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ABOUT THE COVER

This month's *CP* cover features an illustrated map of the ZigZag Ranger District of Mt. Hood National Forest by artist Liz Cox. The map showcases the numerous wilderness zones and cherry picks her favorite rivers, lakes, and recreational areas within the District. The colors, whimsy, and detail, are Liz's love language, for representing her favorite spaces. You can find more about Liz and her work here: **www.lccartography.com**.

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LETTER FROM THE EDITOR

After a brief sojourn into the important question of ethics within cartography, handled by our excellent guest editors Nat Case and Aileen Buckley, I am once more taking the editorial reins to welcome you to issue 106 of *Cartographic Perspectives*, our second of 2025. This issue contains three pieces that went through our formal peer-review process, six reviews (of five books), and an intriguing entry in our *Views on Cartographic Education* section entitled "Map Projections Don't Have to be Hard." Across the board, I'm excited to bring all of these writings to you and hope that you find as much joy, interest, and sometimes consternation in them as I have shepherding them through our editorial process.

If there is one theme I see running through this issue, it remains that age old question of "What exactly *is* a map?" What makes a map a map, and not something else? How does one define "mappiness"? While, at times, this may seem akin to enumerating angels dancing on a pinhead, I think the long-standing, sometimes heated debates around this topic that continue to crop up across varied academic disciplines and fields of practice demonstrate that—at its heart—it remains a discussion worth having, one that touches upon both ontological and epistemological issues.

In this issue, we first have Matthew Edney responding to Denil's (issue 104) response to Edney's (issue 98) response to Denil (also issue 98) who was, of course, writing in response to Edney (specifically his 2019 book, *Cartography: The Ideal and Its History*). Edney takes pains to correct what he argues are, at times, elisions and distortions of his own arguments around *what is a map*. Personally, I have found this discussion fascinating and, judging by download metrics on our website, so have many of our readers. However, given the lengthy back-and-forth, I do feel a different format, as well as opening the discussion to more direct input from other members of our community, would help it to move forward. Ultimately, *we don't have to agree* on what makes a map a map (or what is or isn't a map!) and I view that as a strength of our discipline and practice—different folks engage with cartography in different ways in different places and at different times. Perhaps what's next could be a round-table or a special issue on this discussion; I would certainly want both Mark and Matthew involved, but I am very open to hearing from the wider CP reading community as to where they'd like to see this ongoing debate go next.

On the heels of our issue on ethics, Timothy Prestby contributes a wonderful piece on why people do or do not *trust* maps (though he does offer his own definition of maps along the way!). Drawing from media studies and communication psychology, Prestby provides an

overview of existing studies and an analysis of work that remains to be done on this important topic. Our third peer-reviewed article in this issue comes from Léa Denieul-Pinsky, and examines the roles we, as cartographers, might play in *maintaining* maps, through the lens of Léa's experience working with the Kanehsatà:ke Land Defense mapping project. This article contains perhaps my favorite passage in this entire issue: "[m]uch like outdated satellites lingering in the Earth's orbit after their operational lifespan, these online maps have become a part of a growing collection of junk" (28). While this piece focuses on the role of maintenance in indigenous and decolonial mapping efforts, Léa's observations and resulting discussion open a space for all cartographers to reflect on the legacy of their projects. What happens to all the maps we make? This question seems of particular importance as we increasingly rely upon a networked miasma of code libraries and data repositories outside of our direct control to build our increasingly digital products.

On the other side of the spectrum from digital obsolescence, we find the first entry into the *Views on Cartographic Education* section since Daniel Huffman has graciously taken over its editorship. In it, Fritz Kessler offers the outline to and resources for a *hand-drawn* projection exercise entitled "Map Projections *Don't* Have to be Hard." I was, frankly, blown away as—having arrived as a cartography professor long after the advent of digital tools—I had not considered teaching projections through such a manual process. While I'm not sure if the exercise transforms (pun intended) projections into something "easy," I know for certain that I will be using it in my upcoming classes this fall and encourage other readers to do the same (or to simply work through it for their own edification).

Finally, we have six reviews in this issue, spanning five works that run the gamut of cartographic interest. Shriya Malhotra and Aimée C. Quinn provide complementary (and complimentary) reviews of the *Radical Atlas of Ferguson, USA*. Both find it a provocative and necessary reminder of the power of maps and the horrors of racial capitalism. Michael Sparks reviews the new *Teaching Mathematics Using Interactive Mapping*, a book I find of particular interest given my own research at the intersection of the two. While noting the work suffers from a somewhat superficial focus at times (in particular, Michael would like to see more on projections; if only the authors had known they need not be hard), Michael finds it an exemplary attempt to demonstrate to students the "real-world relevance of mathematical concepts" (70).

Ally Shah provides a review of *The Art of Terrestrial Diagrams in Early China* and Lucy Haggard has written one for *The Cognitive Life of Maps*. While disparate topics in some ways, what I found striking was how both engage with the core idea of *what is a map*. Shah details how Wang explores the difference between maps and diagrams and comes to a conclusion with which I'm uncertain many cartographers would agree; meanwhile, Haggard examines how the philosopher, Roberto Casati, defines maps in terms of representational accuracy and cognitive reasoning—again, resulting in a series of distinctions that I think might cause controversy among cartographers. The reviewers find both works well researched, well written, and worth the time to read—and, I'd argue, they help reiterate my point above: that the question of *what is a map* spans time, place, and discipline.

Our final review, by Daniel Cole, is of *A History of The Railroad in 100 Maps* and finds it likely of more interest to railroad aficionados than cartographers per se. Amusingly enough,

both Wang and Casati make exceptions for rail and subway maps as being "not maps" due to their divorce from accurate representation (Wang, in particular, suggests that Vignelli's classic 1972 New York subway map is more akin to the diagrammatic *ditu* than to a map).

I know that no one reads *Cartographic Perspectives* for my editorial introductions, so I will end here before this one grows longer. However, I would like to, first, thank you all for your continued support for and engagement with *Cartographic Perspectives*. It remains an honor to serve as your editor and I do encourage you to reach out with ideas or feedback; and, finally, I would like to assure you that we continue to revise and make improvements to our policies behind the scenes. We will have more on this front shortly. Once more, thank you and keep mapping.

Best,
Jim Thatcher

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PEER-REVIEWED ARTICLE

A Response to Denil (2024)

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Clarity of concepts and an honest respect for ideas and evidence are the hallmarks, in an ideal world, of meaningful and productive intellectual debate. In practice, however, rhetoric becomes heated and standards slip. At times, argumentation can cross into unethical distortion and fabrication. This is, unfortunately, the case with Mark Denil's (2024) response to my critique (Edney 2022) of his essay seeking to define the map/non-map boundary (Denil 2022).

It is difficult to engage with Denil's further ideas when it appears that his argumentation actively seeks to gin up controversy. The purpose of this short essay is therefore to explain the character of that argumentation, as something of a cautionary tale. I do not address every issue; that would be counterproductive. Nor do I seek to reiterate my position in full (see esp. Edney 2024 for a succinct statement). Instead, I offer a few, concise examples of three basic failings that should disqualify any academic work from consideration: ad hominem aspersion; out-of-context quotations; and mischaracterization.

I responded to Denil's initial essay because it significantly misrepresented my arguments in *Cartography: The Ideal and Its History* (Edney 2019) and veered into ad hominem aspersions. For example, Denil (2022, 11) stated that I relied on my personal status to make *ex cathedra* statements, like a bishop pronouncing what is true according to faith and theological reasoning and without reference to matters of external evidence. Denil has now doubled down by stating, without offering any supporting evidence, that I routinely seek to excommunicate anyone I deem heretical: "[Edney] aggressively goes after—**with bell, book, and candle**—anyone that suggests any such commonality exists" [43, added emphasis].[1]

The second problem is that Denil repeatedly contravenes basic academic principles by isolating short phrases from my critique and presenting them in unrelated contexts so that they appear to mean something quite different from how they read in the original. Doing so allows him to accuse me of intolerance and illogicality. For example:

> According to Edney, maps are so bewilderingly diverse that "map studies are properly studies of the glorious multiplicity and variety of ways—processes—by which people construe and communicate spatial complexity" (Edney 2022, 58), and that **anyone who thinks differently is seeking to "limit and control the ability of map readers to interpret maps"** (Edney 2022, 54). [43]

The emphasized portion was taken from this paragraph:

> [Denil's] position is completely in line with **the dominant agenda of modern academic cartographers, who have consistently sought to limit and control the ability of map readers to interpret maps**. This was the aim of postwar psychophysical experimentation, which sought to understand how people see and comprehend color, shape, and size and how to refine map design accordingly (Petchenik 1983, 38; Montello 2002, 285–288; Tyner 2005; McMaster and McMaster 2015, 2, 5). It was also the aim of Jacques Bertin's (1967) semiotic approach to designing information graphics as agglomerations of rigidly monosemic signs (MacEachren 1995, 229; Palsky 2019, 191). Denil concurs with academic cartographers' adamant claims that the intellectual labor of cartography is the preserve of the mapmaker. (Edney 2022, 54)

1. Bold type in quotations signify my emphasis; all italics are original to the quotations. Page references to Denil (2024) are in square brackets.

This passage referenced the well-recognized character of post-war academic cartography in the USA, as seeking to develop design strategies that would constrain people's interpretations so that they understood the mapmaker's intended message and did not construe it in alternate ways that the mapmaker had not intended. It had seemed to me that Denil (2022) remained caught in this same position, even as he recognized the significance of map readers in creating meaning as they read the map in light of their prior knowledge, etc. Plainly, I neither stated nor inferred that "anyone who thinks differently" to me is guilty of seeking to "'limit and control the ability of map readers to interpret maps.'" (How would that work, anyway?)

