla Apache Nation; *cf*. Nat'l Audubon Soc'y, Press Release, *Audubon Joins New Mexico Municipalities in Water Releases to Recharge Vital Habitat Along the Rio Grande* (July 17, 2018), https://www.audubon.org/news/audubon-joins-new-mexico-municipalities-water-releases-recharge-vital-habitat; Paul Tashijian, *In Driest Year in Half Century, Audubon Release Water into Rio Grande to Sustain Flows*, Western Water News (July 27, 2020), https://www.audubon.org/news/in-driest-year-half-century-audubon-releases-water-rio-grande-sustain-flows (noting that "[f]lexible tools and timed releases help support people and birds in central New Mexico," and describing "'string of pearls' strategy" developed by the MRGCD, an "innovative water management strategy that takes advantage of irrigation infrastructure to efficiently deliver water to key habitat locations").

313. *Id.*

314. Nat'l Audubon Soc'y, Press Release, *Audubon Joins New Mexico Municipalities in Water Releases to Recharge Vital Habitat Along the Rio Grande,* NAT'L AUDUBON SOC'Y (July 17, 2018), https://www.audubon.org/news/audubon-joins-new-mexico-municipalities-water-releases-recharge-vital-habitat.

315. *See* Tashijian, *supra* note 312 (noting that "[f]lexible tools and timed releases help support people and birds in central New Mexico," and describing "'string of pearls' strategy" developed by the MRGCD, an "innovative water management strategy that takes advantage of irrigation infrastructure to efficiently deliver water to key habitat locations").

316. *Id.*

Applying the legal mapping concept, this section will continue in Gillon's spirit by characterizing the contours of other emergent environmental flow mechanisms, some of which, like Abiquiu's Environmental Pool, have grown out of the minnow litigation, and taken some time to operationalize and refine. It will also describe a technical tool which models the operational, legal, and accounting framework for water management, including reservoir operations in the Middle Rio Grande. Within both the technical–operational–transactional frame, and the primarily regulatory–collaborative frame, it appears that "collaborative governance [has] transformed the ESA from a statute *prohibiting* certain *outcomes* (such as harm or jeopardy to a species), to a regulatory program implementing collaboratively craft *best practices*."[317] These combined empirical results match William deBuys' assessment that the endangered Rio Grande silvery minnow is really a blessing as opposed to a curse.[318] However, it has not come easy. Matching deBuys' other critical insight that the key challenge of water governance in the Middle Rio Grande is one of political ecology, Susan Kelly reported in 2007 that, in a "collaborative process for developing simulations that can be used to understand the probable effect of changes of the system of Rio Grande reservoir," stakeholders involved showed that "even developing *hypothetical* model runs can be controversial."[319]

Mapping analytics foregrounds how, in the Middle Rio Grande Basin, the Law of the River emerges from the dominance of many elements. Those elements include a large network of components with no per se central control, and ostensibly simple rules of operation, from which complex collective behavior, sophisticated information processing, and adaptation, as well as adaptive water management emerge. Within this setting's characteristic legal complexity, the analysis is also emergent, proceeding by way of intuition, analogy, and cases. Thus descriptive, prescriptive, and ethical approaches are merged to highlight system structure and behavior, with an eye towards assessing system feedback and logical traps such as determinism. In this mode, system structure is mapped in terms of hierarchies, both formal and information of agents, system architecture, and information. System structure can be looked at in terms of complex, emergent system "feedback," for example, the spread of social paradigms. With another eye to future research, both model-driven, in the predictive realm and empirical, in the domain of measuring and monitoring, the following section also describes the foremost technical tool, the multi-agency URGWOM as a coupled legal–hydrologic framework for water management, including reservoir operations in the Middle Rio Grande.

This legal mapping methodology confronts well-sorted taxonomy, within URGWOM, of myriad, entangled legal authorities. Outside and beyond the model, where the law is not so hermetically sealed, the practical starting point is nonetheless a focus on reservoir operations: policy and legal rules as well as water exchanges constituting this work's first parsing of the Law of the River in the Middle Rio Grande as entangled assemblage. More important than precisely understanding the grammar of this rule-based system by speaking in terms of system/network analytics—legal or otherwise—and empirical measuring, monitoring, and modeling,

317. Fishman, *supra* note 93, at 1.

318. DEBUYS, *supra* note 10, at 280.

319. *See* Kelly (2007b), *supra* note 136, at 653 (emphasis added).

a better frame for answering the practical question of *what does this all mean?* is to understand what the paradigmatic Law of the River, as water management language and discourse, *leaves out*. As a mapping technique, this is a sort of foreground/background inversion, extending, if not overturning, the technical model's "boundary conditions," necessary as they are for the model to actually run. This inversion points towards a more nuanced system architecture that cannot, strictly speaking, be incorporated into URGWOM.

In this manner, law can serve as a "map of misreading," as Boaventura de Sousa Santos has suggested.[320] Such a conceptual "[m]ode of [i]nquiry into [m]odern [e]xistence," to employ the shorthand of philosopher Bruno Latour in his extensively developed methodology for investigation "[a]nthropology of the [m]oderns."[321] This points towards the urgency of more fully incorporating context and experience. Here, legal philosophy, jurisprudence and social policy are proxies into holistic strategies for addressing such existential issues as access to essential resources which the Rio Grande, as the Critical Zone now so clearly presents.[322] However tangential or conceptual, this article aspires to contribute a small step towards the ongoing project of incorporating "[e]thical [k]now [h]ow" into a more integral legal analytics. For when it comes to the distribution, quality, and even *disposition* of essential resources like water, not only justice and quality of life but survival itself is at stake—not just of species like the Rio Grande silvery minnow, but of humans too.[323]

1. Operations Accounting and Modeling[324]

Most immediately, water in the Rio Grande Basin is managed to meet specific demand on a particular suite of constraints, as the Law of the River makes

320. BOAVENTURA DE SOUSA SANTOS, TOWARD A NEW LEGAL COMMON SENSE: LAW, GLOBALIZATION, AND EMANCIPATION at 496–521 (3rd ed. 2019).

321. *See* BRUNO LATOUR, AN INQUIRY INTO THE MODES OF MODERN EXISTENCE (cover) (2013).

322. *See* Kelly (2007b), *supra* note 136, at 673.

323. *Id.*

324. For a synopsis of URGWOM, *see* Boroughs (2010), *supra* note 263. These authors summarize URGWOM's capabilities in this way:

> A fundamental needed . . . is assisting managers in delivering supplies to all water users on time, in the desired quantities, and with minimum conflict between users with a specific focus on deliveries, exchanges, and leases of water allocated to contractors for San Juan-Chama Project water. URGWOM is used to provide the community of water managers and water users with a clear, consistent, and a common set of data. With the established model for the Rio Grande system in New Mexico including methods representing the key physical process in the basin and established accounts, rule-based simulations can be completed with the URGWOM ruleset set up to simulate baseline operations of the system and resulting river and systems conditions. Rules are coded for meeting all the different demands using available supplies for those specific water uses as tracked with separate accounts. Coded rules allow for Annual Operations Plan to be developed with accurate representation of different implemented water agreement and any deviations from typical operations. . . . Changes in operations or other proposed actions can be

clear. In this system, dams and reservoirs are sentinel way-points, through which flows water of many colors.[325] The facilities at Heron, El Vado, Abiquiu, Cochiti and Elephant Butte thus store and release to meet a variety of demands on different temporal scales, with water that is both native to—and imported from outside—the Rio Grande Basin.[326] To facilitate this complex legal, management, and operational scheme, water is transferred between different accounts; reservoirs are a primary mechanism.[327] Reservoirs thus serve as banks, of a sort. Continuing the financial metaphor, water managers, both government agencies and quasi-government institutions serve as the brokers. Meanwhile, law and policy are the "rules of the game."[328]

URGWOM is a decision-support and systems modeling tool for the management and accounting of water in this complex system, as well as related planning efforts.[329] URGWOM is built on RiverWare, a platform put out by the University of Colorado-Boulder's Center for Advanced Decision Support for Water and Environmental Systems.[330] This tool facilitates "operational decision-making, responsive forecasting, operational policy evaluation, system optimization, water accounting, water rights administration, and long-term resource planning."[331] RiverWare also offers probabilistic modeling capabilities,[332] a useful feature for planning in the context of climate change.

In its modeling of water storage and delivery operations, URGWOM models focus respectively on accounting, water operations, forecasting, and planning.[333] The physical system, including both the river and reservoirs, is represented in the accounting model, which rectifies inflows and outflows throughout the system.[334] The accounting model deals only with historic data. The water operations model, in turn, adds a forecasting capability to the accounting model. Accordingly, the operations model uses accounting data as a foundation to predict future storage and release of water. In due order, this model applies policy

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> analyzed with URGWOM to evaluate the impact on the water supply, river flows, and water deliveries.

325. *See* App. B, at tbls. 2(a)–(c), 3, 4.

326. *Cf. id*.

327. *See generally* Dave Owen & Colin Apse, *Trading Dams*, 48 U.C. DAVIS L. REV. 1043, 1080–1102 (2015) (discussing a variety of potential environmental transfers involving dams, including treatment of requisite legal framework, possible regulatory leverage, and information needs).

328. *Id.*

329. *See generally* UTTON CTR., *supra* note 161 (Excel column "OTHER RECLAMATION PROGRAMS: URG Water Ops Model"); GAIL STOCKTON, ET AL., UPPER RIO GRANDE BASIN 7–8 (2004); URG WATER OPERATIONS REVIEW, *supra* note 230, Vol. I, at 2-2 (Key Tools: URGWOM Planning Version").

330. URGWOM Ruleset, supra note 21, at 4.

331. UNIV. OF COLO.–BOULDER, CENTER FOR ADVANCED DECISION SUPPORT FOR WATER AND ENVT'L. SYSTEMS, River Ware, https://www.colorado.edu/cadswes/creative-works/riverware.

332. *Id.*

333. *See* URGWOM Model v–4.1.2 User Manual, *supra* note 41, at 3–5, § 1, pp. 3–5 ("Introduction'), § 3, pp. 33–43 ("Inputs and Model Setup"), including §§ 3.1–3.1 (Accounting, Forecast, and Water Ops Models, respectively); Boroughs (2010), *supra* note 263, at 1–2, 33–43 (outlining sections for Accounting, Forecast, and Water Ops Models, respectively); URGWOM Ruleset, *supra* note 21, at 2–3.

