

Cover: Luis Camnitzer, *You are here*, 1966, vacuum-formed polystyrene mounted on a synthetic board

Rivers mark the passing of time. This was proven true in 1967 when James Hill, a researcher at Arizona State University, recovered historic maps that showed how the illegal straightening of a bend of the Río Bravo (aka Rio Grande), which demarcates nearly half of the Mexico-United States border, moved more than 400 acres of U.S. territory to the Mexican side.

What is now Rico Rico, Tamaulipas used to be Texas—surrounded by a deep curve of the river that folded south—until 1906 when the American Rio Grande Land and Irrigation Company created a deviation of the river's course to secure direct access to its waters. International laws established that human interventions to the river course would not affect the border line. However, over time, and with the Río Bravo/Rio Grande as an organizer between both countries, the territory was slowly forgotten by the U.S. and integrated into the day-to-day authority of the Mexican government. The unclaimed land became an alcohol trafficking hub and a drinking destination for American tourists during the prohibition era even though, ironically, still "legally" in the U.S.—its only territory south of the river. Almost a decade after the maps were found, the U.S. officially ceded the territory to Mexico and provided citizenship to those who could prove that they were born there before the treaty.



1912 map showing the artificial cutoff for diverting water of the Río Bravo/Rio Grande (Courtesy UTRGV Digital Library, The University of Texas – Rio Grande Valley)

In the case of Rico Rico, it took some digging to change the geometry of the Mexico-U.S. border, but rivers are constantly in motion and their curves subject to natural cutoffs. As water accelerates, meanders exaggerate to the point where bends can complete themselves as loops and separate as independent bodies of water. Avoiding the path of its own curves, a river will seek a shorter course to its destination. The water flow erodes its terrain, pushing sediments that fortify the interior of its curves. As materials accumulate on the inside, the outside areas soften, generating what geologist Elizabeth A. Wood calls a positive feedback loop, "making meanders seems to be a self-intensifying process in which greater curvature results in more erosion of the bank, which results in greater curvature," and so on until the loop eventually closes itself.

RIVERS ARE PROCESSES

In *Identity, Ostension, and Hypostasis* (1950), philosopher W.V. Quine offers an unfamiliar alternative to the well-known paradox that Heraclitus pondered centuries ago: "You can not bathe in the same river twice, for new waters are ever flowing in upon you." While Quine also recognizes rivers as processes in time, he divides them into "stages" distributed as momentary parts. These are fractions of what we understand to be a single river, and the same goes for the stages of the water that runs through the river channels, down to the molecular assemblage of water particles themselves. "You may bathe in the same river twice without bathing in the same water twice," he writes, "and you may, in these days of fast transportation, bathe in the same water twice while bathing in two different rivers."



Rivers are time-consuming objects made of river stages and water stages.

For those of us who might need matter broken into apples and oranges, Quine imagines three stages of the same river: **A** is a concrete yet random moment of the river; **B** corresponds to the same site in the river but two days later; and **C** represents the same water that was in the river during stage **A**, but taken two days later during stage **B**. The molecules of water in the river are not the same at **A** and **B** and the place where the molecules of stage **A** are at the time of stage **C** is different. **A** and **B** are related by their shared condition as river and **A** and **C** by their shared condition as water. The momentary object **A** is part of both the river and the water, while **B** is part of the same river but not the same water, and **C** is part of the same water but not the same river. Together with points through time, the condition of the river must be understood along its extension in space. Referring to the river as a process must include not only the moments in which it is being observed, but also the specific places where observations take place. Just as we integrate time-based fractions into time-based wholes, spatial entities are also products of multiple individual identifiable locations.