The third problem is that Denil mischaracterizes my arguments so that he can then deride them. For example, he distorts the "preconception of individuality"—one element in the web of preconceptions that I argue constitutes the ideal of cartography—by presenting it as the supposed "sin" (his term) of acknowledging the agency of the individual in making and using maps. This allows Denil to denigrate my work as ideologically motivated, even tyrannical:

> That Edney singles out "individuality" as one of the many sins of his "Cartographic Ideal" (2019) is not surprising—to acknowledge existence of *any* individual's agency would mean surrendering the hegemony of the spatial discourse, and like any authoritarian system, processualism cannot tolerate such undermining. Thus, my pragmatic foregrounding of individual agency in symbiosis with communal culture draws Edney's ire. [49]

Denil further cites my longer discussion of the preconception of individuality in the book (Edney 2019, 64–73). There, I do *not* deny individual agency in mapping. Rather I criticize the problems caused by *over*-emphasizing the individuality of mapmaking, and especially the racist and sexist attitudes that stem from the presumption that maps directly replicate the cognitive maps of their makers, such that the form of a map indicates directly how its maker thinks about and understands their world.

In his similar distortion of my discussion of the preconception of materiality (Edney 2019, 74–75), Denil commented that it constitutes a "two page Busby Berkeley number" [49]. Although intended as derisive, I actually take this claim to be a compliment: in the 1920s and 1930s Berkeley created intricate, intensely planned choreographies that formed a counterpoint to the musical score and that were designed to reveal complex patterns when viewed from a distance or on film (Robbins 2013). I would very much like my own work to achieve such a high degree of design and effect in elucidating the patterns of mapping.

Denil repeatedly presents spatial discourses as authoritarian structures [49] that limit and "govern" human action [44], as if they were the determinative economic structures posited by dogmatic Marxism. My concept of "spatial discourse" is therefore "hegemonic" [43] and "artificial" [48, 63]. Denil portrays these spatial discourses as rigid and independent, utterly unconnected to each other or to any other discursive formation, each a discrete silo. This would indeed be an "absurdity [that] is pretty darn hard to swallow" [45] were it in fact what I argue. Denil, however, misconstrues my arguments to mean that every spatial discourse is distinct and that every map is unique, so that "no map can be compared to any other" [42]. Furthermore,

> Because, in [Edney's] model, each map is a creature of a wholly autonomous spatial discourse . . . **one simply cannot compare one map to another**: "there are **[just too many]** fundamental differences in just what are considered as 'maps.'" (Edney 2022, 58). [43]

Denil quite improperly inserted the bracketed phrase—"just too many"—without cause. The imputed phrase manifests his ideas, not my own, and completely changes the meaning of the original statement:

> but as one shifts analysis from discourse to discourse, from thread to thread, it becomes apparent that there are fundamental differences in just what are considered as "maps." (Edney 2022, 58)

There is nothing in this passage, or the rest of my critique, to suggest that I think that there "too many" differences to make sense of mapping. Also, I do plainly engage in the comparison of maps with one another (e.g., Edney 2019, 28–31). Denil's allegations and accusations all run counter to my arguments concerning the complexities of mapping processes, of their similarities as well as differences, and of how individuals participate in particular spatial discourses at different moments in their lives because of different personal, political, or public ends. Spatial discourses are not isolated silos that determine action, as

Denil mischaracterizes, but are constitutive, being formed and changed over time by their participants (Edney 2019, 9–49; Edney 2024).

The differences between Denil's and my positions are indeed "not trivial" [42]. For Denil, this apparently means that my position must be the antithesis of his own. He insists that maps all share something, so I must insist that maps have nothing in common with each other. He insists that map making and reading are accomplished by individuals, so I must insist that they are structured and determined activities that leave no room for individuality. (Denil does not seem to appreciate that the two positions he imputes to me are contradictory.) What I actually argue is much more nuanced: there are both differences and commonalities in *mapping* that we can appreciate by considering how mapping processes intersect.

I have specified these few examples to indicate how, throughout his essay, Denil relies not on the intrinsic value and coherence of his own ideas to counter my critique, but on sneers, snide remarks, and straw figures. His mischaracterizations do not meet basic academic standards of clarity and honesty. I look forward to continuing our discussion on a more ethical and intellectually appropriate footing.

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PEER-REVIEWED ARTICLE

Situating Trust in Cartography: Why do People Trust Maps and What does Trust in Maps Mean?

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A longstanding assertion among cartographers is that people place a great deal of trust in maps. Despite this claim and the growing importance of understanding trust in a post-truth society, research on trust in cartography is scarce. It remains unclear why, how, and if maps are inherently trustworthy. Moreover, the existing research on trust in maps fails to define trust, or uses inconsistent definitions that muddy whether trust is actually being studied or not. This paper sets out to situate trust in cartography by examining the arguments as to why people may trust maps more than other kinds of information and by exploring how trust has been defined. I propose five reasons as to why maps may be inherently trustworthy, owing to their authoritative, objective, realistic, ubiquitous, and useful nature. I buttress each of these reasons with psychological theory and I discuss variable-specific characteristics of maps that may affect trust. Additionally, I generate a theoretical definition of trust in maps by extracting key components from existing definitions and conceptualizations. This definition emphasizes that trust in maps revolves around relying on the visual geospatial information interpreted from a map and on believing the map is accurate.

KEYWORDS: trust; cartographic design; persuasion; misinformation; psychology

INTRODUCTION

Mapmaking is a complex process, involving a string of design choices that always result in some sort of simplification and bias. People who have some cartographic education are trained to follow cartographic best practices to minimize the potential for maps to be misleading, but even they can make mistakes and create misleading maps. Moreover, maps enjoy a long history of use as rhetorical devices that push a particular narrative and serve narrow interests (Tyner 1982). Maps are effective propaganda tools because they seem neutral and convey information in an intuitive way. These traits, among others, are believed to make maps especially trustworthy forms of communication. This trustworthiness is potentially dangerous in the modern media landscape as misleading maps are more abundant and can easily become viral if people place high degrees of trust in them, thereby amplifying their negative impact.

Cartographers have made several arguments that maps are inherently trustworthy (Bar-Gal 2003; Boggs 1947; Churchill and Slarsky 2004; Francaviglia 1995), but little empirical evidence exists to back these arguments up. To make these arguments testable and robust, it is necessary to identify specific mechanisms driving the psychological tendency to trust maps. Thus, one of the two major goals of this paper is to tease out specific traits of maps that may prompt people to trust them more.

While *trustworthiness* constitutes a property of something, and is tied up with perceived credibility, *trust* refers to a psychological state of vulnerability where an individual relies on someone/something based on positive expectations of their/its behavior (McKnight and Chervany 2001; Sundar and Venkatesakumar 2013). Considerable work has been dedicated to conceptualizing and studying interpersonal (Ganesan and Hess 1997) and institutional (Cole and Cohn 2016) trust, but it remains unclear if these conceptualizations and definitions extend to the context of maps. Conceptualizations of media *trust* and *credibility* (terms used interchangeably in media studies)

offer stronger parallels to trust in maps, as they are concerned with whether people trust the information that they consume (Fisher 2018). Specifically, *message credibility* describes "an individual's judgment of the veracity of the content of communication" (Appelman and Sundar 2016, 63). I argue that message credibility is suitable to inform the conceptualization of trust in maps, as maps are a type of communication that visualizes spatial content.

While trust has been defined in numerous other disciplines, and some preliminary definitions exist in cartography, these definitions do not tap into what is unique about trust in maps, nor do they carefully consider the fundamental pieces that make up trust in maps. Thus, the second goal of this paper is to explore what is unique about trusting maps and distill the concept into its core characteristics. Explicating trust in maps will resolve these limitations of prior works while working towards a more robust definition. I accomplish the two major goals of this paper—investigating traits of maps that promote trustworthiness and defining trust—by reviewing existing research on trust in maps and connecting such research to theory in (communication) psychology.

Since the outcome of the second goal helps orient a reader to the rest of the paper, I will provide here the definition of trust in maps that I arrived at: *the willingness to rely on the map contents based on the expectation that the representation of geographic phenomena is accurate and unbiased*. I document how I arrived at this definition and argue that trust is unique when maps are the *trustee* (the entity in which trust is placed) in the rest of the paper. Since defining *map* is a whole research paper in itself, I adopt the following definition to scope this paper: an authored spatial representation of reality (Griffin 2021; International Cartographic Association 2003). Such a definition includes thematic maps, reference maps, and satellite maps.

The rest of the paper is organized as follows. First, I synthesize different hypotheses as to why maps may be perceived as an especially trustworthy type of information communication. I attempt to augment these hypotheses by grounding them in psychological theory and identify specific traits of maps that may make people trust them more. In doing so, I make a case for what is unique about trust when the trustee is a map. Second, I survey different conceptualizations and definitions of trust in cartographic literature to tease out its core elements. These core elements are fused together in order to construct a robust definition of trust in maps. Finally, I conclude by summarizing key contributions, disclosing limitations of my work, and charting future work.

TRUSTWORTHY TRAITS OF MAPS

In this section I explore the traits of maps that foster trustworthiness. I begin by introducing multiple theoretical frameworks that can help explain why people may trust maps. I then synthesize the arguments of cartographic scholars as to why people are predisposed to (overly) trust maps. For each of these arguments, I identify theoretical reasons backing them up. Finally, specific characteristics of maps that may affect trust judgments are identified and discussed.