334. *See* URGWOM Ruleset, *supra* note 21, at 5.

rules, as needed.[335] The forecast model builds on the model's simulation capabilities, using spring runoff forecasts and historic hydrographs to predict daily flows at the different control points contained in the water operations model.[336] Finally, the planning model involves a simplified rule structure to carry out longer term forecasting runs, which are computationally more intensive.[337]

Reclamation and the Corps, along with the New Mexico Interstate Stream Commission, used URGWOM in the landmark 2007 study of water operations of the Upper Rio Grande Basin, from the river's headwater in Colorado through New Mexico.[338] This Upper Rio Grande Water Operations Review[339] and the associated Environmental Impact Statement addressed the agencies' development of an integrated plan for water operations at Reclamation and the Corps' existing facilities upstream of Ft. Quitman, Texas.[340] The backdrop of this interagency effort was the exigency of meeting new habitat and species needs under the ESA while also meeting existing demands under conditions of protracted drought.[341] Given the Rio Grande's "highly variable flow regime," the newly-developed URGWOM permitted the study to "evaluate the operations of multiple water management facilities as a system, *enabling technically valid comparison of different scenarios*."[342] Thus, the Review's goal was to use URGWOM to "evaluate a full range of water operations in an integrated systems approach and to examine whether the full range of discretionary actions were being implemented for better ecosystem management."[343]

In investigating water operations and associated discretionary actions, the Review looked in detail at five main areas: 1) reservoir operations; 2) opportunities for operational optimization of the system as a whole; 3) planning for future water operation; 4) capabilities for improved decision-making; and 5) compliance with

335. *See id.*, at 7–23, 25–29 (outlining sections for "Synopses of Policy Control" and "Priorities for Rule Execution"); *see also* App. A–I, B-1–B-153 (presenting "Flowchart for Overall Policy" and individual policy rules, respectively); *cf.* URGWOM Model v–4.1.2 User Manual, *supra* note 41, at 6–32 (outlining "Modeling Assumptions" with subsections for, respectively: water "demands" (e.g., MRGCD and ABCQUA), "reservoir storage and releases" (e.g., San Juan–Chama Project water and, *inter alia*, loans with Project water contractors), and "water agreements," including Reclamation leases, Relinquishment Credits, Emergency Drought Water, and "Cochiti deviations," among others), at § 2 (detailing "Modeling Assumptions").

336. *See* URGWOM Model v–4.1.2 User Manual, *supra* note 41, at 34–38, 39–43 (providing forecast and water ops. models, respectively).

337. *See* STOCKTON, *supra* note 329, at 7; *see generally* URGWOM Ruleset, *supra* note 21, at 1–2 (explaining that URGWOM creates Annual Operating Plans using rule-based simulations to make forecasts through the end of the year); *URGWOM Summary*, U.S. ARMY CORPS OF ENGINEERS, https://www.spa.usace.army.mil/Missions/Civil-Works/URGWOM/ (last visited Apr. 23, 2021) (providing a useful overview and linking to detailed URGWOM information including, inter alia, model documentation and data, technical review, committee notes, and model output for different rule-based simulations (e.g., monthly forecast runs and current year "Annual Operating Plan" model runs)).

338. URG WATER OPERATIONS REVIEW, *supra* note 230, Vol. I, at I-1–I-2, II-1–II-2.

339. *Id.*

340. *Id.* at I-1.

341. *Id.*

342. *Id.* (emphasis added).

343. *Id.* at I-1.

extant authorities.[344] Within these focus areas, the Review explicitly incorporated the need to operate the system within existing legal authorities, namely extant water allocation schemes and prior appropriation.[345] Compliance with these authorities permits Reclamation, the Corps, and the state of New Mexico to "store and deliver water for agricultural, domestic, municipal, industrial, and environmental uses," meet Rio Grande Compact delivery obligations to Texas, provide flood control, and meet obligations under legal authority, treaty, and contract.[346]

The Review also identified low-water flows and endangered species needs, as well as water conveyance efficiency and sediment and flood control capabilities as the *major* water operations issues in this inherently complex space.[347] URGWOM's planning model permitted the Corps and Reclamation, among other water managers such as New Mexico's Interstate Stream Commission, to navigate this inherent complexity, including overlapping and variable jurisdictional, hydrologic, and climatologic demands.[348]

Another type of institutional arrangement for water management flexibility that URGWOM has modeled are deviations from "normal operations" at Cochiti reservoir,[349] which facility is primarily operated for flood and sediment control purposes.[350] The objective of such operations is to provide spawning and recruitment flows for the ESA-protected silvery minnow. When runoff conditions would not otherwise permit such flows, water is temporarily stored and released to provide a spring pulse flow that mimics the natural pulse of snowmelt runoff.[351] The 1960 Flood Control Act requires that such deviations from the Act's Reservoir Regulation Plan be authorized by the Rio Grande Compact Commission.[352] URGWOM permits an evaluation of such deviations, which differ from typical reservoirs.[353]

URGWOM incorporates approximately 180 discrete law-based policy rules into its water operations simulations, and thus provides for a modeling of a range of system conditions, physical and legal.[354] It supports water managers' operations need to meet various water demands under multiple constraints, including those contained

344. *Id.* at I-1–I-2.

345. *See id*. at 1–3 (providing the Record of Decision [ROD]).

346. *Id.*

347. *Id.* at I-6.

348. *See* URG WATER OPERATIONS REVIEW, *supra* note 230 (explaining that the Interstate Stream Comm'n [ISC] was a cooperating institution for, with interests in, this Water Operations Review for which URGWOM served as a lodestar). The area includes state, federal, and tribal jurisdictions where considerations range from managing U.S. government's federal trust responsibilities to hydrology, riparian ecology, and river geomorphology. *See id.* at I-2, I-5, II-1 (explaining URGWOM's long-term planning module was the outcome of a process that water managers pursued to develop a tool that would "facilitate the sharing of daily water operations data" and clearly memorialize "existing procedures by which the river has come to be managed.").

349. *See generally* M.H. Benson (2014), *supra* note 45, at 219; Gillon (2007), *supra* note 57, at 630 n. 102, 635 (explaining constraints to such a deviation).

350. *See* Kelly (2007a), *supra* note 183, at 547.

351. *Id*.; *cf*. URGWOM Ruleset, *supra* note 21, at 28, app. B-56–B-59.

352. Kelly (2007a), *supra* note 183, at 547.

353. URGWOM Ruleset, *supra* note 21, at 28.

354. *Id.* at 4–5.

in the legal authority.[355] This process reduces, in part, to an accounting exercise, where water demands for people, agriculture, and the environment are met with both native Rio Grande Basin water and non-native, imported San Juan-Chama Project water. Water operations in URGWOM use policy rules to track water in different accounts, starting with the overarching issues of whether a particular demand is to be met with native and/or non-native water.[356] Of course, there are many more colors of water when different types of water rights, such as ownership rights, are considered.[357]

Therefore, policy rules are a fairly high-resolution attempt at modeling, both in substance and in terms of hierarchy, the legal authorities that control the allocation and use of water in the basin, as well as the associated (or derivative) regulatory and operational mandates. Appendix C compiles and presents an annotated summary of URGWOM's ruleset, excerpts important rules, and attempts to capture their hierarchical status. The remainder of this section presents a further summarization of the most relevant policy rules, in a synthesis whose structure derives from the overarching legal and management hierarchy.[358]

Heron Reservoir, furthest upstream on the Rio Chama, stores only imported San Juan-Chama water, so URGWOM is programed to bypass native Rio Grande flows.[359] Downstream, native flows are captured at El Vado.[360] Storage occurs there to the extent required, first, to ensure supply of Prior and Paramount water to the Six Middle Rio Grande Pueblos should the mainstem Rio Grande provide insufficient flows to meet this need and, second, for the irrigation needs of the MRGCD.[361] Importantly, El Vado storage is controlled by the Rio Grande Compact.[362] As a post-1929 reservoir, El Vado storage of native Rio Grande water for the MRGCD is prohibited when Compact Article VII is in force.[363] Further downstream, native Rio Grande flows are bypassed through the reservoirs of the Middle Rio Grande Project, Abiquiu and Cochiti, unless the exigencies of flood control dictate their temporary storage.[364] In certain circumstances, flood waters may be detained until after the irrigation seasons.[365]

URGWOM also offers the ability to track reservoir releases of both native Rio Grande Basin and imported San Juan-Chama Project water for different water uses.[366] The lion's share of these water uses comprise MRGCD irrigation diversions and ABCWUA's Drinking Water Project.[367] URGWOM also tracks, for example,

355. *Cf. infra* notes 435–45 and accompanying text.

356. *See* URGWOM Ruleset, *supra* note 21, at 5, 7.

357. *See, e.g.,* App. A(2)(ii)(b)(6)(b) and accompanying text (detailing seven types of water rights with the boundaries of the Middle Rio Grande Conservancy District).

358. URGWOM Ruleset, *supra* note 21, at 6–8.

359. *Id.* at 10; *cf. id.* at B-40., at 9; *cf. id*. at app. B-40.

360. *Id.* at 15, 25; *cf. id.* at app. B-98–B-102.

361. *Id.* at 15–16, 24–25; *cf. id.* at app. A-1, B-7, B-9, B-41–B-49.

362. *Id*. at 12–15.

363. *Id.* at 14; *cf. id.* at app. A-1, B-13–B-19.

364. *See id.* at 11, 15–16, 26–27; *cf. id.* at app. A-1, B-51–B-70.

365. *See id.* at 11.

366. *Id.* at 30.

367. *Id.* at 8.

so-called "letter water deliveries," by which federal water project contractors—MRGCD and ABCWUA—leave water in the river to pay back groundwater depletions which have impacted surface flows.[368] URGWOM further tracks water in borrow/payback schemes by which one contract borrows water from another contractor and agrees to subsequent repayment.[369]

The MRGCD diverts water at four points between Cochiti and Elephant Butte, namely the Cochiti, Angostura, Isleta, and San Acacia diversions.[370] URGWOM treats these diversions as exogenous, that is, this data is inputted into the model based on crop irrigation requirements. To accurately reflect the physical system, URGWOM also accounts for irrigation return flows to the river.[371]

As modeled, diversions by ABCWUA's Drinking Water Project, in turn, are nominally supplied by the ABCWUA's San Juan-Chama Project allocation. The Drinking Water Project diversions depend on current river flows and before the ABCWUA diverts its full allocation, minimum rivers flows must be obtained.[372] As permitted, these diversions require Project water to be carried by an equal amount of native Rio Grande water.[373] Therefore, ABCWUA's Drinking Water Project physically diverts twice its allocation by volume, but 50 percent of the diversion returns to the river as return flow.[374] When river flows are too low for the ABCWUA to divert water, the Drinking Water Project's inflatable diversion dam deflates, allowing the remaining flows to pass unimpeded.[375]

URGWOM also accounts for in-stream, environmental flows as water uses. For example, from 2003 until late 2016, the then-operative Biological Opinion mandated flow targets at certain locations in the Middle Rio Grande Valley as an attempt to vouchsafe endangered species and related habitat needs.[376] These targets were seasonal but also differed based on relative annual flows. Under the 2003 Biological Opinion, each year was designated as "wet," "dry," or "average" and flow targets decreased with natural runoff.[377] URGWOM would compute water releases necessary to meet these flow targets.[378] Sometimes, compliance with these flow targets would necessitate release of supplemental water supplies, such as San Juan-Chama water leased by Reclamation[379] or native Rio Grande Basin water stored

368. *Id.* at 10.

369. *Id.*

370. *Id.* at 15; *cf*. *id*. at app. A-1, B-9, B-63–B-70.

371. URGWOM Ruleset, *supra* note 21, at 7.

372. Albuquerque Bernalillo County Water Utility Authority, WATER 2120: SECURING OUR WATER FUTURE 3.3, 3.3.1.2 (2016).

373. *Id.*

374. *Id.*

375. *Id.*

376. 2003 BIOLOGICAL OPINION, supra note 224, at 92–95.