And yet, even accepting Quine's argument, identifying a river with a fixed set of spatial coordinates through which stages continuously flow will still force us to bathe in two different rivers; it is not only the water that moves, but also the entire terrestrial foundations of what we call rivers. At the moment where the momentary stage **B** is observed, the position of stage **A** would have changed: the soil particles that make up the river bank would not be the same. This would be negligible on a human scale within the two days of Quine's example, yet for the morphological changes of rivers in geodetic times — a scale more appropriate to river logic — the differences between measurement positions might be significant.



Any given measurement of a river stage will migrate position over time.

It is then necessary to rethink the nature of the relationship between **A** and **B** so that it assumes a higher degree of instability like the relationship between **A** and **C**. We can continue to consider the river as a total entity given the sum of the multiple possible momentary stages and the imperceptibility of its material displacement in human time. But in continuing to subdivide the river into stages, it becomes necessary to articulate the difference between the position and geometry of each one.

MAPPING TIME

A recent effort to register the historic evolution of the Río Bravo/ Rio Grande's serpentine paths was undertaken in 2020 by a group of researchers coordinated by the Land Arts of the American West group, an architecture program at Texas Tech University. The resulting "living map" superimposes in time the course of the river as lines of different shades of blue. Carving its channels over thousands of years, the river embeds a geological record that is permanently changing.



Rio meander detail at La Junta de los Río near Ojinaga/Presidio (Courtesy Land Arts of the American West, Texas Tech University)

Using QGIS, a license-free software designed to sunthesize geospatial information, the group captured the shifting river from around 200 historical maps. It is difficult to know, however, the degree to which the various meanders truly correspond to the geometry of the river at different moments, as they are liable to register imprecisions within the charting efforts of the time. As project contributor Patrick O'Shea explains, "What we ended up making is a history of the evolution of mapping as a colonizing technology ... a history of human interaction with the river as a space regulated by instruments." The oldest record of the river they used is taken from a map that color-codes the relative positions of the river near El Paso between 1852 and 1907. As you move deeper into the database, the drawings become more detailed and the density of information starts to coincide with the history of mapping the river as a military effort to identify and secure the border. While a good amount of these maps come from the International Boundary and Water Commission, a binational entity created to administer water management, their records seem to be designed to precise border configurations: "They seek to simplify, codify and fortify a single line," Chris Taylor, the professor in charge of coordinating the project, argues.

So while maps seek to objectively represent space, they inevitably mirror the imaging technology used to make them — codifying the conditions of their own production. O'Shea reminds us of a recent reenactment published by *National Geographic* in 2019, of a well-known series of maps

created by Harold Fisk in 1944 to visualize the historical floodplains of the lower Mississippi River. A cartographer working for the Washington Geological Survey captured the current state of the same river using LiDAR (highly accurate spatialization sensors), resulting in visualizations that were strikingly similar to Fisk's. The geomorphological memory of the river can now be visualized with stunning exactitude from a snapshot made by a laser attached to an aircraft.

Control over spaces increasingly depends on the authority exercised over their descriptions, namely, those maps that regulate and legitimize them. The maps of the meandering Río Bravo/Rio Grande articulate how the river has been variously represented and misrepresented by successive generations of technology, consistently designed to control the application of power over land. One wonders if the reverse could also be possible. In other words, how might the present space-time articulation of the river's conditions affect the configuration of the borderline? Does the history of the river contain its future?

The shape of a river results from the complex relationship between the force of its water and the firmness of its channel. The latter is in constant transformation as water seeps into the subsoil and erodes the outer bank, while vegetation accumulates on the inner bank and makes it stronger. Interactions between water and sediment formations are crucial to forecasting a river's trajectory. The softness of a given surface and the water's velocity are among the determining factors of a river's behavioral patterns. Neck cutoffs, for instance, are an important phenomenon to take into account when considering long-term curvature migration. They are the process by which rivers get rid of excessively deep curves towards more efficient channels. Studying these cuts provides a record of a given river's history and anticipates its future evolution.



The oxbow lakes a river leaves behind might contain information on the future routes it will take.