THEORETICAL FRAMEWORKS

The MAIN Model

This work will largely draw on the MAIN model (Sundar 2008) to provide theoretical backing to the claims made by cartographic scholars. The MAIN model posits that media have four major classes of technological affordances (i.e., modality, agency, interactivity, and navigability) that can cue cognitive heuristics that in turn affect credibility assessments. Cognitive heuristics are mental shortcuts that enable people to make quick decisions, which, in the case of the MAIN model, are about credibility judgments (Sundar 2008). A major assumption of the MAIN model is that digital media users predominantly base credibility judgements on peripheral cues that do not require intensive cognitive effort, since the current media consumption environment overloads users with information (Metzger 2007; Sundar 2008). These cues trigger cognitive heuristics that reduce cognitive effort, so users are not cognitively overloaded when browsing media (Lang 2000).

One major class of heuristics, *modality*, derives from visual cues afforded by the form of communication (i.e., text, image, and video). Modality cues and heuristics are of particular relevance to maps, as maps are a hybrid modality that primarily use non-verbal visuals but also use verbal text to convey information. When maps are coupled with

modern technology, they can trigger cognitive heuristics. For instance, a map viewed on an augmented reality headset cues the *being-there* heuristic since the multimedia is immersive and allows a user to feel as if they are in the map. Consequently, users will trust the map more, as it feels authentic and immersive.

Agency affordances will also be investigated in this paper, as maps have a long history of being made by trustworthy institutions, but in the recent past maps have been increasingly made by entities of unknown trustworthiness. Nonprofessionals can more easily make polished-looking maps that may evoke the authority that maps have historically carried. Further, maps are now often disseminated on social media where collaborative assessments of maps can affect their apparent credibility (Robinson 2019). For example, if a map has a high number of likes and positive comments from other users, this will likely cue the *bandwagon heuristic* and make people trust the content more, since it is endorsed by many other users. The idea of agency revolves around the source of communication and whether users feel as if (1) they are the source, (2) others are the source, or (3) the source is a competent expert (Sundar 2008).

While the MAIN model centers on *credibility*, I argue that it is suitable to also apply it in the context of *trust* and maps. The terms trust and credibility represent related but distinct concepts. Credibility is synonymous with believability whereas trust is synonymous with dependability (Fogg and Tseng 1999). Credibility is often defined as an individual's perception of the believability and truthfulness of information, and researchers measure it in terms of attractiveness, expertise, and trustworthiness (Metzger et al. 2003). While credibility can be thought of as an assessment of information, trust is a mental state in which an individual is willing to rely on information with an expectation that reliance will lead to a desirable outcome (Kelton et al. 2008). Trust also has three dimensions: emotional, cognitive, and behavioral (Lewis and Weigert 1985).

Despite the differences between the two concepts, they are closely related to each other, and they are used interchangeably in media studies (Fisher 2018) and information visualization literature (Kong et al. 2019; Elhamdadi et al. 2022). Researchers view credibility as an antecedent to trust and vice versa (Van Dalen 2020). In addition, the two variables demonstrate strong associations with one another (Soh et al. 2009). Provided that, this paper assumes that the MAIN model is appropriate as a theoretical framework to explore trust in maps.

The Heuristic-Systematic Model of Persuasion

In addition to the MAIN model, this paper will draw on the Heuristic-Systematic Processing Model (HSM). According to HSM, individuals can process information systematically and/or heuristically (Eagly and Chaiken 1993). Systematic information processing requires high cognitive effort as individuals scrutinize with great detail the message that is provided to them. On the flip side, heuristic processing involves the assessment of messages based on cognitive heuristics (simple decision rules) formed through lived experiences. Put another way, someone reading a map made by the US Census Bureau via systematic processing will thoughtfully and carefully consider the visualization—from who made it, where they got the data, how legible it is, which colors were used, etc. Someone reading the same map via heuristic processing will make a quick judgment about the map by using a mental shortcut such as "experts are reliable" and trust the map because it was made by the US Census Bureau, a reputable government organization. The MAIN model relates to HSM in that the former focuses on how affordances (traits of maps) can cue cognitive heuristics (mental shortcuts), that tend to be associated with heuristic processing. When someone processes information heuristically, they are generally less critical and are more likely to trust something.

There are three major factors that influence whether people process information heuristically or systematically: motivation, ability, and the modality of information. People tend to default to heuristic processing according to the *least effort principle*, which states that people are cognitive misers who prefer to exert as little effort as possible to arrive at a decision, so they generally have a preference for processing information heuristically (Chen and Chaiken 1999). However, a person's *motivation*, their desire to exert time and energy to process information, influences the type of information processing as well (Eagly and Chaiken 1993). In conditions of low motivation and low ability, people will tend to default to heuristic processing. Conversely, when someone is highly motivated and has the capacity to process information deeply, they will likely process a message systematically. Motivation is often operationalized in terms of *issue involvement*, which is defined as one's interest and investment in a topic (Mittal 1995). Issue involvement has been shown to affect credibility

judgments. When issue involvement (i.e., motivation) is low, more visually oriented modalities (e.g., videos, maps, graphics), may prompt people to process information more heuristically, resulting in more favorable credibility judgements (Sundar et al. 2017). Conversely, when issue involvement is high, visual modalities act like a catalyst and prompt people to process the information more deeply and be more aware of poor information.

The capacity to process information in depth, known as *ability*, can also affect which type of information processing is used. Ability can be affected by prior knowledge as well as characteristics of the medium, such as perceptual bandwidth (the number and type of sensory channels; Chen and Chaiken 1999; Sundar et al. 2015). When users have the potential to understand a message deeply, they will likely process the content of the message (i.e., engage in systematic processing) rather than relying on peripheral cues. Users are also more likely to engage in heuristic processing when dealing with information overload according to the Limited Capacity Model of Mediated Message Processing (LC4MP; Lang 2000). Therefore, when users deal with information overload or have low ability from other factors, they are more likely to have favorable credibility perceptions.

Finally, the type of information processing can be impacted by the modality of the information. Textual modality often requires more cognitive effort than visual modalities as individuals tend to carefully and analytically examine information via systematic processing, thereby making more thoughtful credibility judgments (Eagly and Chaiken 1993). In contrast, visual modalities can be interpreted more easily and appeal to our senses, so they are more likely to be processed quickly (via heuristic processing) and generally perceived positively (Sundar et al. 2021). Multimodal visuals may also lead to cognitive overload since there is extraneous content besides the message that must be processed (Lang 2000). Consequently, multimodal visuals are more likely to be processed heuristically based on LC4MP. Maps are a multimodal type of information that blends text and visuals, so people may tend to process them heuristically. The tendency for multimodal information like maps to be processed heuristically tends to lead to greater trust.

Halo Effect

The halo effect is the tendency for an individual to perceive a single positive trait of something and extend this positive impression to other traits and to their overall impression of something (Cooper 1981). The impression of credibility is a common outcome of the halo effect, as a user perceives a map to have positive qualities (attractiveness, for example), and then transfers that positive assessment to its credibility (Djafarova and Rushworth 2017; Sundar and Venkatesakumar 2013). In other words, perceiving a single positive characteristic about a source, message, or modality of information can lead to an overall positive perception that bolsters perceived credibility.

Mere Exposure Effect

The mere exposure effect posits that people will have greater familiarity with something and consequently more positive perceptions of something if they are repeatedly exposed to it (Janiszewski 1993). One such positive perception is trustworthiness. Lowry et al. (2007) demonstrated that repeated exposure to a website logo boosted perceived credibility and trust.

ARGUMENTS AS TO WHY MAPS ARE TRUSTWORTHY

I introduced each of the theoretical frameworks in the previous section because in this section I will apply these frameworks to explain why maps may be inherently trustworthy. I begin by outlining the arguments that researchers have made as to why people trust maps. Then, I address each argument individually by synthesizing the body of work behind the arguments. I buttress each argument with one or more of the theoretical frameworks discussed above. Specifically, I isolate traits of maps that link to said frameworks.

Five major reasons for why maps are more trustworthy than many other media of information have been proposed by researchers in cartography. Some of these reasons overlap and build on each other. First, maps are perceived as authoritative pieces of information, and individuals/entities that create them are viewed as being authority figures. Second, maps appear to be objective since they tend to be derived from numbers or other empirical data and appear to be complete representations of reality. Building on this, the visual and realistic nature of maps gives the illusion that what someone sees on a map is true. Maps are also ubiquitous, so they may be perceived as familiar and trustworthy. Finally, maps enable readers to see what they otherwise could not see, so their unique utility entices us to place faith in them.

The Authority of Maps

Maps may intrinsically invoke a sense of authority, since most popular Western maps produced in the last century or so have been made by experts at reputable institutions through rigorous means, and the data used to create those maps have been held to high-quality standards. The source of most of these maps has been government agencies, which were perceived as authoritative due to their tight quality control mechanisms, detailed metadata, and access to exclusive mapping technologies and data (Goodchild 2009; Muehlenhaus 2012). Likewise, Flanagin and Metzger (2008) point out that until recently, geographic datasets have been almost exclusively produced and shared by a centralized set of government agencies and other professional entities who adhered to strict data quality standards. These entities were instrumental in providing the public valuable maps that were also held to high standards; otherwise they risked enduring an erosion of trust (Flanagin and Metzger 2008). Therefore, maps were perceived as credible pieces of information since they were created by authoritative organizations.

Mapmakers themselves can also be seen as authorities, since they have unique expertise and purportedly communicate truthfully (Kent 2017). However, in recent years it has become relatively easy for anyone with internet access, sufficient time, and some computer skills to make widely distributed maps. In addition, traditionally "trustworthy" sources now face scrutiny and distrust due to the rise of post-truth politics where truth is less about fact and more about "belief." It remains unclear how these trends have influenced the perceived authority of maps. On the one hand, maps not only exhibit cultural and political authority themselves, but they also can imbue authority to those who leverage them (Shannon and Walker 2020). Shannon and Walker argue that anyone who creates—or even shares—a map may be seen as an authority figure that is also trustworthy. On the other hand, people may not have as great of a propensity to trust maps because of shifts in who makes maps and the zeitgeist around truth.