377. *Id.* at 92.

378. *Cf.* URGWOM Ruleset, *supra* note 21, at 18; *cf*., *id*. at app. A-1, B-8–B-9, B-63–B-76.

379. U.S. BUREAU OF RECLAMATION, REPORT TO THE RIO GRANDE COMPACT COMMISSION 44 (March 2017).

pursuant to the EDWA, as described below.[380] URGWOM can track these releases and storage balances.[381]

Finally, URGWOM considers so-called "letter water deliveries" pursuant calculations made by the New Mexico Officer of the State Engineer ("OSE").[382] These communications, addressed to Reclamation, indicate the extent to which San Juan-Chama contractors—mainly ABCWUA—are obligated to leave Project water in the river to repay the river for water withdraw from this system through groundwater pumping. This determination is in large part on OSE's modeling of the interconnection groundwater–surface waters system.[383] As a matter of policy, the flows are distributed between the irrigation season to avoid curtailment of MRGCD diversions, and the off-season to facilitate Compact deliveries to Elephant Butte.[384] In this scheme, exchange of San Juan–Chama water for groundwater is treated as a (ground)water debt subject to subsequent payback vis-à-vis San Juan–Chama Project water deliveries to the river. URGWOM handles these water accounts as well as the OSE-calculated delivery schedules, which are fed into the model.[385]

* * *

URGWOM, thus enumerates a suite of enabling constraints that provides some measure of stability within an otherwise complex, entangled system of rules, institutions, law, and policy that constitutes the Law of the River. In this way, URGWOM serves as an algorithmic tool designed to support decision-making in the realm of water management and environment law and policy. But it's representation of the system is not the system itself; the map is not the territory. Such algorithmic technical decision-support tools as URGWOM appear on their face to be "policy neutral but [actually] embody bias and hidden values that affect democracy," as Sonya Ziaja has recently asserted.[386] As Ziaja's proposed evaluation framework suggests, a critical inquiry into URGWOM's modeling structure and process must reflect, on the one hand "how, and whether, existing law and policy is incorporated," and on the other "how, and whether, stakeholders and end-users collaborated in the models development."[387]

Thus, the URGWOM model appears to provide a reasonable, fairly high-resolution, first-order approximation of the legal regime. Indeed, it not only models both "wet" water and paper water, but its policy rules also model complex legal–physical reservoir operations as well as a menu of water management. Many items on this menu are water exchanges of one sort or another. In the domain of exchanges, agents such as MRGCD and Reclamation essentially "encourage some users to use less water" or to vary the timing, magnitude, or location of water storage and

380. *Id.*

381. S*ee, e.g.*, URGWOM Ruleset, *supra* note 21, at 6–7.

382. *Id.* at B-33–B-38.

383. *Id.* at 7.

384. *Id.*

385. *Id.*

386. Sonya Ziaja, *How Algorithmic Assisted Decision Making is Influencing Environmental Law and Climate Adaptation*, 38 Ecology L.Q. ___(forthcoming, 2021) (working paper on filed with author).

387. *Id*.

delivery, in the case of reservoir operations, which then "allow[s] other user to" either "use that water" or "leave the unused water" in the system. In so doing, various "colors" of water—groundwater and surface—treated as fungible within a set of "institutional rules."[388]

Still, URGWOM needs to be "ground-truth'ed" to assess its performance under the latter criteria, which boils down to meaningful public participation. Where does this leave the Middle Rio Grande as an integrated social–ecological system facing existential threats with both intensive and extensive implications in the domain of rights, dignity, wellbeing, and survival,[389] both physical and cultural? While the foregoing two-pronged URGWOM evaluation must wait, given the constraints of the present article, a brief investigation into contemporary water law-and-policy-in action, under specific resilience criterion will serve as a useful point of departure.

2. Resilient Water Law and Policy

Diverse water managers and stakeholders share the operative goal that even under the constraints of drought and generally increased use and storage demand, water must be delivered to people and ecosystems.[390] Sustainability scholars have argued that this challenge demands a resilient response, one that operates "beyond sustainability" and must acknowledge the operative demands and realities of the "novel system."[391] For its part, the Rio Chama Flow Project has prioritized interdisciplinary lobbying, planning, and the scientific study of managed flood pulses in the Wild and Scenic reach of the otherwise highly engineered Rio Chama between the El Vado and Abiquiu reservoirs.[392] Even Congress has recognized the importance of such demands, having added the promotion of "flow dependent ecological resiliency" to the Corps' mandate.[393]

The December 2016 Biological Opinion appears to be an attempt at such a resilient response. This latest iteration of the Middle Rio Grande Biological Opinion is a core component of the Law of the River. In terms of legal hierarchies, the ESA forms the cornerstone of the *modern* Law of the River for the Rio Grande, both in theory and practice. Federal law such as the ESA may preempt contrary state law, according to the Supremacy Clause of the U.S. Constitution.[394] As well, Congress provided in 2004 that the Middle Rio Grande water operations 2003 Biological Opinion would be the Law of the River through 2013.[395] In this way, Congress came

388. Robert Glennon, *Powell's Legacy—The Bureau of Reclamation and the Contemporary West: Water Exchanges, in* VISION & PLACE 76, 88 (Jason Robinson, et al., eds. 2020).

389. *See, e.g.*, Kelly (2007b), *supra* note 136, at 673.

390. *See generally* UTTON CENTER, WATER RESILIENCE IN A TIME OF UNCERTAINTY (2015).

391. M.H. Benson (2019), *supra* note 13.

392. *See, e.g.*, RCFP Proposal, *supra* at 43.

393. Science and Engineering to Comprehensively Understand and Responsibly Enhance (SECURE) Water Act (2009) at Sec. 4(g), approved in Omnibus Public Lands Act of 2009, P.L. 111–11 (Mar. 30, 2009).

394. *See, e.g.*, Robin Kundis Craig, *Does the Endangered Species Act Preempt State Water Law?*, 62 UNIV. OF KANSAS L. REV. 851 (2014).

395. Consolidated Appropriations Ct of 2005, Pub. L. No. 108-447, § 205, 118 Stat. 2809 at 2949 (2004).

to define Middle Rio Grande ESA compliance as compliance with the Biological Opinion.[396] Specifically this means compliance with the Reasonable and Prudent Alternatives and incidental take limits it sets forth, in concert with certain collaborative actions.[397] This rider was itself a more permanent codification of the previous year's "Minnow Rider," attached to the Energy and Water Development Act of 2004,[398] which water attorney Lara Katz characterized as "purporting to divest [Reclamation] of its newly acknowledged discretion."[399] This Act was recognized just the year before in a 10th Circuit ruling blessing the agency's discretionary to curtail water delivery during severe drought for ESA compliance.[400]

The current Biological Opinion has emerged, through characteristic wrangling, from a series of earlier Biological Opinions issued, challenged, and operationalize throughout the early 2000s. A federal District Court conditionally upheld the 2001 Biological Opinion on a finding, *inter alia*, that it contained Reasonable and Prudent Alternatives which the Service has formulated based on the "best available science," despite various procedural flaws.[401] Serious drought would effectively break the Biological Opinion within a year's time.[402]

Around the same time the 2001 Biological Opinion was issued, New Mexico and the U.S., among other parties, signed the Conservation Water Agreement.[403] With the Compact Commission's approval, the Agreement provided for the storage of Rio Grande Compact "relinquishment credit water" in a temporary "Conservation Pool' at Abiquiu, up to a total of 100,000 acre-feet of wet water.[404] The following year, due to the worsening drought, Reclamation re-commenced consultation with the Service and a new Biological Opinion was issued in September 2002.[405] This Opinion would be invalidated by the court as "arbitrary and capricious," since Reclamation "did not adequately consult on water sources" for the endangered minnow and the Biological Opinion "improperly stated there was no [Reasonable and Prudent Alternative]." The court would then go on to order injunctive relief through unilaterally imposed flow targets, among other measures.[406]

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396. *Id.*

397. Energy and Water Development Appropriations Act of 2004, Pub. L. No. 108-137, § 208(b), 117 Stat. 1827, 1849 (2003).

398. Pub. L. No. 108-137, § 208(a)–(b), 117 Stat. 1830 (N.b. – Energy and Water Development Appropriations Act, 2004, Pub. L. No. 108-137, § 208, 117 Stat. 1827, 1849–50 (2003) (providing, overall, that no federal funds would be applied to the San Juan-Chama Project for the benefit of the Silvery Minnow unless such water purchased from a willing seller pursuant to relevant Office of the State Engineer [OSE] permitting, and deeming that compliance with the 2003 BiOp would comprise compliance with Endangered Species Act requirements for a ten-year period).

399. Lara Katz, *History of the Minnow Litigation and Its Implications for the Future of Reservoir Operations on the Rio Grande*, 47 NAT. RES. J. 675, 685, n. 62 and accompanying text (2007).

400. Rio Grande Silvery Minnow v. Keys, 333 F.3d 1109, 1138 (10th Cir. 2003).

401. Rio Grande Silvery Minnow v. Keys, 469 F. Supp. 2d 973, 1002–1003 (D.N.M. 2002).

402. Katz, *supra* note 399, at 680–81.

403. *Id*. at 681.

404. *Id.*

405. *Id.*

406. *Id*. at 681 nn. 36–39 and accompanying text (citing *Rio Grande Silvery Minnow v. Keys,* 356 F. Supp. 2d 1222, 1235, 1237–38 (D.N.M. 2002)).

In this contentious environment, Reclamation began to take various water management actions in response to ESA requirements and the uncertain legal and hydrological context. For example, it initiated a program of leasing imported San Juan-Chama water, under the Supplemental Water Program, begun in 1996 when drought hit the basin for the first time in decades.[407] Additionally, Reclamation participated in the newly created, multi-stakeholder Middle Rio Grande Endangered Species Collaborative Program, established in 2000.[408] Finally, it also drew up, along with other water users and managers, the Conservation Water Agreement of 2001. All this to keep water in the river, or generate storage capacity in upstream reservoirs, where evaporation would be less.

In a similar, operational vein, the March 16, 2003 Biological Opinion dictated differentiated flow targets on a wet year/dry year basis;[409] required that decreases in flow rates be "ramped down;" and provided for silvery minnow salvage operation when the river became disconnected.[410] These were some of the provisions of the Biological Opinion Congress would subsequently denote as the Law of the River.

Following the 2003 Biological Opinion, various voluntary, collaborative efforts have been conducted with the aim of achieving ESA compliance while meeting municipalities' water needs, all in the context of ongoing drought. For example, in April of 2003, MRGCD and Santa Fe allocated 217,500 acre-feet of relinquishment credit water under the EDWA.[411] In 2005, the City of Albuquerque settled with WildEarth Guardians, who protested the City's OSE permit application for their San Juan-Chama Project contract water, yielding 30,000 acre-feet of Abiquiu Reservoir storage space for an Environmental Pool of water.[412] Significantly, Reclamation continues to operate its Supplemental Water Program, leasing primarily San Juan–Chama Project water from contractors like ABCWUA, for the benefit of the silvery minnow. This Program now comprises a core "Conservation Measure" under the current Biological Opinion.[413]

Turning to December 2016, the Service released its fourth Biological Opinion on water operations in the Middle Rio Grande Valley affecting the

407. *Id*. at 679 n. 20 and accompanying text.