Imagine the two closest points within the neck of a river's deep curve. Point **A** and point **B** would be physically next to each-other, but far enough following the course of the river along the bend. The geographic distance between **A** and **B** betrays the river's bend marking its potential to cutoff. Given the water's inertia and disturbances in the inner bank, water would erode the terrain to find a shorter path from **A** to **B** and avoid the curve. Give the river time and point **A** and **B** would connect by a new straighter line, leaving behind an abandoned body of water with an oxbow shape.

A river changing course involves so many variables that *any* projection is liable to fall short. Instead of using traditional mapping procedures, a hypothetical model of a river might be better formulated by considering the possibility of its interactions. The incommensurability of a river calls for descriptions based not on the terrain itself, but rather its geometric potentials. This shift away from representation is exemplified by researcher Nick Houde, who writes about the stick charts used for aeneralizing complex sea patterns to be interpreted by trained navigators of the Marshall Islands. By modeling fragile conditions into abstractions that might be usefully transferred in other similar conditions, such traditional methods of "wave piloting" (the subtle perception of wave and swell patterns along with the sighting of atolls and islands) are revealed as systems of accumulated knowledge that become operational in their transferability. House wonders whether "such a shift would entail modeling our understanding of reality as a space of what it could be rather than what it is."



Marshall Islands navigational chart made of thin wooden sticks with islands as shells (Courtesy Penn Museum)

ONE OR MANY RIVERS?

In the essay *Site as Procedure as Interaction*, Anil Bawa-Cavia and Patricia Reed discuss the descriptive responsibility of speculative maps, arguing that they must go beyond merely tracing interrelationships, to the point where they elaborate "genres of relationships." In other words, the idea of what is possible must not only describe the existence of relationships, but also include the ways in which their qualities mutually condition each other.

The authors insist that imagining feasible scenarios depends on two levels of spatial articulation: topological (its structural details) and geometric (its form). The relationship between these spatial levels, they say, can be measured by considering its homotopic logic — a branch of mathematics used to study topological spaces and establish the possibility of identifying continuity between deformations within regions. Two spaces maintain a homotopic relationship as long as it is possible to continuously transform one into the other.



These two paths are homotopic, one can be reshaped into the other.

From these foundations we can differentiate between what is possible and what is realizable, identifying the invariable conditions that bind material laws to transformations. Returning to Quine's differentiation of the stages of a river, it would be wrong to think that **A** and **B** are identical from a perceptual point of view: they are simply related through our empirical experience of the concept "river." Likewise, it would be incorrect to think that the water particles in point **A** and **C** remain the same once the river reaches the sea. Our relationship with rivers has demonstrated that what is most useful to us is to identify them as processes in time and not distinguish between their momentary stages of being.

This tendency to group similar impressions separated in time as wholes, it has been argued, is an erratic form of identification. By contrast, Quine suggests that identifiable objects may be separated not only in time, but also in space. Identity encompasses the possibility of geometric discontinuity. Not only is it possible to identify the same river from different places along its continuous form, but we can sustain a relationship between different objects distributed in space as a single totalizing entity: "The territory of the United States including Alaska is discontinuous, but it is nonetheless a single concrete object," he writes. Different momentary spatial entities can be thought of as parts of or in relation to a larger whole that in turn establishes a relationship between the parts that would otherwise be unperceivable.

But what if we attribute two different identities to the same space-time process? Something different happens when the geometric relationship between the course of the river breaks with the course of the borderline. The concept of border loses formal continuity within the space-time spectrum of the river since one cannot be deformed into the other through a continuous path of transformations. Here, the meaning of the border based on its relationship with the river requires the institutional imposition of artificial articulations to maintain its identity. The border is not derived from the geometric possibility of a consistent line; it is a semantic mandate that divides via public policies reinforced technologically in space.

SOFT BORDERS

Borders between territories take advantage of the presence of rivers to define limits, but the distinction between natural and artificial borders is unsustainable.