The MAIN model (Sundar 2008) posits that when the source of information is an expert or authority figure, that information will be perceived as more credible than if the information did not come from an authority. This *authority heuristic* is an agency affordance that may be cued by maps. In the 1900s, spatial information was largely provided by a small number of entities such as government agencies and professional organizations. Flanagin and Metzger (2008, 142) note, "credibility was granted based on the perceived authority of these few entities, which was generally agreed upon within the relevant scientific community and was (dis)proven over time." These sources produced lots of public-facing maps that were held to high-quality standards to maintain trust. Thus, people may exhibit a fallacy about maps in thinking that all maps are created by expert cartographers, and in doing so, placing higher trust in maps because of their historical prestige (Shannon and Walker 2020). Alternatively, when people see a map, they may not be able to imagine themselves as the maker of the map (since it is beyond their skill set) and they imagine the mapmaker as a more skilled, more professional, more *trustworthy* person than they (the reader) are.

Certain design elements of maps can cue people to perceive the map as being made by an expert. Muehlenhaus (2012, 363) found that authoritative-looking maps (e.g., maps that "look scientific, official, and magisterial") were perceived as the most trustworthy compared to three other aesthetic styles. Each aesthetic style that he tested with his participants had multiple variations in their design elements, so it is not possible to tease out the specific variables driving this result. However, the authoritative maps were unique in that they included multiple layers of data, had weak visual hierarchy, included all common map elements such as scale, legend, and data sources, and "typically follow[ed] the academic norms for graphicacy and map design" (Muehlenhaus 2012, 363). Future work needs to investigate to what degree each of these design elements can cue the authority heuristic. The inclusion of some map elements (i.e., legend, north arrow, scale bar) is the most logical cue for the authority heuristic since they are unique features of maps that signal to the reader that a cartographer is competent and an expert. Essentially, there is an expectation that a map has certain elements and if this expectation is violated, people may begin to scrutinize the map(maker) more and trust less.

The limited empirical evidence on trust and maps suggests that the relationship between the authority heuristic and trust may be moderated by characteristics of the source and the beliefs of a user. Skarlatidou, Wardlaw, et al. (2011) identified the source's reputation and reliability as a major component. Indeed, a follow-up experiment revealed that map users without a formal cartographic education primarily rely on peripheral cues, such as the presence/absence of a logo denoting the author's affiliation, to

determine the trustworthiness of a map (Skarlatidou et al. 2013).

For individuals with strong political beliefs, the authority heuristic may be cued only if a map is created by a source that conforms to their ideologies. Peck et al. (2019) asked rural residents of Pennsylvania to rank a set of two maps and eight other visualizations in terms of utility. Rural residents were recruited because they represented an understudied population that generally leans more conservative politically. After the rankings, researchers revealed the sources of the visualizations and asked participants whether they wanted to change their rankings. Just under half of participants changed their rankings and exhibited greater concern for whether sources were reputable. Interestingly, after the reveal, a map by the *New York Times* was ranked higher by more liberal individuals and lower by conservative individuals. Also, a map by *The Economist* was ranked roughly the same regardless of leaning, perhaps since it is perceived as a moderate outlet. Although the rankings were based on usefulness, qualitative responses indicate that trustworthiness was a major factor in the ranking process (Peck et al. 2019). Therefore, these results suggest that the authority heuristic may have led many participants to change their rankings of the maps depending on the perceived credibility of the source, derived largely from political congruence. Future confirmatory experiments should be conducted to validate these findings.

While this section outlines reasons as to why maps may be intrinsically authoritative, empirical evidence suggests that the source of the map is indicative of perceived authority and trust. Maps made by authorities may not be trusted if the "authority" is not reputable or is aligned against the prior beliefs and ideologies of a user. However, the aforementioned studies do not examine the relationship between trust and maps when the source of a map is obscured or hidden behind other layers on social media. These are fairly common characteristics of a typical map consumption environment (Lisnic et al. 2023), so future experiments should be designed in these conditions to maximize the external validity of the research.

The Objectivity of Maps

Maps may be perceived as trustworthy because they exhibit a façade of objectivity. The early years of cartographic research in the mid-1900s were characterized by the reduction of cartography to a perceptual science that focused on how maps served to unveil objective truths about the world (Kent 2018). While this paradigm has since been critiqued and largely abandoned (e.g., MacEachren 1995), many people, especially non-academics, may still view maps as containing objective information. One reason for this is that maps are products of numerical measurements and other seemingly objective data, so they appear truthful (Monmonier 1991). Numbers and statistics are generally perceived as trustworthy, since they are associated with objectivity and the absence of bias (Porter 2020). Therefore, if people view maps as products of quantitative data, this imbues them with an "aura of truth" that inclines people to trust them (Meier 2017). The corresponding psychological mechanism explaining this behavior is the halo effect. Numbers in a map's legend or features labeled with what appear to be hard data may cause the halo effect. Additionally, most maps include elements such as metadata, scale bars, or graticules that make a map seem as if it is a highly quantitative product.

Since I could not find any studies that explore this issue with maps specifically, I will discuss research on visualizations broadly. Over a quarter of the rural Pennsylvania participants in Peck et al.'s (2019) study of perceptions of visualizations elected not to change their rankings of how useful visualizations were after the authors revealed sources, because they believed that the data, and thus the visualizations derived from the data, were objective and trustworthy. The study included maps and other visualizations in the sample. Tal and Wansink (2016) found that including a simple bar chart in a pharmaceutical ad significantly increased the believability of the ad. This finding was attributed to graphs being imbued with a scientific aura that seems objective and credible, as they are made from quantitative data. Likewise, Kong et al. (2018) demonstrated that many users trusted visualizations that had misleading titles because they were blinded by the scientific aura of the visualization that seemed to be an impartial product of statistics. Instead of critically interrogating the title, people developed a positive impression of the data of the visualization, and expanded this impression to the rest of the visualization (including the title) (Kong et al. 2018).

Another trait of maps that lends them their perceived objectivity is their seemingly complete appearance. Tyner (1982) attributes people's (blind) trust in maps to the fact that they do not realize that all maps are incomplete; instead, they see maps as true and complete representations of reality. This is perhaps because, on the surface, maps

rarely draw attention to the many simplifications such as generalization, classification, and aggregation that actually make them paint a limited picture of reality. Even satellite maps that appear to capture a geography in full face limitations such as spatial and temporal resolution (Kent 2017). Again, the halo effect may be at play here with people's positive impression of maps' completeness extending to their overall perception of maps. In turn, this can bolster credibility.

The traits that make maps seem complete all revolve around mapmaking decisions and design choices. The symbolization choices for representing data can make a map seem complete, as data are often represented without any missing pieces, and uncertainty in the data is rarely shown. The seamlessness and certainty of mapped data make maps seem to be complete and credible representations. Finally, the inclusion of borders make maps appear organized, and provide bounds for space (Kelly 2019). Effectively, maps provide familiar context that allows readers to form a coherent representation of reality.

The Realism of Maps

Maps not only appear complete, but they give the illusion that what they portray is reality, even though that is not the case. This illusion works since maps convey "to the mind a vivid, true picture of the distribution of certain phenomena on the earth's surface that could not be obtained in any other manner" (Boggs 1947, 474). These visuals coax us into trusting maps because they generally fit what we would expect reality to look like. Overall, "the visual character of maps reinforces this perception [of objectivity]" as people regard maps as reality and not representations of space (Churchill and Slarsky 2004, 23). Since people can see the data in a realistic manner, people will be predisposed to trust it.

This argument can be attributed to the *realism heuristic,* which posits that "seeing is believing"—in that information that looks realistic will be perceived as more credible since it appears to be reality (Sundar 2008). According to the MAIN model, the realism heuristic is cued by visual modality affordances. In the following few paragraphs, I outline the specific affordances of maps that may cue the realism heuristic.

First, the particular shapes used to represent boundaries, landmarks, and other features on a map will be familiar to many of its readers, and will help them orient themselves to the mapping landscape. Encountering these features can trigger rich associations and memories pertaining to a particular place (Francaviglia 1995). Consequently, people may feel immersed in the map and judge it as more real.

Maps may also cue the realism heuristic if they include satellite imagery. As Dodge and Perkins (2009, 2) note, these high-resolution glimpses at Earth's surface offer "a heightened sense of pictorial realism, a heterogeneity of colorful patterns, and a sense of apparent naturalism." These images are highly realistic and thus may give the impression that they are truthful. Whether they are standalone, or they constitute the background of the map in terms of visual hierarchy, satellite images likely can cue the realism heuristic.

Third, thematic maps, which use different visual variables (e.g., color value, shape, size) to communicate attributes about different geographic features, cue the realism heuristic by superimposing data visualization on top of familiar geographic features. Hence, the data visualized in maps appears inextricable from the geographic features they correspond to (Monmonier 1991). Since people can actually see information being mapped to particular places, they are more likely to believe it as true and credible. In other words, unlike textual descriptions of geography, maps provide a visual confirmation of the information that seems concrete and representative of the real world.

Finally, most maps make use of a bird's-eye view, in that the perspective of the visual is as if the map reader is gazing down at Earth from above (Kelly et al. 2022). As Hillis (1994, 3) explains, "Perspective maps such as bird's-eye views gain power through their seemingly natural representational structuring of reality." The bird's-eye view gives the illusion that the reader is viewing something that is real and true even though the map is highly authored and abstracted. Therefore, the bird's-eye view characteristic of maps may cue the realism heuristic.