408. *Id*. at 689 n. 79 and accompanying text.

409. Dry year flow targets under the 2003 Biological Opinion, applicable to the Rio Grande from the outlet of Cochiti Dam and Reservoir through San Marcial, comprise a "continuous flow" requirement in the winter and spawning season, from November 16 through June 15, and a minimum 100 cubic feet per second ("cfs") during the post-spawning and summer months. *See, e.g.*, BUREAU OF RECLAMATION, RIO GRANDE PROJECT ANNUAL OPERATING PLAN: WATER OPERATIONS MODELING 26 (2016), https://www.usbr.gov/uc/albuq/rm/RGP/pdfs/2016-AOP.pdf.

410. 2003 BIOLOGICAL OPINION, *supra* note 224.

411. Emergency Drought Water Agreement (Apr. 22, 2003) (on file with author). Similar agreements were carried out as amendments to this original 2003 agreement in 2008 and 2016. Amendment No. 1 to the Emergency Drought Water Agreement of 2003 (Mar. 31, 2008); Emergency Drought Water Agreement of 2016 (Apr. 22, 2016).

412. Settlement Agreement Between Rio Grande Silvery Minnow v. Keys Plaintiffs, the City of Albuquerque, and the Albuquerque-Bernalillo County Water Utility Authority (Feb. 23, 2005) (on file with author).

413. 2016 BIOLOGICAL OPINION, *supra* note 56.

endangered minnow.[414] Since the first silvery minnow Biological Opinion issued in 2001, the vulnerable fish's fate has evolved along a complex and litigious path. The Biological Opinion's development was—and its implementation continues to be—fundamentally informed by longstanding cooperative water management effort dating back to the origins of the silvery minnow litigation more than 20 years ago. Additionally, flexibility-generating mechanisms like Reclamation's flagship Supplemental Water Program, the landmark Conservation Water Agreement of 2001, and three iterations of the EDWA—2003, 2008, and 2016—continue to provide critical operational flexibility amidst the tight margins of water scarcity.[415]

This latest Biological Opinion attempts to balance increasingly complex operating criteria with competing water demands,[416] such as environmental flows for endangered species, and water for Pueblos, municipalities, and irrigated agriculture.[417] In service of this goal, the 2016 Biological Opinion explicitly conditions its no-jeopardy finding on voluntary "Conservation Measures."[418] Most of these require a high degree of multi-stakeholder collaboration, which necessarily unfold within a contested and litigated space. Accordingly, the Conservation Measures require not just stakeholder collaboration, but also federal water managers' de facto, if not de jure, discretion, within a jurisdictionally, ideologically, and biologically complex environment.[419]

Perhaps the most important Conservation Measure included in the 2016 Biological Opinion, and certainly the flow operation of oldest vintage—dating from the mid-1990s—is the Supplemental Water Program.[420] In this scheme, Reclamation leases surplus San Juan-Chama Project water, which it stores at Abiquiu in "up to" 20,000 acre-feet of space leased from the ABCWUA.[421] This water is subsequently released for the silvery minnow.[422] Reclamation then exchanges this San Juan-

414. Press Release, U.S. Fish and Wildlife Service, et al., Efforts to Protect Endangered Species in the Middle Rio Grande Continue with Renewed Commitments from Key Water Management Agencies (Dec. 5, 2016), https://www.fws.gov/southwest/es/NewMexico/documents/BO/Joint_BiOp_Press_Release_Version6a.pdf.

415. *Cf.* Amy McCoy et al., *Water & Climate Resilience: Ten Strategies for Climate resilience in the Colorado River Basin*, THE WATER REPORT NO. 205, 1 (Mar. 15, 2021) ("within the last decade have new components of the 'Law of the River' . . . contemplated increased conservation as a central management tool") (internal citation omitted).

416. 2016 BIOLOGICAL OPINION, *supra* note 56.

417. *See* Faler, *supra* note 211 (citing, *inter alia*, 2016 BIOLOGICAL OPINION); *cf.* 2016 BIOLOGICAL OPINION, *supra* note 56, Tbl. 1, at 149–159 (*see, e.g.,* Conservation Measures corresponding to various Federal and non-federal entities); 1981 P&P Agreement, *supra* note 193.

418. *Id.* at 18.

419. *Cf.* App. A(4), *supra* note 224, at nn. 277, 282; *see* 2016 BIOLOGICAL OPINION, *supra* note 56, Tbl. 1, at 149–159; *see also* 2003 BIOLOGICAL OPINION, *supra* note 224.

420. 2016 BIOLOGICAL OPINION, *supra* note 56, at 10–11, 18–19, 21, Tbl. 1.

421. *Cf.* U.S. BUREAU OF RECLAMATION, 2011–16 SUPPLEMENT TO THE RIO GRANDE SUPPLEMENTAL WATER PROGRAMMATIC FINAL ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT, AAO-11-022, at 8 (signed Feb. 17 & 22, 2011) ("up to") [hereinafter Supp. Water Progr. FONSI (2011)].

422. Gillon (2007), *supra* note 57, at 632 n. 119 and accompanying text (citing Agreement between the U.S. Department of the Interior, Bureau of Reclamation and the Albuquerque Bernalillo County Water Utility Authority to Lease Abiquiu Reservoir Storage Space (on file with author).

Chama Project water for native Rio Grande water. Accordingly, MRGCD only diverts San Juan-Chama water and so an equal amount of native water flows unimpeded, for "beneficial instream flow."[423] This accounting scheme presents no major legal issues since San Juan-Chama water is not required under the Rio Grande Compact to be delivered to Texas, and thus this Project water must be consumed within the Middle Rio Grande.[424]

As stated in a Supplemental Water Program report to the Rio Grande Compact Commission, it "provides additional water for endangered species needs"[425] through five Program components:

1) surplus San Juan-Chama Project water leases;
2) assent to contractors' waiver of Heron carryover storage requests;
3) Low Flow Conveyance Channel water management;
4) temporary off-channel storage at "refuges"; and
5) groundwater pumping.[426]

Treatment of Low Flow Conveyance Channel's, off-channel storage, and groundwater pumping are beyond the scope of this report. Operationally, leased San Juan-Chama water is "released for diversion and use by the MRGCD."[427] Furthermore, this Program transaction allows for "an equivalent amount of native Rio Grande water (minus conveyance losses) to remain undiverted," and thus dedicated to the river ecosystem itself. [428]

According to Reclamation, the Supplemental Water Program is the San Juan-Chama Project's "primary conservation measure" for ESA Section 7 compliance.[429] The goal of this measure is to avoid jeopardy to listed species or adverse modification to their habitat. Reclamation contended that through this Program, the agency was able to maintain compliance with the 2003 Biological Opinions, Reasonable and Prudent Alternatives and Reasonable and Prudent Measures, including flow targets.[430] However, thirteen years after this claim, Reclamation reports "reduced opportunities" for leasing of San Juan-Chama Project

423. *Id.* at 633 n. 120–23 and accompanying text.

424. Rio Grande Compact, Art. X (1938).

425. Engineer Advisers Report, at 10–11, in RIO GRANDE COMPACT COMMISSION, ANNUAL REPORT (2001) (citing 2001 Final Rio Grande Supplemental Water Program Programmatic Environmental Assessment) (cited in UTTON CTR., Policy and Operations, *supra* note 161, at "RGCC.Ann.Rpt-Eng'rAdv" tab) [hereinafter RGCC EA 2001].

426. *Id.* at 10–11; *accord* Supp. Water Progr. FONSI (2011), *supra* note 421, at 1–3, 5–10 (inserting word Purpose and Need statement and Alternatives Description–Proposed Action, respectively).

427. Engineer Advisers Report, at 26, in RIO GRANDE COMPACT COMMISSION, ANNUAL REPORT (2002) (cited in UTTON CTR., Policy and Operations, *supra* note 161, at "RGCC.Ann.Rpt-Eng'rAdv" tab) [hereinafter RGCC EA 2002]; *accord* Supp. Water Progr. FONSI (2011), *supra* note 421, at 5.

428. RGCC EA 2002, *supra* note 427. This exchange is governed by the July 3, 2001 Rio Grande Water Management Agreement between the United States and MRGCD.

429. *Water Marketing Activities within the Bureau of Reclamation,* U.S. BUR. OF REC., 24 (Dec. 2016), https://www.usbr.gov/watersmart/docs/2016/2016watermarketingreport.pdf.

430. Supp. Water Progr. FONSI (2011), *supra* note 421, at 5 (avoiding jeopardy), 47 (Response to Comment) ("The Supplemental Water Program has allowed for maintaining compliance with the 2001 and 2003 Biological Opinions.").

water, which the agency characterized as a mainstay of the Supplemental Water Program.[431]

The reduced availability of San Juan-Chama water for leasing, largely a function of the ABCWUA's Drinking Water Project of 2008,[432] together with extended drought, leaves the Supplemental Water Program vulnerable. These exigencies demand innovative water management of available supplies. Indeed, the current Biological Opinion has moved away from the strict wet year/dry year-pegged seasonal flow targets of the previous Biological Opinion to more of an adaptive management model.[433] Based on this connection and in light of lessons afforded by polycentric governance principles can afford, it would figure that non-federal agencies, such as the MRGCD, will need to bear a greater burden of providing environmental flows going forward than were previously achieved through the Supplemental Water Program alone.

As if to underscore the polycentricity of water governance in the Middle Rio Garden, already in the early 2000s, on the heels of what would what become known as a megadrought, and soon after the 2003 Biological Opinion was issued,[434] New Mexico and the U.S. entered into the EDWA.[435] This negotiated agreement was a successor to the landmark Conservation Water Agreement two years prior. To enable operations pursuant the 2003 EDWA, Texas would, at some point, need to accept a "relinquishment" of 122,500 acre-feet of "credit" water under the terms of the Rio Grande Compact, which it did in 2003.[436] The agreement itself allocated a total of 217,500 acre-feet of relinquishment credit water between the MRGCD (140,000 acre-feet), Reclamation (70,000 acre-feet)—for endangered species purposes—and the City of Santa Fe (75,000 acre-feet).[437] Under the EDWA, release of the MRGCD's and Reclamation's allocations would be annually limited to 46,667 and 20,000 acre-feet, respectively (except in 2003, when Reclamation's cap was 30,000 acre-feet).[438] As with the Conservation Water Agreement of 2001, New Mexico also agreed in the EDWA that MRGCD, Reclamation, and Santa Fe had carryover rights for "any unused portion of a particular year's allocation."[439] The

431. *Id*.; *c.f.* Flanigan & Haas, *supra* note 263, 371–376 (previewing or foreshadowing this eventuality, which Reclamation explicitly recognized in their 2016 water marketing report).

432. *See* Flanigan & Haas, *supra* note 263; App. B, at tbl. 8 (detailing relevant Supp. Water Progr. operations from 2002 through 2018, including amounts leased, from willing San Juan-Chama Project contractor, and release to the river for the benefit of the silver minnow, by Reclamation—by year).

433. 2016 BIOLOGICAL OPINION, *supra* note 56.