The vocabulary of borders reinforces the illusion of rivers as natural limits, despite the fact that these are consistently manipulated based on human needs, either to ensure access to water or to preserve international limits. To return to the example of the map produced by the Land Arts of the American West group, the decisions they made regarding which places to represent were consistent with the amount of data they could find for each region, which is in turn determined by the number of surveys made as a result of engineering and military efforts. Records of the river started to appear when better cartographic information was needed for the development of flow control, water management, and border regulation programs. "The River is asked to perform as a border, exploited in every turn ... In some places it is exploited in really formal hard ways and in other places in more provisional ways," says Taylor. Focusing on six regions to sample the length of the river, the resulting map portrays an ecosystem disciplined over time — from the dispersal of the river into a network of irrigation channels at the Juárez/El Paso border; to Junta de los Ríos, where the meanders were rectified in the 1970s to contain water levels across the border towns of Ojinaga and Presidio; to Presa Amistad, where archaeological sites thousands of years old are buried under water; and to the Matamoros/Brownsville border where the river marks infrastructure limits and farming parcels.

Water levels are directly impacted by political decisions that manage the risk level involved in crossing the border at a given time, while qualities that cause the geometric transformations of the river (water velocity, the accumulation of sediment) are also the result of techno-natural engineering resulting from border policies.

Given their material ambiguity, rivers are not the best way to demarcate a political border as they do not match the fiction of sovereign stability. Rivers move. However, borders are not designed to fully prevent flows of people, rather to increase the danger of crossing between sides. The technical operation of rivers as borders has been used to discourage the movement of people while controlling the circulation of cultural and economic flows. "Perhaps more tellingly," say researchers Ifor Duncan and Stefanos Levidis, "the very flexibility of a river—its interstitial condition between water and sediment—is useful in the production of an 'indeterminate' space that is materially porous, shifting, and thus difficult for trespassers to cross." That same flexibility works as a reason to militarize soft borders, making it essential to regulate movement based on surveillance systems and to apply force. The incessant transformation of the river paradoxically generates the conditions that are used to justify the operational regimes that reinforce, reproduce, and maintain the border as an artificial limit.

U.S. Customs and Border Protection uses ground-based radars, motion sensors, license plate readers, giant X-ray scanners, facial recognition drones, and high-definition infrared video cameras to capture and index information about people who cross their borders. The collection of data shapes a less visible but perhaps truer border. When discussing the division between the U.S. and Mexico, we should think of it not only as a region that extends over 60 miles on either side of the international line, but equally as a political map that, produced under the logic of data transfer, is constantly reconfigured via a thicker understanding of the border as a process. The border is permanently expanding and contracting, being renegotiated and performed dynamically beyond its under-dimensional representation as a line — one that is historically contingent and constantly evolving, in which each act of measurement allows for recalibration by the authority performed over it.

MOVEMENT

From the perspective of movement, according to Thomas Nail, all entities we perceive as being discrete are actually flows of matter involved in recursive patterns of motion. This also applies to borders, being active processes that redirect the flow of people away from themselves. Beyond any totalizing division of sovereign territories, they fragment continuities between natural and social groups. With this in mind, Nail reminds us that borders should not be studied as geographical lines that include or exclude, but as "open vectors" of circulation.

Nail's philosophy of social motion provides a conceptual framework organized under three principles: FLOW, JUNCTION, and CIRCULATION. Flows are indivisible processes that can be analyzed not in terms of units but by their continuous redirections, tendencies, and bifurcations. Flows are, however, dependent on the flexible adaptation of their limits, which are modulated by junctions. While all social dynamics are flows, junctions explain perceived stasis: they are not actually static objects, but rather vectors that redirect flows back into themselves or into other flows, allowing for pattern repetition, sequentially generating what he calls "mobile stability." Circulation connects a series of junctions into complex movement paths, redirecting flows into networks of junctions while also expanding them. Flows are connected by junctions, and junctions act together as circulation, which binds flows together. Nail's system is explicitly dynamic.