The Ubiquity of Maps

People may place (excessive) trust in maps because maps are so ubiquitous. For example, navigation maps are a vital part of many people's daily lives and are increasingly relied on (Laor and Galily 2022). Trapsilawati et al. (2019) demonstrated that users place high levels of trust in two of the most popular wayfinding applications: Waze and Google Maps. Users tended to place more trust in the application that they used more, potentially indicating that ubiquitous use fostered trust. Even though navigational maps are quite different than thematic maps and satellite

images, people may extend their trust in navigational maps to other map types because of their similarities.

Overall, the main psychological mechanism that causes our frequent use of maps to create trust is the *mere exposure effect*. The mere exposure effect posits that people will have greater familiarity with something, and consequently more positive perceptions of it, if they are repeatedly exposed to it (Janiszewski 1993). Since familiarity has been demonstrated to be an antecedent of trust, greater familiarity with maps may lead to heightened trust (Gulati and Sytch 2008). So, the abundance and general reliability of maps as navigational tools leads to a perception of general trustworthiness.

The Utility of Maps

Finally, maps often provide critical information that can only be effectively communicated through their unique spatial representation. Consequently, people are inclined to put faith in (i.e., trust) maps, because they must rely on them to acquire certain information about space and place. Since many of the things that maps depict are not observable or accessible in day-to-day life, maps are intriguing and prompt us to exercise our faith in them (Kent 2017). This argument is echoed by Boggs (1947) and McGranaghan (1999). These authors articulate that it is impossible to fully experience the complexity of the world, so we must place trust in something like maps that can depict aspects of reality that we cannot directly observe. This may be attributed to both the halo effect and the realism heuristic. On the one hand, if people find maps useful to orient themselves to space and place, this positive perception may extend to a perception of trustworthiness (Cooper 1981). On the other hand, in the absence of being able to directly observe the phenomenon a map represents, seeing it on the map makes it seem real and credible (Sundar 2008).

CONCEPT EXPLICATION

Concept explication is the process of surveying the theoretical and operational definitions of a particular concept in the literature to identify commonalities and distinctions among definitions, and to distill the concept into its defining characteristics. Since trust has many different meanings across disciplines and within the discipline of cartography, it is necessary to establish a robust and consistent meaning for the context of maps. This ensures researchers are studying the same thing and using consistent terminology (Appelman and Sundar 2016).

The main component of concept explication is a *meaning analysis* that involves "boiling the idea down to its essential elements" (Chaffee 1991, 26). While meaning analyses are not common in the cartography/GIScience literature, they are frequently performed in communication literature to clarify what constitutes a particular concept, and what does not. I model my approach after prior examples by identifying definitions of trust and categorizing these definitions before paring them down to isolate key aspects of trust (Appelman and Sundar 2016; Kiousis 2002; Molina et al. 2021). These aspects will springboard the development of a robust theoretical definition of trust in the context of maps.

The rest of the section is organized as follows. First, I describe three categories of theoretical definitions. Next, I explore the similarities and differences among these groups of definitions. I also briefly discuss definitions of media trust. Finally, I propose the key components underlying trust in maps and operationalize these components into a robust definition.

CATEGORIES OF THEORETICAL DEFINITIONS

I extracted theoretical definitions of trust/credibility from over twenty articles on cartography, as well as those on non-spatial information visualization. These definitions can be found in Table 1. Only about a third of these papers explicitly defined trust. The rest offered implied definitions or did not provide any semblance of a definition. In this section, I outline the three major groupings of trust definitions, including belief in correctness, dependence on maps, and confidence in information produced or conveyed.

Belief in Correctness

Within cartography, trust is largely defined as someone's belief that a map conveys geographic information that is truthful to reality (Muehlenhaus 2012; Tyner 1982). Trust is also defined as how certain an individual is that the map communicates correct geospatial information (MacEachren et al. 2012; Schiewe and Schweer 2013).

Paper(s)	Definition Type	Concept Captured	Definition	Viz / Map
Mason and Azzam (2019)	Absent	Credibility	-	Viz
Zheng and Ma (2022)	Absent	Credibility	-	Viz and Map
Meier (2017)	Implied	Credibility	Perceived qualities of expertise and trustworthiness	Viz and Map
Li et al. (2018)	Implied	Data Credibility	The perceived accuracy and trustworthiness of data	Viz
Link et al. (2021, 577), Appelman and Sundar (2016, 63)	Defined	Message Credibility	"An individual's judgement of the veracity of the content of communication"	Viz
Xiong et. al (2019)	Absent	Trust	-	Map
Kübler et al. (2020)	Absent	Trust	-	Map
Platte et al. (2016)	Absent	Trust	-	Viz
Guo et al. (2019)	Absent	Trust	-	Viz
Mohanty (2022)	Absent	Trust	-	Viz
Zhao et al. (2023)	Absent	Trust	-	Viz
Peck et al. (2019)	Absent	Trust	-	Viz and Map
McGranaghan (1999, 4)	Defined	Trust	"accepting that the cartographer has tried to communicate accurately and was capable of doing so to some adequate approximation"	Map
Schiewe and Schweer (2013, 60)	Defined	Trust	"The subjective certainty regarding the correctness of a map"	Map
Christen et al. (2021, 2)	Defined	Trust	"the validity of a user's conclusions made from a data display"	Map
Mayr et al. (2019, 25), Padilla et al. (2023, 12)	Defined	Trust	"the user's implicit or explicit tendency to rely on a visualization and to build on the information displayed"	Viz
Boukhelifa et al. (2021, 46)	Defined	Trust	"Trust is the level of confidence and belief that the system is presenting the most relevant information"	Viz
Lin and Thornton (2021, 22)	Defined	Trust	"how much do you believe that the information described by the graph is accurate"	Viz
Burns et al. (2022, 3427)	Defined	Trust	"how much they believe the information communicated by visualizations is accurate"	Viz and Map
Tyner (1982)	Implied	Trust	Accepting the information conveyed in a map as true and complete	Map
Skarlatidou et al. (2011)	Implied	Trust	Willingness to rely on a web GIS tool	Map
Muehlenhaus (2012)	Implied	Trust	Believing what is shown on a map as reality	Map
Skarlatidou et al. (2013)	Implied	Trust	Willingness to depend on a web GIS tool	Map

Table 1. Breakdown of trust/credibility definitions. Continues on next page.

Paper(s)	Definition Type	Concept Captured	Definition	Viz / Map
Gartner (2022)	Implied	Trust	the confidence in or reliance on a map	Map
Joslyn et al. (2013)	Implied	Trust	Willingness to rely on and use information visualized	Viz
Dasgupta, Burrows et al. (2017)	Implied	Trust	the degree of confidence in a visual analytics tool	Viz
Kong et al. (2019)	Implied	Trust	Believing a visualization was unbiased and appropriate	Viz
Dasgupta, Lee et al. (2017, 274)	Present	Trust	"self-calibrated degree of confidence in their analysis outcome that is produced in course of their interactions with any data analysis medium."	Viz
MacEachren et al. (2012, 2498)	Defined	Trustworthiness	"Source dependability or the confidence the user has in the information"	Map
Antifakos et al. (2006)	Absent		-	Viz

Table 1, continued. Breakdown of trust/credibility definitions.

Similar definitions exist in information visualization, with Kong et al. (2019) characterizing trust as an individual's belief that the information that a visualization presents is accurate and appropriate. Accuracy is echoed by Lin and Thorton's (2021, 22) definition of trust: "how much do you believe that the information described by the graph is accurate." Together, these themes conceptualize trust as an individual's belief that the information underlying a map is accurate and/or truthful.

The theoretical definitions of credibility used in visualization research are like those of trust, but they revolve around judgements of trustworthiness instead of the act of trusting. Indeed, Meier (2017) and Li et al. (2018) define credibility in terms of the perceived trustworthiness, accuracy and/or expertise of a visualization. Link et al.'s definition of credibility (2021) focuses on the veracity of the visualization content. Hence, these definitions differ from trust in that they focus on the perceived quality of the visualization in terms of trustworthiness and/or other attributes.

Dependence on Maps

Trust is also defined as the state of someone relying/depending on a map for information or decision making, or their level of willingness to do so. For instance, Gartner (2022) defines trust as the confidence in or reliance on a map. MacEachren et al. (2012) take a slightly different approach by characterizing trustworthiness as the dependence on an information source (i.e., the map and/or mapmaker). This definition hinges on the argument that it is impossible to experience all the world has to offer, so we must place trust in someone (mapmakers) and/or something (maps) to selectively communicate key information (Kohring and Matthes 2007; Usher 2020). As McGranaghan (1999, 4) puts it, "trust is accepting that the cartographer has tried to communicate accurately and was capable of doing so to some adequate approximation." Thus, trust in maps entails relying on the mapmaker and thereby the unique geographic information encoded in maps. Two definitions, by Skarlatidou et al. (2013) and Skarlatidou, Haklay, and Cheng (2011) emphasize the choice of trusting a map; the *willingness* to rely/depend on a web GIS application.

Reliance is not only a key component of trust definitions in cartography research but also in information visualization research. Mayr et al. (2019, 1) define trust as "…the user's implicit or explicit tendency to rely on a visualization and to build on the information displayed." This definition is also employed by Padilla et al. (2023). Featuring reliance/dependence in a trust definition is predicated on conceptualizations of trust in interpersonal relationships. Accordingly, trust relationships involve a trustor who depends/relies on a trustee to act in their best interest (McKnight and Chervany 2001).