434. 2003 BIOLOGICAL OPINION, *supra* note 224.

435. EMERGENCY DROUGHT WATER AGREEMENT BETWEEN THE STATE OF NEW MEXICO, U.S. DEPT. OF INTERIOR AND THE U.S. ARMY CORPS OF ENGINEERS, CONTRACT NO. 03-WC-40-886 (April 22, 2003) [hereinafter 2003 EDWA].

436. Engineer Advisers Report, at 22, 34, in RIO GRANDE COMPACT COMMISSION, ANNUAL REPORT (2003) (cited in UTTON CTR., Policy and Operations, *supra* note 161, at "RGCC.Ann.Rpt-Eng'rAdv" tab) [hereinafter RGCC EA 2003] (citing 2003 EDWA, *supra* note 435).

437. RGCC EA 2003, *supra* note 436, at 26.

438. *Id.*

439. Engineer Advisers Report, at 26, in RIO GRANDE COMPACT COMMISSION, ANNUAL REPORT (2004) (cited in UTTON CTR., Policy and Operations, *supra* note 161, at "RGCC.Ann.Rpt-Eng'rAdv" tab) [hereinafter RGCC EA 2004].

State furnished the allocations, under the terms of the 2003 Agreement, to MRGCD, Reclamation, and the City of Santa Fe.[440]

In 2008, the EDWA was amended for the first time.[441] This 2008 agreement was actually an amendment to the Conservation Water Agreement of 2001, which arose out of negotiations surrounding the 2001 Biological Opinion.[442] Pursuant to this iteration of the EDWA, New Mexico relinquished 125,000 acre-feet of Rio Grande Compact credit water to Texas at Elephant Butte.[443] Texas's assent to this relinquishment had the effect of permitting New Mexico to physically store the same amount of water upstream at El Vado as a hedge against drought. The EDWA allocated this special tranche of stored water between Reclamation, MRGCD, and certain municipalities.[444] The URGWOM tracks these different accounts. As an engineer and URGWOM expert noted, URGWOM "served as an excellent tool for agencies and stakeholders to analyze the impact of such agreement on various indicators in the basin."[445] Under the 2008 EDWA,[446] which was the first institutional arrangement set up under URGWOM, New Mexico was able to store native water at El Vado reservoir when it would have otherwise been precluded by operation of Compact Article VII.[447]

Another three-year EDWA was signed in 2016.[448] This Agreement, which corresponded to and would comprise a key Conservation Measure in the then-soon-to-be-released Biological Opinion,[449] allocated 110,000 acre-feet of relinquishment credit water to satisfy both ESA needs as well as MRGCD irrigation demands.[450] Under the new 2016 EDWA, Emergency Drought Water[451] was allocated outright to

440. Engineer Advisers Report, at 11, in RIO GRANDE COMPACT COMMISSION, ANNUAL REPORT (2008) (citing Feb. 5, 2008 Relinquishment Agreement) (cited in UTTON CTR., Policy and Operations, *supra* note 161, at "RGCC.Ann.Rpt-Eng'rAdv" tab) [hereinafter RGCC EA 2008].

441. Emergency Drought Water Agreement, Amendment No. 1 (Mar. 31, 2008) [hereinafter 2008 EDWA].

442. *Id.* at 1 n. 389; *cf.* Gillon (2007), *supra* note 57, at 633, 635.

443. *See* KEVIN REIN ET AL., CALENDAR YEAR 2017 REPORT TO THE RIO GRANDE COMPACT COMMISSION 16 (2018).

444. 2008 EDWA, *supra* note 441; URGWOM Ruleset, *supra* note 21, at 14, app. B-17.

445. URGWOM Ruleset, *supra* note 21, at 6.

446. *See generally* Gillon (2007), *supra* note 57, at 633–35, nn. 123–37 and accompanying text (analyzing the Conservation Water Agreement, which is predecessor to Emergency Drought Water Agreement).

447. *See* 2008 EDWA, *supra* note 441.

448. EMERGENCY DROUGHT WATER AGREEMENT OF 2016, BETWEEN NEW MEXICO, MIDDLE RIO GRANDE CONSERVANCY DISTRICT, U.S. BUREAU OF RECLAMATION, AND DEPT. OF INTERIOR SOLICITORS' OFFICE 3 (Apr. 22, 2016) [hereinafter 2016 EDWA].

449. *Id.* at 1, § 2 (citing 2015 JOINT BIOLOGICAL ASSESSMENT, which paved the way for the Dec. 2016 BIOLOGICAL OPINION), 2, § 2(f) (conditioning MRGCD's allocation on District making its "best efforts" at meeting flow requirement of 2003 Biological Opinion or those of "any subsequent Biological Opinion") and, while it has "stored native Rio Grande water available," supporting Silvery Minnow Recovery Implementation Program).

450. *Id.* at 1, §§ 1, 2 (citing November 2012, February 2013, and March 2015 letters from New Mexico Rio Grande Compact Commissioner which relinquished credit water to Texas, pursuant to the Rio Grande Compact article).

451. *Id.* at 1, § 2 (defining Emergency Drought Water as "up to 110,.000 acre-feet of relinquishment credit water" that MRGCD and the United States agree to "seek to capture, store, and release," subject to require "approvals and regulatory requirements").

the MRGCD (78,000 acre-feet), leased to Reclamation (19,000 acre-feet) at a cost of $1.9 million.[452] 13,000 acre-feet was set to be used "by the [MRGCD] or the United States, consistent with [New Mexico's] commitments in the 2015 Biological Assessment ['BA']" and "at the direction of" New Mexico's Interstate Stream Commission.[453] Under the 2016 EDWA, Reclamation may only store or release up to 10,000 acre-feet in any given year,[454] and MRGCD' storage and releases are limited to 45,000 acre-feet annually.[455] Notably, MRGCD is required to manage Reclamation's 14,000 acre-feet allocation under the 2016 EDWA "for the sole purpose of ESA compliance."[456]

In making these allocations for endangered species' needs and irrigated agriculture, the 2016 EDWA recognized operative "hydrologic realities and limitations on the water supply in the [M]iddle Rio Grande [B]asin."[457] It therefore aimed to "collaboratively provide for the coordinated storage, release and management of water." Accordingly, emergency drought water is required to be "beneficially used, consistent with New Mexico law" in accordance with the relevant Biological Opinion "and/or as part of the planned Middle Rio Endangered Species Collaborative Programs Recovery Implementation Program[.]"[458]

Water operations pursuant to the 2016 EDWA are thus controlled by the parameters of the Biological Opinion and the Recovery Implementation Program, both ESA institutes, within the broad confines of the Rio Grande Compact and New Mexico water law. In terms of the December 2016 Biological Opinion, the parties' agreed that this allocation of relinquishment credit water "will be considered a combined contribution to the 2015 [Joint] offsetting and conservation measures."[459]

The EDWA of 2003, which would be durable through amendments to the Agreements in 2008 and 2016, had their roots in the Conservation Water Agreement of 2001. This was a truly innovative effort to shore up water for the endangered silvery minnow and its Rio Grande habitat. By way of water operations flexibility, as with the EDWA's subsequent reincarnations, Reclamation and other parties entered into an innovative agreement in 2001 to store relinquishment credit water in reservoirs upstream of Elephant Butte, when not otherwise permitted under the terms of the Rio Grande Compact.[460] First proposed by the State of New Mexico as a

452. This amount equates to $100 per acre-foot of water. *Id.* at 1, § 2(c).

453. *Id.*

454. *Id.* at 1, § 2(b).

455. *Id.* at 2, §2(d).

456. *Id.* at 2, §2(e).

457. *Id.* at 1, § 2(a).

458. *Id.*

459. 2016 EDWA, *supra* note 448, at 1, ¶ 2(c); *see* 2015 JOINT BIOLOGICAL ASSESSMENT, *supra* note 74.

460. *See* Santa Ana Pueblo, Office of the Gov., Lt. Gov, and Sec'y, Resolution of the Tribal Council, Storage of Rio Grande Compact Accumulated Credit Water in Jemez Canyon Reservoir, No. 01-R-06 (signed Mar. 27, 2001); Memorandum of Agreement [MOA] Among the Pueblo of Santa Ana, the [N.M] Interstate Stream Comm'n [ISC], and the [U.S.] Army Corps of Engineers [COA] (signed on various dates, April 2001) (on file with author) [hereinafter 2001 CWA MOA].

settlement offer during the early stages of the minnow litigation in March 2001,[461] the Conservation Water Agreement[462] aimed to facilitate compliance with the 2001 Biological Opinion's Reasonable and Prudent Alternatives.[463] Under the Conservation Water Agreement, New Mexico would take advantage of the Compact's credit status to store native Rio Grande relinquishment credit water in upstream reservoirs for subsequent release for instream use.[464] This arrangement was subject to various conditions precedent, that is, acts or events required before a duty to perform arises,[465] specifically, regulatory approvals.[466] As a deviation from normal operations, the agreement required the Rio Grande Compact Commission's "advice and consent," which was obtained via resolution in advance.[467] It also required approval from the Corps, as a non-emergency deviation, as well as NEPA compliance by the Corps for that same action.[468] Finally, the Conservation Water Agreement was subject to the terms of a permit issued by the OSE.[469] The permit required Conservation Water Agreement water be released "for beneficial uses occurring in the Rio Grande"[470] for purposes of complying with the ESA or managing the Compact delivery obligations.[471]

Under the Agreement, Conservation Water was defined as:

> . . . water stored and made available consistent with state law by New Mexico as a conservation pool above Elephant Butte Reservoir[, *i.e.*,] native Rio Grande water that, if not stored, would otherwise have flowed downstream to Elephant Butte Reservoir and contributed to New Mexico's compact deliveries.[472]

Total storage under the Conservation Water Agreement was limited to 100,000 acre-feet in Abiquiu and Jemez Canyon reservoirs, which would then be released—up to 30,000 acre-feet per year—between 2001 and 2003. Water stored, but not used, in any given year would not be lost but carried over.[473]

The Agreement authorized storage of water in excess of downstream demand and was feasible due to three discrete conditions: 1) at the time New Mexico had a credit status under the Compact; 2) hydrologic conditions did not preclude

461. Gillon (2007), *supra* note 57 and accompanying text (citing Letter from Stephen Farris, N.M. Asst. Att'y Gen. et al., to Andrew Smith, U.S. Dep't of Justice et al. (Mar. 5, 2001) http://www.ose.state.nm.us/doing-business/mrgsettle/3-5-01-Settlement-Proposal.pdf.

462. *See* Gillon (2007), *supra* note 57, at 633–36 (summarizing and analyzing agreement, including rationale, contractual provisions, legal authority, operational aspects, and "lessons learned").

463. *Id.* at 633.

464. 2001 CWA MOA, *supra* note 460, at ¶¶ 1–17.

465. *Conditions Precedent*, BLACK'S LAW DICTIONARY (11th ed. 2019).

466. *See, e.g., id.* at ¶¶ 1–3, 10, 15.

467. *Id.* at 634.