Made of their own FLOWS (water) and JUNCTIONS (soil), rivers are turned into JUNCTIONS to redirect migration FLOWS.

On these terms, migration is a FLOW while the river comprises a JUNCTION of water and the sediments that condition the speed and possibility of crossing. To continue Nail's movement theory, there are two versions of junctions — those contained within a coherent CIRCULATION system, and those that mark limits after which flows are unbound or enter into a new SOCIAL CIRCULATION. When rivers are considered as borders and borders as junctions, their potential to redirect or exclude responds to their physical properties, and these are manipulated by humans. The river is a form of circulation structured by its own flows and junctions. Each of the momentary stages through which we identify the river as one thing provide a seemingly static identity point within a larger circulation of discourse. In the logic of language, momentary objects are also junctions and remain under constant revision given the variable forms of conceptual interpretations. Naming any collection of water and land a river starts this loop in motion. If we think that the same river has different names depending where we are standing, we might also consider how words are also situated and transforming as we use them. Recognizing the river as a potentially permeable junction is not only a matter of abstraction; it is also a concrete environmental concern. International laws define the border as the line along the deepest channel in the Río Bravo/Rio Grande. They also explicitly determine that the river-defined border must follow the changing path of the boundary river in response to the gradual deposition of its channel, but not to human intervention beyond explicit binational treaties. But it is hard to deny that the river's multidimensional geometry is a product not only of the alteration of its flows caused by the engineered redirection of water, but also a result of the human impact on water at a planetary scale.



Closing oxbow at Río Bravo/Rio Grande near the Matamoros-Brownsville border

The sharpest bend along the 1,896 miles of the Río Bravo/Rio Grande is two kilometers from the Matamoros-Brownsville border. The curve is so pronounced, its neck barely a few feet from closing, that it has almost become a full loop. It is possible to stand in front of the river on the Mexican side with the territory of the U.S. both in front and behind you. The inner part of the loop on the Mexican side currently contains crops, but if it closes it would be absorbed by a golf club on the U.S. side. And yet given the decreasing water levels in the river in recent years, the possibility of the bend closing is low. The same climatic conditions that displace migrant populations, forcing them to move north, are simultaneously causing the river to dry up, and with it, the excuse to reinforce the border with walls, fences, and expanded surveillance systems. The space-time dimension of the river defies attempts to think about it as a line, yet its high degree of complexity requires a language up to the task of making it legible. We might not yet have proper vocabulary to process the hyper-relationality of planetary-scale phenomena. Rivers and other high-dimensional spaces require forms of relationality beyond our reflex tendency to assert environments as acts of separation. As art historian Sara Garzón elaborates:

Relationality presupposes a post-human mode of being in the world, a mode of equivalence with nature that dissociates it from being an object of man and thus, a representational trope for the future. It insists instead on a radically different form of becoming with both human and non-human beings through relationships of reciprocity.

No matter how expansive the map is, it will always be incomplete. "The fidelity of the portrait won't be accurate enough to track back to the source," says Taylor of his group's Río Bravo/Rio Grande map; "it allows the river to be its own thing on its own terms." Indeed, any portrayal of the river is an impossible task, a compression of both geologic time and human time. "I continue to be pulled by these scales that are seemingly irreconcilable," he adds. On one hand, the scalar magnitude of the river's geology turns any attempt to capture it into a miniscule event; on the other, the urgency of the ecological and humanitarian crisis at the border call for precise positions to generate necessary action.

The blue lines that meander across the group's map are less a declaration than an invocation of the river as a hydrologic system of deeper time.

But maybe, as Taylor recognizes, that idea is already a trap. Perhaps we shouldn't think of it as a system at all, and catalog water as water and land as land. After all, those are not the river's terms. As he rightly puts it: "Dig a hole and you will find water and land together."

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