Confidence in Information Produced or Conveyed

A final group of definitions revolves around confidence in the tool or system that facilitates analytical reasoning through exploratory information visualizations called *visual analytics*. Dasgupta, Lee et al. define trust as the "…self-calibrated degree of confidence in [the user's] analysis outcome that is produced in course of their interactions with any data analysis medium" (2017, 274). Building on this, Dasgupta, Burrows, et al. (2017) define trust in terms of confidence in a visual analytics tool. Hence, trust is about how confident users are that a visual analytics tool is steering them in the right direction to generate insight. Similarly, Boukhelifa et al. (2021) conceive of trust as the confidence that a visual analytics tool is providing a user with the most useful information.

THEORETICAL DEFINITION COMMONALITIES AND DISTINCTIONS

The definitions relating to beliefs about a map being correct raise an important question: since all maps are simplifications of reality that suffer from distortions (Monmonier 1991), what is a correct map? In other words, what is an accurate, truthful, and/or appropriate map? Maps are objects of power relations, so the correctness of a map is highly individual and subjective (Del Casino and Hanna 2005). Therefore, a definition of trust in maps should account for the subjective nature of an individual's decision as to what is truthful and what is not.

Each of the three groups of definitions include reliance on the map/visualization to varying degrees. Reliance is the greatest for the group that bases trust solely on whether a reader depends on maps. Conversely, when trust is framed in terms of confidence, reliance seems relatively low since confidence is fundamentally a question of likelihood, and thus it embraces uncertainty. Lastly, belief concerns a mental state that is based on accepting something as true. In accepting that a map's information is true, someone must rely on it to a degree. However, reliance is usually dictated by actions which may or may not happen as a result of believing something.

Media Trust

It is valuable to explore definitions of media trust, as media function to selectively communicate information to the public much like maps do (Usher 2020). Hanitzsch et al. (2018, 5) define media trust as "the willingness of the audience to be vulnerable to news content based on the expectation that the media will perform in a satisfactory manner." In other words, trust entails accepting the information that the media provides as true, even though it could be wrong; and in doing so, people open themselves up to the possibility of being misled or misinformed. Kohring and Matthes (2007) define trust as the expectation that news media selectively communicate information that enables an individual to successfully orient themselves to the complexities of modern society. Here, vulnerability is implied since an individual expects news media to provide timely, accurate, and relevant information that enables that individual to make informed decisions and orient to the ever-changing world. A final definition of trust was synthesized by Strömbäck et al. based on several prominent works on trust in media studies: "the relationship between citizens (the trustors) and the news media (the trustees) where citizens, however tacit or habitual, in situations of uncertainty expect that interactions with the news media will lead to gains rather than losses" (2020, 142). Hence, trust involves a favorable expectation, based on past experience, toward news media in communicating accurate and reliable information.

Each of these definitions emphasize that trust entails believing that the information communicated by media has the audience's best interests in mind. Trust is also an inherently risky action but is necessitated by the desire for more knowledge about the world.

KEY COMPONENTS OF TRUST IN MAPS

An essential component of trust in maps is choosing to rely on visualized information, with many definitions noting that trust is a deliberate decision or tendency to depend. Reliance entails vulnerability, which is a key component of institutional and interpersonal trust.

This vulnerability is tempered by another key component—positive expectations—which in the context of maps translates to believing that the map was ethically and accurately made. Many definitions emphasize the accuracy or correctness of a map, while others focus on truth, which is inseparable from ethics, as no map tells a complete truth (Del Casino and Hanna 2005). What constitutes truth and accuracy depends on an individual's worldview as well as the larger sociocultural context in which mapped knowledge is produced and consumed. Further, the truth

an individual arrives at in reading a map derives from their interpretation of it. Maps do not communicate a single message, rather they are imbued with multiple layers of meaning that come to life through a map reader's individual interpretation of information (MacEachren 1995). Hence, trust is not in the information itself but rather how an individual interprets the information from the map.

While many visual modalities exist (e.g., photos, videos), maps are unique in that they function as representations by employing abstract, visual symbols to relay information about geospatial realities. These symbols are shaped by cartographers who transform numerical, verbal, and other data into a visualization that is grounded in space. Maps do not appear contrived, but convey just a single possible representation of reality, depending on the choices of a cartographer and the subsequent interpretation of map readers. Therefore, trust in maps hinges on the visual representation that a cartographer produced.

Each of these core components is reflected in the definition of trust in maps that I offer:

> ***the willingness to rely on the map contents based on the expectation that the representation of geographic phenomena is accurate and unbiased***

This definition is not meant to be final, but rather serve as a starting point for conceptualizing trust in cartography.

CONCLUSION

In this article, I have examined the concept of trust through a cartographic lens. I synthesized the main five arguments of researchers as to why maps may be inherently trustworthy. These arguments revolve around the purported authority, objectivity, realism, ubiquity, and utility of maps. I then expanded upon these arguments by connecting them to relevant theories that may explain why maps may be inherently trustworthy. Most notably, the MAIN model offers explanations as to why maps may be trusted to a greater degree than other types of information due to their unique modality and agency affordances.

Additionally, I conducted a concept explication to explore the meaning of trust in maps. Different theoretical definitions of trust in maps (and visualizations) were compared and grouped to identify the most important elements. I integrated these elements into a single, cohesive definition that embodies trust in maps.

There are several limitations of this work that can be addressed in future work. While I bridged the gap between theory and arguments as to why maps may be trustworthy, it remains unclear if these arguments, and the backing theory, are valid. Many publications I used to synthesize arguments as to why maps are trustworthy are from the mid to late 1900s. Trust in maps may be drastically different today due to our reliance on wayfinding applications, the emergence of post-truth politics, and the digital media consumption environment. Therefore, we need to empirically test whether the unique traits of maps identified in this paper do indeed bolster trust and if it is because of the theorized mediators. For example, do satellite maps foster trust because they look real?

Another limitation is the use of concept explication as it is a challenging and inherently subjective process that arrives at definitions and meanings based on an individual's critical evaluation of the literature. Other researchers should perform concept expectations on trust in maps using a similar body of works and see if the key pieces of trust and the resulting definition remain similar.

The sample of works used in the concept explication present two limitations at tension with one another. On the one hand, inferences drawn from literature outside of cartography (information visualization and media studies) may not be applicable. On the other hand, I did not draw from sociology, anthropology, and other related fields that also have extensive work on trust. A future study should investigate whether conceptualizations and definitions of trust in sociology are useful for cartographers. Another avenue is to assess the suitability of the proposed definition of trust in maps using focus groups or other means.

This paper lays the groundwork for answering the longstanding question of why/if people trust maps more than other media. Determining if maps are trustworthy is crucial to both combatting misinformation spread by maps

and leveraging maps in science communication campaigns. Moreover, isolating the specific characteristics of maps driving this tendency will help enrich theory in psychology alike. Finally, defining trust in the context of cartography will help ensure that researchers are talking about and studying the same concept.

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PEER-REVIEWED ARTICLE

Every Mapping Project Needs a Fire Keeper: Lessons From the Kanehsatà:ke Land Defense Mapping Project

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This paper explores the critical yet often overlooked aspect of maintenance in decolonial and Indigenous mapping projects. Indigenous communities across Canada have developed alliances with university researchers to develop mapping projects that communicate their relationships to land to outsiders. However, without ongoing maintenance and care, maps can deteriorate or be repurposed in ways that can be harmful to Indigenous communities. I introduce the "fire keeper" as a person or group of people tasked with maintenance, care, and responsibility for the life cycle of maps incorporating Indigenous data. Using the Kanehsatà:ke Land Defense mapping project *developed with a Kanehsata'kehró:non Land Defender as a case study, I describe how the role of the fire keeper facilitated the adaptation and evolution of the map in response to the Land Defender's changing objectives. Maintaining the* Kanehsatà:ke Land Defense mapping project *became an exploration of options rather than a rush to deliver an output. Based on a series of four semi-structured interviews that I conducted with (1) a campaigner, (2) a digital media strategist, (3) university students, and (4) a Québécois history enthusiast, the Land Defender was able to make strategic decisions about how the* Kanehsatà:ke Land Defense mapping project *should be deployed and which objectives and audiences, if any, would best support the reclamation of Kanehsata'kehró:non lands while also protecting their geospatial and archival intellectual property. The paper concludes by encouraging mapmakers to dedicate more time, energy, and resources to map maintenance than they currently do.*

KEYWORDS: Indigenous mapping; decolonial mapping; maintenance; Indigenous data sovereignty

INTRODUCTION

The "fire keeper" role was developed by my colleagues and I following a series of online mapping projects conducted in collaboration with government, university, and activist partners from 2017 to 2021 (Shahamati et al. 2022). These projects were launched with different goals but share a common thread. Despite being initiated at the partners' request, with a mapping tool (uMap) chosen based on their predefined criteria (Markovsky 2017), none of these partners have since adopted or used the maps. Much like outdated satellites lingering in Earth's orbit after their operational lifespan, these online maps have become part of a growing collection of junk: web maps that no longer function or that provide inaccurate information due to lack of maintenance. We concluded that as mapmakers, we may not have fully recognized or appreciated the maintenance work needed to sustain our creations or the resources needed for their successful implementation (Shahamati et al. 2022). This concern is common in participatory projects with university collaborators, yet it is frequently overlooked and remains unresolved (Krüger et al. 2021).