468. *Id.*

469. *See* CONSERVATION WATER AGREEMENT BETWEEN THE STATE OF NEW MEXICO, U.S. DEPT. OF INTERIOR, AND THE U.S. ARMY CORPS OF ENGINEERS § 5.D, at 4 (June 29, 2001) [hereinafter CONSERVATION WATER AGREEMENT]; Permit No. SP-4822 (Apr. 28, 2003).

470. Gillon (2007), *supra* note 57, at 635, n. 134.

471. *Id.* at 635 n. 137 (citing Permit No. SP-4822).

472. *Id.* at 634 n. 130 (citing CONSERVATION WATER AGREEMENT, *supra* note 469, § 3, at 2).

473. *Id.* at 634 n. 128 (citing CONSERVATION WATER AGREEMENT, *supra* note 469, § 4, at 3).

upstream storage under Compact Art. VII since there was more than 400,000 acre-feet in storage at Elephant Butte; and 3) storage space was available at the Abiquiu and Jemez Canyon reservoirs.[474]

This confluence of enabling conditions shows what is typically required to operationalize even modest reservoir flexibility, at Abiquiu or otherwise. In the case of the now-operationalized Environmental Pool at Abiquiu— whose storage rights have now been exercised to store environmental water for instream flow operations since Audubon's first use of the water space in 2016[475]—the Conservation Water Agreement, which provided the framework for this innovative water storage space could, as a result, be subsequently release for environmental purposes.[476] The landmark agreement itself was catalyzed by the fraught Rio Grande silvery minnow litigation, a suit the environmental plaintiffs brought under ESA. As Gillon highlighted, now roughly a decade and a half ago, "[m]any of the documents used to implement the Conservation Water Agreement . . . serve as templates for [such] agreements . . . [and] draw attention to the conditions for storing and releasing water in [the] Environmental Pool."[477]

Such operational collaboration and discretion, as codified in the present Biological Opinion, increasingly characterizes the polycentric governance system that is emerging on the Middle Rio Grande, that is "a series of partly overlapping institutions . . . working within a cooperative structure defined by agreements and basic rules."[478] This summary description of the concept, extensively developed by institutional economist and political theorist Elinor Ostrom, draws on the work of Hungarian polymath Michael Polanyi.[479] More recently, polycentric governance has been described as "a social system of many decision centers having limited and autonomous prerogatives and operating under an overarching set of rule."[480] Students of the philosopher–architect Christopher Alexander have summarized this set of rules as "formal laws, contractual agreement, and informal or even tacit agreements" between entities comprising this system.[481] Perhaps most relevant to the present work, polycentric governance appears to be constitutive of the transformation and resilience that diversity produces.

In formulating and operationalizing its core Conservation Measures, the current Biological Opinion *constructs* discretion as a primary mechanism for achieving environmental flows. ESA compliance is thus a function of long-term collaboration and trust-building between federal agencies such as the Service and

474. *Id.* at 635.

475. National Audubon Society, *Audubon Announces Historic Water Release to the Middle Rio Grande*, (Sept. 7, 2016) https://www.audubon.org/news/audubon-announces-historic-water-release-middle-rio-grande.

476. *Id.* at 636.

477. *Id.*

478. Michael W. Mehaffy, Yulia Kryazheva, Andrew Rudd, Nikos A. Salingaros, A NEW PATTERN LANGUAGE FOR GROWING REGIONS: PLACES, NETWORKS, PROCESSES 281 (SUSTASIS PRESS, 2020).

479. *Id.*

480. *Id.* (internal citation omitted).

481. *Id.*

Reclamation, together with nonfederal stakeholders like MRGCD and New Mexico's Interstate Stream Commission.[482]

This view of discretion lies in contrast to the view of some environmental advocacy groups that agency discretion is, per se, detrimental to the environment because government agencies have not wielded their discretionary authority properly.[483] This rationale, however, can ignore the fact that the Rio Grande is a novel system, which cannot easily be restored by fiat but must be managed cooperatively—already the emerging pattern. In this environment, managing Rio Grande reservoir operations for flexibility is a key variable; such operations are themselves governed by various legal authorities, including Congressional authorizations.[484] This flexibility requires discretion on the part of both federal water managers and river stakeholders.[485] Thus, the Biological Opinion's discretionary space comprises coupled legal–physical dimensions, manifesting in practical and political and as well as scientific and administrative registers—all in a transboundary, social–ecological context.

The Biological Opinion also serves as a microcosm for larger surrounding questions of, and approaches to, sustainability and water management in the arid West. For example, what is the proper place for collaboration as opposed to litigation in water politics? Some environmental groups have emphasized the perils of such discretion and the benefits of adversarial legal action.[486] In contrast, stakeholder

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482. *Cf.* App. A(4); 2016 BIOLOGICAL OPINION, *supra* note 56, at 13 (regarding draft Hydrologic Objectives for seasonal water needs for silvery minnow support), 18–24, 109–110 ("Conservation Measures" and implementing regulations/programs/partners, corresponding to ESA-required "reasonable and prudent measures," and subject to the BiOp's enumerated "terms and conditions"); *cf id.* 116–18 (concomitant Federal and state agencies' discretionary "conservation *recommendations*") (emphasis added).

483. *Cf.* App. A(4)(iii) (regarding mid–2010's WEG v. Corps litigation); *see* WildEarth Guardians v. United States Army Corps of Engineers, 314 F.Supp.3d 1178, 1184–85 (D.N.M. June 6, 2018, *amd'd* Aug. 14, 2018); WildEarth Guardians v. United States EPA, 759 F.3d 1196 (10th Cir. 2014) (defining what counts as an "action" that triggers § 7(a)(2)).

484. *See, e.g.*, Kelly (2007b), *supra* note 136, at 656, 663–71, 671 (highlighting the work of MRGESCP's Water Acquisition and Management, or WAM, subcommittee, many of whose member "felt it was important," in "researching, developing, evaluating, and implementing water management alternatives; examining ideas for efficient water use; and finding strategies to offset depletions caused by program activities," to "address reservoir storage and operations (especially focusing on gaining long-term flexibility in reservoir storage) because they are important components of water management and supply."), 665 (noting WAM members ultimately agreed that "long-term," as opposed to short-term, "storage flexibility should be one component" of the Committee's work on a "Preliminary Analysis," beginning in 2004, and concomitant attempt to develop consensus regarding scenarios to be modeled, which would ultimately be fairly limited scope, ultimately "not resulting in [actual] model runs" of alternative water operations scenarios.).

485. *See, e.g., id*. at 664 n. 29 (reporting that URGWOM's ruleset "consists of [the URGWOM] technical team's interpretation of operational policy, regulatory, preferences, and other decision-making logic."), 666 (WAM alternatives analysis, during the mid-aughts, "[d]iscussion of Cochiti Lake surfaced immediately, but it was brief and the proposals were quickly dropped because the Pueblo de Cochiti was not ready to discuss various operations of the lake."), 670 (noting that Reclamation has "negotiated temporary waivers [of San Juan–Chama Project water] with contractors to allow carryover [of such water] until April 30 in order to provide release rates on the Rio Chama to enhance the fishery between El Vado and Abiquiu Reservoirs during the winter and provide flexibility in managing river flows"), 671 (noting that, one point, "discussion of . . . [Cochiti and Abiquiu] was taken off the table").

486. *See id.; c.f.,* Fishman, *supra* note 93, at 63–65 or 101–103.

groups and water management, law, and policy practitioners comprising the Rio Chama Flow Project emphasize the practical and environmental benefits of collaborative approaches.[487] In this context, real, if only incremental changes allow for adaptive management of a novel system.

IV. ADAPTING: A PARTIAL INTEGRATION, INSTITUTIONAL DIVERSITY

Finding a balance between flexible management and operating certainty is a perpetual challenge in water management. In governmental institutions there is always a tension between maintaining functional stability and adapting to changing circumstances. Those who are regulated or served by government want and need of a stable operating environment. However, dynamic circumstances require government to respond to immediate needs in our ever-changing world.

Water management is an incredibly dynamic operating environment, especially in the American Southwest. Water managers face dramatically changing conditions from one water year to the next. They do so within what is perceived as a tightly constrained legal and regulatory environment. Nonetheless, over time New Mexico water managers have shown great imagination in developing new tools within existing legal authorities.

The development of new water management tools does not occur overnight. At times it seems that New Mexico's water managers can respond remarkably quickly to new challenges. However, in the background of these apparently rapid responses there have always been pre-existing collections of information, positive working relationships, and conversations about new ideas that range from the embryonic to the fully developed. Thus, new water management regimes are often the result of decades of discussion and contemplation.

Rules are made by people and can be changed by people. New laws are passed, new regulations are crafted, and new agreements are forged all the time. While it may seem impossible to challenge the status quo due to fears of disrupting society and the economy, the truth is that all rules can be changed. Ideally, water management regimes are constantly being improved through well-thought-out responses to changing circumstances.

A. Current Flex Point for Rio Chama Reservoirs

Given the focus of the Rio Chama Flow Project on operations at the Heron, El Vado, and Abiquiu Reservoirs, these three critical water-works form an important piece of water management in the Middle Rio Grande. All three of these reservoirs are operated in compliance with the Compact, but deviations from their standard operations can be granted by the Rio Grande Compact Commission.[488]

With Heron as an initial waypoint, importation of San Juan-Chama water into the Rio Grande Basin provides much needed flexibility given that it is authorized to be used for a multitude of purposes. Most notably, San Juan-Chama water can be

487. The Utton Center is one such participating institution. *Cf.* RCFP Proposal, *supra* note 43, at 1; 2014 RGR WaterSMART Proposal, *supra* note 198, at 2, 8–13.

488. Gillon (2007), *supra* note 57; M.H. Benson (2014), *supra* note 45; App. B(2)(ii)(a)–(c).

used for wildlife purposes such as endangered fish.[489] San Juan-Chama water also adds flexibility to basin-wide storage scenarios as it can now be stored in any reservoir.[490]

For the first twenty years of San Juan-Chama Project operations, it was believed that San Juan-Chama contractors must evacuate their annual allotment of water from Heron Reservoir by December 31 each year.[491] This was based on an interpretation of a provision in the Colorado River Project Storage Act.[492] In 1983 the San Juan-Chama Project Engineer proposed that carryover of water be allowed until March 31 of the following year.[493] This was suggested to alleviate the negative effects of reduced flows in January on the trout population in the Rio Chama. Carryover waivers were at first thought to be illegal but quickly found to be allowed.[494] A field solicitor issued a legal memorandum on September 7, 1983, which held that carryover of San Juan-Chama water from year-to-year in Heron was not allowed.[495] After discussions with Reclamation's Southwest Regional Director the same field solicitor issued a revised legal memorandum less than a month later, this time confirming that reading the law to allow for carryover storage was a more proper interpretation.[496] In that same legal memorandum, the solicitor blessed a carryover waiver for the City of Albuquerque, despite acknowledging that Albuquerque's San Juan-Chama contract had a no-carryover clause in it.[497] Furthermore, the solicitor expressed the opinion that other carryover waivers could be granted on a case-by-case basis when there are benefits to the U.S. through more effective Project operations.[498]

El Vado, for its part, differs from the other reservoirs in this article in a significant way. Namely, it was not built by the federal government and does not have explicit federal restrictions on how it may be used, other than those set forth in the Rio Grande Compact.[499] It is used to store both native and San Juan-Chama water, as well as supplemental water for endangered species, and senior Pueblo irrigation water rights.[500] El Vado is often used as a re-regulating reservoir to simplify water

489. Act of June 13, 1962, Pub. L. No. 87-483, 76 Stat. 96–102 (1962).

490. Act of Dec. 29, 1981, Pub. L. No. 97-140, §5(a), 95 Stat. 1717 (1981).

491. *See, e.g.,* Email exchange between Rich Barrios and Karl Martin, *inter alia*, Sept. 15, 1998, Regarding "Nov. 3, 1983 long lost solicitor's opinion for waiving the carryover provision in heron" (on file with author); *cf.* EMMET RICE, RECLAMATION FIELD SOLICITOR OPINION (Sept. 7, 1983) (on file with author) [hereinafter RICE (Sept.)]; EMMET RICE, RECLAMATION FIELD SOLICITOR Opinion (Nov. 3, 1983) (on file with author) [hereinafter RICE (Nov.)].

492. Colorado River Storage Project Act of 1956 ("CRSPA"), App. A(2)(ii)(b) at nn. 74–85 (at issue was Sec. 8(d) of Pub. L. 87-483, 76 Stat. 98 (1956, 1962)).

493. *See* MEMORANDUM FROM REGIONAL DIRECTOR, U.S. DEP'T OF THE INTERIOR, BUREAU OF RECLAMATION, SOUTHWEST REGION, TO REGIONAL DIRECTOR (Sept. 15, 1983) (on file with author); *cf.* Barrios & Martin*, supra* note 205.

494. *Cf.* Barrios & Martin, *supra* note 205.

495. RICE (Sept.), *supra* note 491.

496. RICE (Nov.), *supra* note 491.

497. *Id.*

498. Emmet Rice, Reclamation Field Solicitor Opinions (Sept. 7, 1983 & Nov. 3, 1983).

499. *See* App. A(3)(ii)(a) (Irrigation Water: MRGCD Permits Nos. 1690 and 0620).

500. *See* App. A(3)(ii)(b) ("For their part, the six Middle Rio Grande Pueblos have two varieties of water rights on the main-stem Rio Grande. Their "Prior and Paramount" water rights comprise surface

operations between Heron and Abiquiu Reservoirs. In 2015 and 2016 the Rio Grande Compact Commission authorized new flexibility at El Vado when it approved a deviation in operations to allow for water to be stored and released for the benefit of the Rio Grande silvery minnow despite ongoing storage restrictions.[501]

El Vado provides various examples of flexible water management. It may be the storage of Pueblo water rights that presents the greatest potential for implementing future management flexibility at El Vado. Currently only the Pueblos' Prior and Paramount water rights are stored in El Vado.[502] The amounts and procedures for storage and release of Pueblo water are dictated by a 1981 agreement between the Secretary of the Interior and the MRGCD.[503] This agreement could be renegotiated in the future. Moreover, when the Pueblos decide to assert their water right claims, storage at El Vado could be a major component of water right settlement discussions. For example, it may be found prudent for the Pueblos' Prior and Paramount irrigation water rights to carry over from year-to-year in El Vado.

At Abiquiu, in turn, the Corps can deviate from normal operations with permission from the Rio Grande Compact Commission.[504] The Corps analyzes planned deviations based on the case-by-case merits of the situation.[505] Impacts to flood potential, reservoir conditions, and expected benefits and consequences are all considered. For example, in 2001 the Corps allowed for a deviation by approving the storage of the Compact credit water in Abiquiu for the benefit of endangered species.[506] In 2014, the City of Albuquerque acquired land above the current fill limit elevation of 6,220 feet, with the hopes of increasing its storage in Abiquiu.[507] In 2018, Congress authorized the Corps to create peak flows on the Rio Grande through temporary deviations of operations and both Cochiti and Jemez Reservoirs for a

flows necessary to irrigate 8,847 acres of Pueblo land which were being irrigated before the formation of MRGCD. These Prior and Paramount rights are based on aboriginal sovereignty. In contrast, the roughly 11,000 acres of Pueblo land that have been reclaimed since the MRGCD was formed have shared priority with all the other newly-reclaimed lands within the MRGCD."); App. B, at tbls. 2, 3, & 6.

501. *See* App. B, at tbls. 1 & 2.

502. *See* App. A(3)(ii)(b); App. B, at tbls 1, 2, 3, 6, & 8.

503. 1981 P&P Agreement, *supra* note 193.

504. *See* App. A(2)(ii) ("[T]he Rio Grande Compact Commission would be the last word regarding 'deviations' from normal operations, i.e., those delineated in the Act's "Reservoir Regulation Plan." The 1960 Act provided that MRG reservoirs would be operated in compliance with the Rio Grande Compact but that departures from the regulation plan could only occur with the advice and consent of the Compact Commission—or in the case of an emergency."); *see also* 74 Stat. at 493 ("[A]ll reservoirs of the Middle Rio Grande Project will be operated at all times in the manner described above in conformity with the Rio Grande compact, and no departure from the foregoing operations schedule will be made except with the advice and consent of the Rio Grande Compact Commission.").

505. *See, e.g.,* 2001 CWA MOA, *supra* note 460.

506. *Id*.

507. *See* App. B, at tbls. 1, 2, & 8.

period of five years, once the deviations are resumed.[508] The Corps is required to consult with Cochiti and Santa Ana Pueblos on these deviations.[509]

B. Future Flex Points

It is difficult to predict what will motivate water managers to find and exercise flexibility in their future work. However, there are a number of unresolved issues along the Rio Chama, in the Middle Rio Grande, and beyond that seem ripe for creative thinking. First and foremost is the ongoing U.S. Supreme Court litigation regarding groundwater use within the Rio Grande Project.[510] That litigation was catalyzed by the adoption of a new operating agreement for the Rio Grande Project.[511] That attempt at creating a new flexible management regime for water deliveries from Elephant Butte Reservoir to Texas stretched beyond New Mexico's threshold for flexibly interpreting the Rio Grande Compact. Settlement negotiations for this litigation present an intriguing forum for discussion of creative interpretations of the Compact.[512]

The resolution of Pueblo water right claims is another opportunity for creative water management thinking. The resolution of Pueblo water right claims in northern and central New Mexico has included commitments to create regional water supply systems and implement conjunctive management of ground and surface waters.[513] Future Pueblo water rights claims in the Middle Rio Grande may include claims for ecological water, like spring pulse flows and maintained base flows. Pueblo water right claim settlement negotiations may present the opportunity to reconsider how the Rio Chama and Rio Grande reservoirs are used and operated.[514]

The ongoing corrective action study of El Vado Dam presents an opportunity to think creatively about not only how the dam's current operations can be protected but also how it can be improved to better serve its users.[515] For example, perhaps the repairs to the dam could include upgrades that would allow operators to

508. Water Resources Development Act of 2018, 74 Stat. § 1174 (Middle Grande Peak Flow Restoration); *cf.* JAMES DALTON, DIRECTOR OF CIVIL WORKS, MEMORANDUM ON REVISED IMPLEMENTATION GUIDANCE FOR SECTION 1174 [of 2018 WRDA], May 6, 2019, https://usace.contentdm.oclc.org/digital/api/collection/p16021coll5/id/35434/download; AWIA (2018), *supra* note 244 (containing current Congressional authorization of Cochiti Deviation).

509. *Id*.; *see generally* AWIA (2018), *supra* note 244 (containing current Congressional authorization of Cochiti Deviations); *cf.* App. at § B (citing the Letter from Antoinette Grant, U.S. Army Corps of Engineers, to Estevan Lopez and Brent Rhees (Nov. 12, 2013) (regarding expiration of the Cochiti Deviation) (on file with author); *see also* D'Antonio, *supra* note 211, at 17 (noting the Corps' that such deviations were "unreliable tool[s]" for Silvery Minnow spawning).

510. *Texas* v. *New Mexico and Colorado, Orig. No. 141*, SCOTUSBLOG, https://www.scotusblog.com/case-files/cases/texas-v-new-mexico-and-colorado/.

511. *See id*. *passim*; ELEPHANT BUTTE IRRIGATION DISTRICT [EBID], EL PASO COUNTRY WATER IMPROVEMENT DISTRICT NO. 1 [EPCID–1], AND UNITED STATES OF AMERICA [US], OPERATING AGREEMENT FOR THE RIO GRANDE PROJECT (Mar. 10, 2008); *see also* EBID, EPCID–1, and U.S., RIO GRANDE PROJECT OPERATIONS MANUAL (*rev'n* May 2012).

512. *Cf. Texas v. New Mexico and Colorado, supra* note 510.

513. *See* UTTON CENTER, *supra* note 267.

514. *Cf*. Audubon Soc'y, Historic Partnership*, supra* note 123.

515. Personal Communication, Steve Harris, Exec. Dir. Rio Grande Restoration (Sept. 2020) (notes on file with author).

better control the sediment that is transported downstream. It may be that the need to store water elsewhere during the repair of El Vado will require water managers to be more flexible in their interpretation of existing reservoir authorities.

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C. Metaphysics, Analytics, and Legal Common Sense: What is the Law of the River?

This article has shown how negotiated arrangements leading to in-stream flow innovations, such as the Conservation Water Agreement[516] and its progeny; algorithm-assisted decision-making tools, like URGWOM; and complementary frames such as political ecology[517] are integral to the Law of the River, and thus constitutive of water law, policy, and management in the Middle Rio Grande. How might their adaptive capacity and effectiveness be gaged?

To answer this question, this article has drawn heavily on, and thus sought to extend contemporary complexity theory in the domain of law.[518] As a philosophical matter, the article has been guided by a jurisprudence heavily influenced by Vine Deloria, Jr. A rigorous pluralistic perspective as Deloria's, one grounded in place and experience, hold heuristic value in practical as well as law and policy terms. As Deloria life and works show, synthesizing diverse ways of knowing and being that are independent of and transcend parochial views, as was his focus in *Metaphysics*, is a powerful tool to bring "our transforming institutions" and "expanding legal universe"—our institutional ontology—in line with the exigencies of modern existence.[519]

Through empirical legal research, the resultant conceptual model of what has been called the Law of the River emerges as an unsettled and entangled assemblage. The model and empirical results nonetheless respond to Reclamation's desire for unpacking the dimensionalities of this mode of governance—legal authority which, as this article has shown, is inseparable from the systems' physical, cultural, and political components and their myriad interdependencies. This model, roughly sketched here, serves as scaffolding, and could be extended in support of a larger project of catalyzing legal information extraction, synthesis, and simplification.[520]

In broad strokes, a follow-on applied research agenda going might consider further development of *integral* legal analytics, a mapping project to incorporate such elements as natural language processing, network analysis, and graph theory. It would likely offer insights well beyond the law. In abstract terms, this project would

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516. *See, e.g.*, McCoy, *supra* note 415.

517. *i.e.*, political ecology and jurisprudence *as* social policy—*cf.* historic and contemporary manifestation of settler colonialism attendant to political economies and material cultures in water, natural resources, and the environmental and natural resources.