In this paper, I will argue that map maintenance is an important aspect of decolonial and Indigenous mapping projects specifically. Scholarship on decolonial and Indigenous mapping has emphasized that working with Indigenous communities on mapping projects is a long-term commitment (Louis and Grossman 2009) in which building and sustaining relationships with communities plays an integral part (Rose-Redwood et al. 2020; Lucchesi 2020). Indigenous partners have different levels of resources at their disposal for mapping projects. While some nations have built very sophisticated mapping infrastructures, others working outside of band councils may not have the

time, capacity, or resources to maintain mapping projects and relegate those tasks to non-Indigenous partners (McGurk and Caquard 2020). This paper addresses the second case. How can we, the non-Indigenous partners committed to Indigenous and decolonial mapping, factor in the time, energy, and resources necessary to ensure the mapping projects developed with Indigenous partners stay relevant and useful?

MAINTENANCE IS PART OF THE MAPPING PROCESS

Maintenance tasks are often perceived as less important or less interesting than design work because they are primarily associated with cleaning and preservation rather than innovation. However, Puig de la Bellacasa (2011), Mattern (2018), and Young (2020) argue that maintenance practices should not be understood as static—keeping things as they are—but rather as dynamic processes that demand flexible reactions to unpredictable situations, actions, and actors. Thinking of maintenance as a process, Young (2020, 362) asks us to "consider the life of an artifact not to be punctuated by separate phases of making and using, but rather as a continuous process of growth." Objects evolve through continuous cycles of maintenance, which lead to the creation of new versions. Therefore "maintenance itself can be understood as a form of making" (Young 2020, 365), and those who maintain are actively contributing to an object's ongoing development.

Kitchin and Dodge (2007) have also taken a processual approach to rethink cartography as a mutable practice, where maps are continuously made and remade in response to changing situations. Literature in post-representational cartography (Kitchin and Dodge 2007; Del Casino and Hanna 2015 ; Caquard 2015; Rossetto 2015) has shifted attention towards the map's context of use and production. This perspective highlights the importance of giving equal consideration to the initial decisions that produce a map and the subsequent choices that adapt it to ever-changing conditions. Maps are "mappings" (Kitchin and Dodge 2007), ongoing constructions that evolve through cycles of maintenance.

Indigenous research paradigms, broadly speaking, are inherently processual and relational (Wilson 2008). Thinking of people and things in relation to each other sets the stage for mapping projects to operate under the assumptions of reciprocity, respect, and responsibility. Lucchesi (2020) emphasizes that maintenance in Indigenous mapping projects is not just a technical task but also a relational one. She advises that approaches to map maintenance should be grounded in the protocols of specific territories and answer to the priorities of Indigenous partners. Non-Indigenous cartographers must work closely with Indigenous communities to develop data storage and use plans that are flexible and responsive to the community's evolving needs (Lucchesi 2020; Rose-Redwood et al. 2020). As communities deal with shifting priorities on the ground, their expectations of the map and relationships with the mapmaker evolve as well.

Building on Indigenous explanations of relational ethics (Absolon 2010; Absolon and Willett 2004; Chilisa 2012; Wilson 2008), and feminist theorizations of care (Fisher and Tronto 1990), data feminists argue that maintaining and repairing systems, including databases, is a form of care (D'Ignazio and Klein 2020). María Puig de la Bellacasa (2011, 90) argues that caring for technology "is an everyday labour of maintenance that is also an ethical obligation: we must take care of things in order to remain responsible for their becomings." However, Krüger and colleagues (2021, 11) emphasize that "valuing care also means paying attention to the potential difference between the intended beneficiaries of a technological artifact and those who maintain it." This insight aligns with Murphy's call to "unsettle care" (2015), highlighting that Indigenous communities often do not engage with university researchers on mapping projects as equals. This imbalance frequently leads to maps that are either unsustainable in the long term, poorly maintained, or too complex for practical use (McGurk and Caquard 2020). Maintenance work should not be seen as a heroic act or a "rescue mission" (Murphy 2015) but as an opportunity to understand, support, and sustain practices that are already happening on the ground in communities (D'Ignazio 2024). As Johnson and colleagues (2015, 842) argue, "the sustainability of the tool should be considered dependent on the sustainability of the collaboration" between university and community partners.

INDIGENOUS DATA SOVEREIGNTY

Meaningfully engaging in care work in activist settings means being responsible not only for the data but also for the people, stories, and relationships that the data

represents (D'Ignazio 2024). Mapping projects that handle sensitive data rely on careful maintenance because neglected maps can be repurposed against their creators (Kitchin et al. 2013). For Indigenous land defenders, maintaining geospatial data is particularly critical to prevent it from being exploited by the government and military, who have historically used mapping as a means to gather geographic information for counterinsurgency tactics (Bryan and Wood 2015). Tuck (2009) and Lucchesi (2019, 2022) have strongly criticized the harmful data practices imposed on Indigenous communities by non-Indigenous organizations including government, law enforcement, social services, and academic researchers. Lucchesi (2022) argues that these organizations often appropriate Indigenous data without consent, manipulate it to serve their own agendas, and create narratives that terrorise Indigenous people into submission.

Grounding mapping projects in an Indigenous Data Sovereignty (IDS) framework ensures that Indigenous communities are in authoritative positions to strategically mobilize their data, rather than relying on external parties to make decisions on their behalf (Schultz and Rainie 2014; Briggs et al. 2020; Lucchesi 2020, 2022; Rose-Redwood et al. 2020). IDS was first advanced as the OCAP principles (*ownership*, *control*, *access*, and *possession*) through the efforts of Canadian First Nations communities (Kukutai and Walter 2015). These principles have since been adapted by other Indigenous nations and incorporated into the **United Nations Declaration on the Rights of Indigenous Peoples** (UNDRIP). Within the IDS framework, the CARE principles ensure that data management (access, use, reuse) aligns with the values of *collective benefit*, *authority to control*, *responsibility*, and *ethics* (Carroll et al. 2020).

The IDS and CARE principles are increasingly recognized by geographers as essential for addressing the unique challenges posed by mapping technologies that incorporate Indigenous knowledge (Briggs et al. 2020; Duckham and Ho 2020; Miner 2022; Reid and Sieber 2022). Concerning maintenance specifically, O'Brien and colleagues (2024) suggest that geospatial data repository practices need to be updated by explicitly incorporating CARE principles. This would ensure that repositories not only preserve Indigenous geospatial data for future generations but also make it accessible to the communities it is intended to benefit, both now and in the future (O'Brien et al. 2024). "The challenge," according to Schultz and Rainie (2014, 1) "for tribes is to convert . . . data into a strategic resource. This means making better use of what they already have and shifting to more proactive and strategic collection of new data." Rodriguez-Lonebear (2016) emphasizes the need to train a skilled "data workforce" or "data warriors" within Indigenous communities to create and manage data to align with community priorities or contribute to building the community's capacity for self-managed mapping. O'Brien and colleagues (2024) have recently developed multistep guidelines which detail the repository activities necessary when working with Indigenous people and the ways they connect to specific CARE principles.

THE ROLE OF THE FIRE KEEPER

Based on the literature cited above and my participation in mapping projects with Indigenous partners, I humbly propose that the fire keeper could be a useful role for cartographers to occupy, one that mobilizes IDS principles in mapping work in ways that Indigenous people have repeatedly asked of us (Kukutai and Taylor 2016 ; Carroll et al. 2019; Lucchesi 2020; Carroll et al. 2021). The idea is not to create a whole new concept, but rather to propose a concrete application of CARE principles (Carroll et al. 2020, O'Brien et al. 2024) centred in IDS (Kukutai and Taylor 2016), maintenance (Mattern 2018), and data feminism (D'Ignazio and Klein 2020).

A fire keeper is a person or group of people tasked with maintenance, care, and responsibility for the life cycle of maps incorporating Indigenous data. Designating someone or a group of people as the fire keeper is important for ensuring that Indigenous rights and interests are upheld in relation to the map and the data repository behind it. It is their responsibility "to ensure the longevity of the data in their care, no matter the circumstances, up to and including dissolution of the repository" (O'Brien 2024, 14). This implies (1) identifying types of uses for the map and outreach opportunities with Indigenous partners that promote their well-being and informed decision-making; (2) safeguarding the data on the map to ensure it remains secure and under Indigenous control; (3) ensuring that the accuracy and quality of the data are not compromised over time; (4) assisting in the development of new maps that align with the evolving objectives of Indigenous partners; and (5) sharing skills so that Indigenous partners are empowered to use the maps. By being accountable to the

people, communities, and land, the fire keeper can contribute to improving the relevance and usefulness of their mapping projects for Indigenous partners (Lucchesi 2020).

I come to this conversation as a geographer of European descent having come to Turtle Island (North America) to study and staying nearly a decade as an uninvited guest. During my time in Tiohtià:ke (Montréal), I have been working with a Kanien'kehá:ka (Mohawk) Land Defender from the community of Kanehsatà:ke (hereafter referred to as "the Land Defender") to make maps. This person is affiliated with the traditional governance structures of the Rotinonhsyonni (Haudenosaunee Confederacy). They are guided by principles outlined in the Kayanla' Kówa (Great Law of Peace) rather than the Band Council. In this paper, the Land Defender will not be directly quoted, the pronouns they/them will be used at their request, and the people working with them will not be named, to protect their anonymity.

In the following sections, I reflect on the first mapping project the Land Defender and I undertook together, the *Kanehsatà:ke Land Defense mapping project*. It is important to underscore that this map is a product of direct and initial solicitation by the Land Defender in 2020. Beyond the usual scope of an academic research project, this map was conceived to be a practical resource. I will use the concept of "fire keeper" to focus on a very specific aspect of this work: our attempt to extend responsibility and care in our mapping partnership beyond the data collection and design phase to the post release phase of the *Kanehsatà:ke Land Defense mapping project*, and what can be gained by harnessing these "moments of maintenance" as productive sites to put Indigenous data in Indigenous hands for Indigenous benefit (Kukutai and Taylor 2016). I do not pretend that our process was flawless. But the Land Defender and I have managed to build a relationship that we are happy with, and we continue to work together to this day.