518. MURRAY ET AL., COMPLEXITY THEORY AND LAW: MAPPING AN EMERGENT JURISPRUDENCE (2019).

519. DELORIA, *supra* note 12; *accord* DE SOUSA SANTOS, *supra* note 320; JOHN PROTEVI, EDGES OF THE STATE (2019).

520. *See generally* ASHLEY, *supra* note 20 (like the application of Gillon's (2007) framework in the 2016 (and subsequent) Audubon flows).

be extension of Ashley's computational *legal analytics* in concert with Ruhl & Katz's conceptual model of *legal mapping*. And, in the case of river basin governance in the American West, could also synthesize Amos and Jaeger's hydrologic–economic–legal modeling of the Willamette River, for example, with Deloria's grounded and pragmatic yet expansive jurisprudence. In virtue of such a proposal, as Deloria suggested, actionable Critical Zone-related insights might emerge whereby:

> [a] new understanding and way of life for individuals[,] . . . [in which] [o]ur understanding of societies, of technology, of institutions, and of the place of nature within our legal system points to a radically new conception of individual life and seems to indicate that all transformation of larger social organization and concepts will eventually focus on ourselves as individuals . . . [through a] [re]examinat[ion] of our traditional understanding of the individual.[521]

Moving thus, as Deloria tracked in his Metaphysics, from a "charismatic model" of human affairs, through a "traumatic planetary past," to a "transformation of modern science," and on to a "metaphysics of modern existence," we might come to be informed by "the original . . . perception of realities" which have been, through the ages, "transformed" into philosophes that, though they "purport to give a logical and analytical explanation of ultimate reality," nonetheless Deloria showed have "eliminated the human emotions and intuitive insights of the original experience."[522] By "substitute[ing] a systematic rendering of human knowledge concerning the natural world," our modern paradigm has generated a maladaptive response, overall, to our accumulating planetary catastrophes. What important knowledge might be gleaned from a Deloria-inspired jurisprudence of the so-called *law of the river*?

Going forward, properly analyzing this intertwined physical and legal system will certainly require some automation, a necessary though far from sufficient step, given the characteristic, systemic complexity of the Middle Rio Grande. To keep these matters manageable, Christopher Alexander's theory of building, originally inspired by legal scholar James Ragsdale, Jr.'s phenomenological jurisprudence of land, governance, and being is instructive.[523] Alexander's theory rests on simple "pattern language[s]" which, unfolding on their own, are governed in a "timeless" fashion;[524] an analytical device which aids in digesting synthesis and thus making sense of and deriving some *meaning* and *knowledge* as ethical know-

521. DELORIA, *supra* note 12, at 187–88.

522. *See id.* at 177, 189, 201, 215.

523. *See* Ragsdale, Jr., *supra* note 12. For a complementary perspective, *see* Edward L. Rubin, *Putting Rational Actors in their Places: Economics and Phenomenology*, 51 VAND. L. REV. 1705, 1705–07, 1726–27 (1998) (characterizing the explanatory strength of Husserl's phenomenology in empirical terms, in contrast to purported strength of economics' rational actor theory, sometimes incorporated into legal analysis, in idoneous—i.e., institutional–economics—domains), 1719 ("All human thought, being individual thought, is necessarily limited by cognitive and informational constraints, and must therefore proceed by means of approximation or heuristics.") (internal citation omitted), 1719 n. 38 (noting different approaches to phenomenology-adjacent heuristics in contexts such as institutional economics which, this author would add, is itself a field adjacent to jurisprudence as a close reading of this work would reveal).

524. *See* CHRISTOPHER ALEXANDER, THE TIMELESS WAY OF BUILDING (1979).

how, even wisdom, of the Law of the River as a complex system. This is all the more important given climate change and drought as existential threat and climate *justice* as a normative, even operational, response.

Useful tools such as URGWOM may be necessary for water managers and stakeholder to "unpack" the Law of the River. But insights gleaned from such heterodox modes of thinking as Deloria's, which underlie the thrust of this work, may ultimately prove more valuable. As the Law of the River faces an existential crisis, its transformation in the direction of "expanding the legal universe," as Deloria put it, is of foremost importance. There are indications that such transformation may be underway, as highlighted recently by the interdisciplinary work on Colorado River drought contingency work carried out by a team of consultants, Martin and McCoy and Culp & Kelly. The founding partners of the former firm are an ecologist and an environmental economist who, with support now from a computational biologist, employ a self-described "practice of inquiry." The latter is a boutique law firm specializing in water, environmental, and natural resources law and policy, is perhaps the only firm in the West to have an in-house hydrogeologist.[525] The combined efforts, explained in these orthodox terms, is a token of the sorts of modes of inquiry this article has drawn on, from the philosophy of law and jurisprudence to social policy. All such inquiries—scholarly by nature here, or as a matter of effectively navigating the complex regulatory and transactional landscape of water in the West, as with the Rio Chama Flow Project or Martin & McCoy, Culp & Kelly, and their clients—are quite adjacent to political ecology, recalling historian and conservationist William deBuys' shorthand for describing the Middle Rio Grande's biggest water governance challenges.[526]

In pursuing such a political–ecological inquiry under the guise of legal analysis, this article has described and attempted to explain the origin, persistence, and success or failure of certain ideas of water law in the context of the Middle Rio Grande Basin. As Deloria puts it, the purpose of engaging a critique of "culture and civilization," as this article has attempted, is "perceiving [of] situations in [] total experience" to aid ourselves to "make sense of our lives" and thus "become better people."[527] In retrospect, the Law of the River jurisprudence explored here had its point of departure in an exploration of how and what it means to live in a place together, the age-old political question. But this legal philosophy is not merely an intellectual exercise and even less a purely legal one. Forty years ago, Deloria was already observing that "science [had been] . . . rapidly approaching the area of metaphysics."[528] As the visionary Deloria was well aware, philosophers and physicists—and even philosopher–physicists—alike had accepted this proposition long before he made it.[529]

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525. *Cf*. McCoy, *supra* note 415.

526. *Cf*. LATOUR & WIEBEL, *supra* note 1, at 1 (epigraph); *accord* DEBUYS, *supra* note 10 and accompanying text.

527. DELORIA, *supra* note 12, at 150, 187–88.

528. *Id*. at 64.

529. *Cf*. KAREN BARAD, MEETING THE UNIVERSE HALFWAY: QUANTUM PHYSICS AND THE ENTANGLEMENT OF MATTER AND MEANING 97–132 (2007) (reviewing, extending, and revising legendary 20th century physicist Neils Bohr's philosophical framework).

Beyond the explanatory powers of prediction and feedback mechanisms of interested water managers, the approach proposed, pursued, and applied in this article responds to Deloria's creative injunction to construct a framework, namely a modern metaphysics that synthesizes the insights and values of Indigenous peoples throughout the world with those of Western scientists, philosophers, and theorists.[530] In doing so, the common aim would be to harmonize our beliefs and actions independently of any particular tradition, in order to "arrive at a new vision for the future which accurately and appropriately deal[s]" with reality.[531] It is safe to say that this reality now included a 500-year return period megadrought, as Rio Grande conditions now demonstrate.

In this way, Deloria's "desire . . . to use metaphysics as a bridge between science and religion" could not be more relevant as this method serves "to determine if Western culture and civilization have sufficient universality to provide a meaningful vision of human existence on a planetary basis."[532] Within the preliminary, contingent and defeasible disposition of the law-of-the-river-as-legal-map, a "social imaginary"[533] of sorts has space nonetheless to emerge, one which offers a trace of another possible Law of the River.[534] This is a critical finding, especially in virtue of 1) our current collective's "[g]reat derangement" regarding the "[u]nthinkable" events accompanying climate change,[535] and 2) the ultimately political issue which, doomed the Colorado River Compact from the start, namely "ignoring inconvenient science."[536]

Going forward, the positive project will be to see this diverse constellation of what the law is. In turn, the data of experience must be given space to breathe. Then practitioners and policymakers must articulate a "new legal common sense," in the words and jurisprudence of noted legal scholar Boaventura de Sousa Santos.[537] Vine Deloria, Jr. would no doubt agree and has argued persuasively that this common sense is a prerequisite to "expanding the legal universe," a project he tirelessly pursued and advocated prophetically.[538] Indeed, synthesizing ways of knowing and being independent of parochial views is enormously valuable. Critics of progressive water policies demand empirical proof, especially considering the nominal normativity of such theorizing. To wit, legal and policy analysis grounded in experience is more approachable, and effective. Not only can "irrational things . . .

530. *See* DELORIA, *supra* note 12, at 163–88 (addressing, in consecutive chapter, the extant reality and experience of "[o]ur [t]ransforming [i]nstitutions" and the normative project of "[e]xpanding the [l]egal [u]niverse"), 273–81; *see generally* VINE DELORIA, JR. & DAVID E. WILKINS, THE LEGAL UNIVERSE: OBSERVATION ON THE FOUNDATIONS OF AMERICAN LAW 1–14, 373–76 (2011) (expanding on Deloria's previously articulated "legal universe" expansion norm).

531. DELORIA, *supra* note 12, at 29, 287.

532. *Id*. at 29.

533. *See* CHARLES TAYLOR, MODERN SOCIAL IMAGINARIES (2004).

534. *See infra* Section II.D ("Another world is possible," as the Zapatista maxim suggests.).

535. AMITAV GHOSH, THE GREAT DERANGEMENT: CLIMATE CHANGE AND THE UNTHINKABLE (2017).

536. ERIC KUHN AND JOHN FLECK, SCIENCE BE DAMMED: HOW IGNORING INCONVENIENT SCIENCE DRAINED THE COLORADO RIVER (2019); *see also* Jefferey Hoagland, Book Note, 61 NAT. RES. J. 331 (2021).

537. DE SOUSA SANTOS, *supra* note 320, at cover, *passim*.

538. DELORIA, *supra* note 12, at 177–88, 273–82, 283–91 (afterword by David Wilkins).

occur,"[539] as when physical systems are abstracted into legal terms in the case of Western water law, but also, for example, as Deloria observes: "if our legal system reflects our view of reality, [] we believe we exist [] apart from the physical world."[540] Plainly the consequent does not hold, as shown by this foray into the complexity, and thus ontology, as well as the meaning of the Law of the River within the social–ecological system comprising New Mexico's Middle Rio Grande Basin. The modest empirical results reported here are indexical of this state. This initial inquiry may aid an understanding of how "everything happens" in the Critical Zone and why its habitability "[d]epends on your chosen science," and survival there "depends on your politics."[541]

CONCLUSION

Ultimately, all laws, policies, and other water management rules are human and social constructs. The rules that govern us today were created by yesterday's leaders. It is incumbent on today's water managers to evaluate today's rules and analyze, as best they can, how effective these rules will be in both the predictable and unforeseen future. As this article acknowledges, "rule" changes are not made overnight but rather through long-term contemplation, socialization, and optimization of physical and political circumstances. Making water management more flexible is a complex endeavor that requires mastery of many different disciplines but ultimately depends on the open-mindedness of today's water managers.

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539. *Id.* at 179.

540. *Id.* (citing and interpreting Salt River Water Users' Ass'n v. Kovacovich, 3 Ariz. App. 28, 411 P.2d. 201 (1966)).

541. LATOUR & WEIBEL, *supra* note 1, at 1 n. 1.