I will start by describing the *Kanehsatà:ke Land Defense mapping project*, including its original objectives and target audience. Then, I will explain how shifting political circumstances in Kanehsatà:ke required a complete overhaul of these initial objectives and audience. I will explain how the role of the fire keeper emerged as a response to assist the Land Defender when they wished to continue the project but did not have the bandwidth to fight on every front at once. Finally, I will reflect on what being the fire keeper meant in the context of the *Kanehsatà:ke Land Defense mapping project* and what broader insights might be gained on map maintenance and its importance in Indigenous mapping projects specifically.

1. CONTEXT: HOW THE KANEHSATÀ:KE LAND DEFENSE MAPPING PROJECT CAME TO BE

During the fall of 2020, Kanehsata'kehró:non (Indigenous people from Kanehsatà:ke) land defenders faced numerous challenges, including unwanted archaeological digs, ongoing housing development, deforestation by their own community members, and a bold attempt by the surrounding municipality of Oka to seize control of their sacred pine forest. The initial goal was to create a map that could be used in a targeted direct-action campaign in Kanehsatà:ke and Oka to show that the challenges faced by the Kanehsata'kehró:non were not isolated incidents but were systemic, stemming from a long history of colonization that has impacted their lands and lives since the 1700s. The fight against land dispossession predates both the 2020 events and the well-known 1990 siege of Kanehsatà:ke, also called the Oka crisis. Building on Kanehsata'kehró:non oral history and archival evidence (Gabriel-Doxtater and Van den Hende 1995), the map would attribute responsibility for land dispossession to the state and the Roman Catholic Church (specifically the Sulpicians priests), who broke the Two-Dog Wampum treaty and divided up the 540km^2 they were supposed to hold in "trust" for the Kanehsata'kehró:non into 1,830 individual parcels, which were gradually allocated to European settlers over a span of two centuries.

Today, less than 2% of the original land remains for the Kanehsata'kehró:non (Figure 1). The initial objective of the *Kanehsatà:ke Land Defense mapping project* was to map this massive land theft, parcel by parcel, using the government's and church's own archives. The map would be used to liaise with residents of Oka and open them to the perspectives of Kanehsata'kehró:non land defenders. Just because the settlers who arrived in the seventeenth and eighteenth centuries failed to negotiate coexistence with Indigenous people did not mean that such a path couldn't be explored today.

Figure 1. In grey, the 540 km² of land granted by the King of France in 1735 to the Sulpician priests to hold in trust for the Kanehsata'kehró:non. In red, the 2% of that land left to the Kanehsata'kehró:non.

II. MAPPING COLONIAL ARCHIVES TO SEEK JUSTICE IN THE PRESENT

When the Québec Land Registry and the National Archives of Canada started digitizing the Sulpician priests' cadasters, registries, and land patents for reuse, they probably weren't thinking about it through the lens of Indigenous reuse. Information linked to the dispossession of land carries significant insights into histories of displacement, yet it is often stored in state repositories in formats that are not easily accessible to Indigenous communities (Adberg et al. 2022; Shep et al. 2021). The Québec Land Registry, for instance, was primarily designed to locate single patents within it. For researchers or community members, looking for evidence of fraudulent land deals within this system can feel like searching for needles in an archival haystack. The physical separation of community members from documents relevant to them contributes to the erasure of Kanehsata'kehró:non cultural knowledge, a trend the *Kanehsatà:ke Land Defense mapping project* aims to counter.

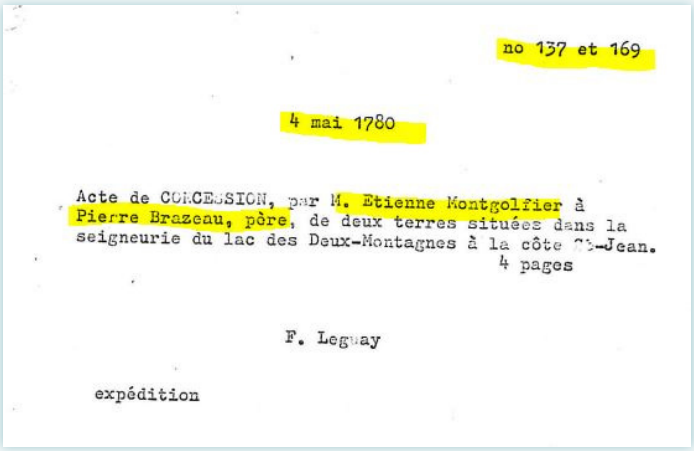
By repatriating ecclesiastical land use records and mapping the archival geodatabase tracking every property transaction between the Sulpician priests and settlers for nearly 200 years (1780 to 1960), the *Kanehsatà:ke Land Defense mapping project* sought to put these records back in Kanehsata'kehró:non hands and draw attention to the incremental expansion of colonial settlement, what land dispossession actually looks like over centuries. While cadastral mapping has been critiqued as a tool of colonial surveillance and control, I flipped the traditional power dynamic by mapping where settlers live and how they acquired

land. As Bryan and Wood (2015) explain, non-Indigenous researchers working on decolonial mapping projects do not have to focus on Indigenous geographies, per se. Instead, they might be more useful exposing the violations in their own institutions instead of waiting for Indigenous peoples or organizations to do the work for them.

An archival geodatabase was created to see who acquired each parcel, when, and under what legal authorities—but also who the land came from and how it came into a settler family's possession. To make the data more accessible, the geodatabase was also converted into a spreadsheet, enabling the Land Defender to use the information without needing GIS software. In addition, a website combining text, animations, and a dynamic map was developed under the supervision of the Land Defender to serve as an interface for outsiders, providing access to the specific parts of the database that the Land Defender chose to share. Although the data repository is private, the Land Defender lacks the resources to host the website on their own server. As a temporary solution, the *Kanehsatà:ke Land Defense mapping project* is currently hosted on a Concordia University server to ensure that it remains a reliable and functional tool for the Kanehsata'kehró:non Land Defender while I still have an institutional connection with the university. Once this arrangement ends, the question of where to host the dataset will need to be addressed, with several possible options that depend on the specific needs of the Land Defender and my own professional situation.

Due to the richness and intricacy of the gathered data, the *Kanehsatà:ke Land Defense mapping project* has three different levels of data curation. To illustrate how this works in practice, we are going to follow the trajectory of a single lot as it surfaces in different visualizations throughout the website.

A tract of land once freely accessible to the Kanehsata'kehró:non was first parcelled on May 4th, 1780. It was attributed the number 137 and granted to Pierre Brazeau by a Sulpician priest called Etienne Montgolfier. Lot 137 sits on the banks of "la petite riviere" in Saint-Benoît, part of the present-day municipality of Mirabel. It first appears as an animation on the website which links the land patent to its specific lot on the cadaster completed in 1798 for the Sulpicians by Louis Guy, then general surveyor (Figure 2).


no 137 et 169

4 mai 1780

Acte de CONCESSION, par M. Etienne Montgolfier à Pierre Brazeau, père, de deux terres situées dans la seigneurie du lac des Deux-Montagnes à la côte St-Jean.
4 pages

F. Leguay

expédition

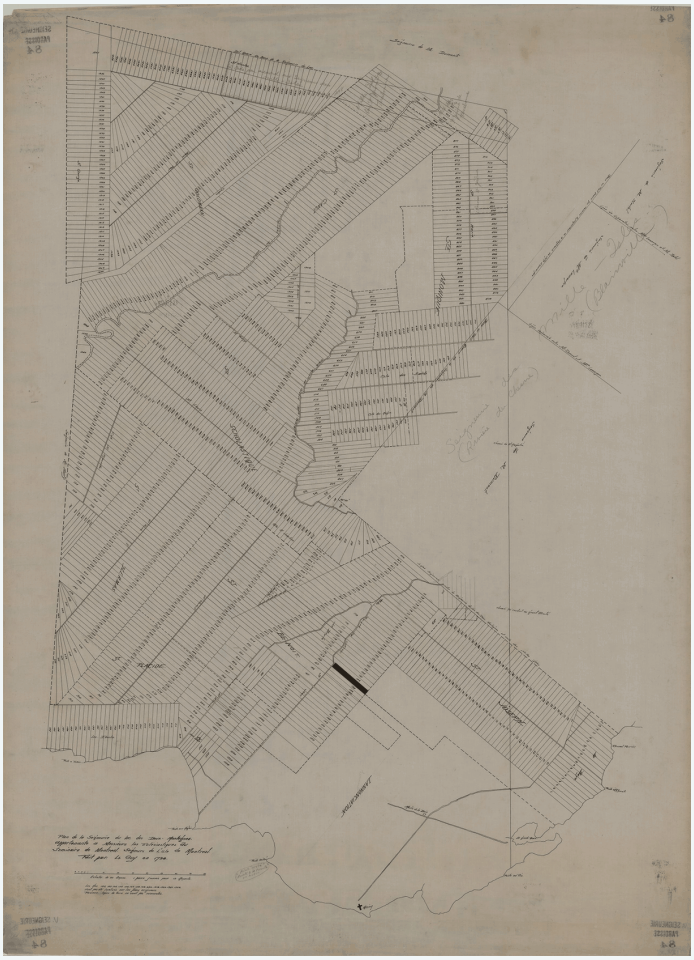


Figure 2. On the website, users can toggle between the Land Patent View (top) and the Cadaster View (bottom).

Pierre Brazeau was amongst the first European settlers to be granted land by the Sulpicians in the Seigneurie du Lac-des-Deux-Montagnes. By tracking the rhythm of dispossession (how fast lots were granted to settlers), we learn that within the first decade of settlement, 21,000 acres of

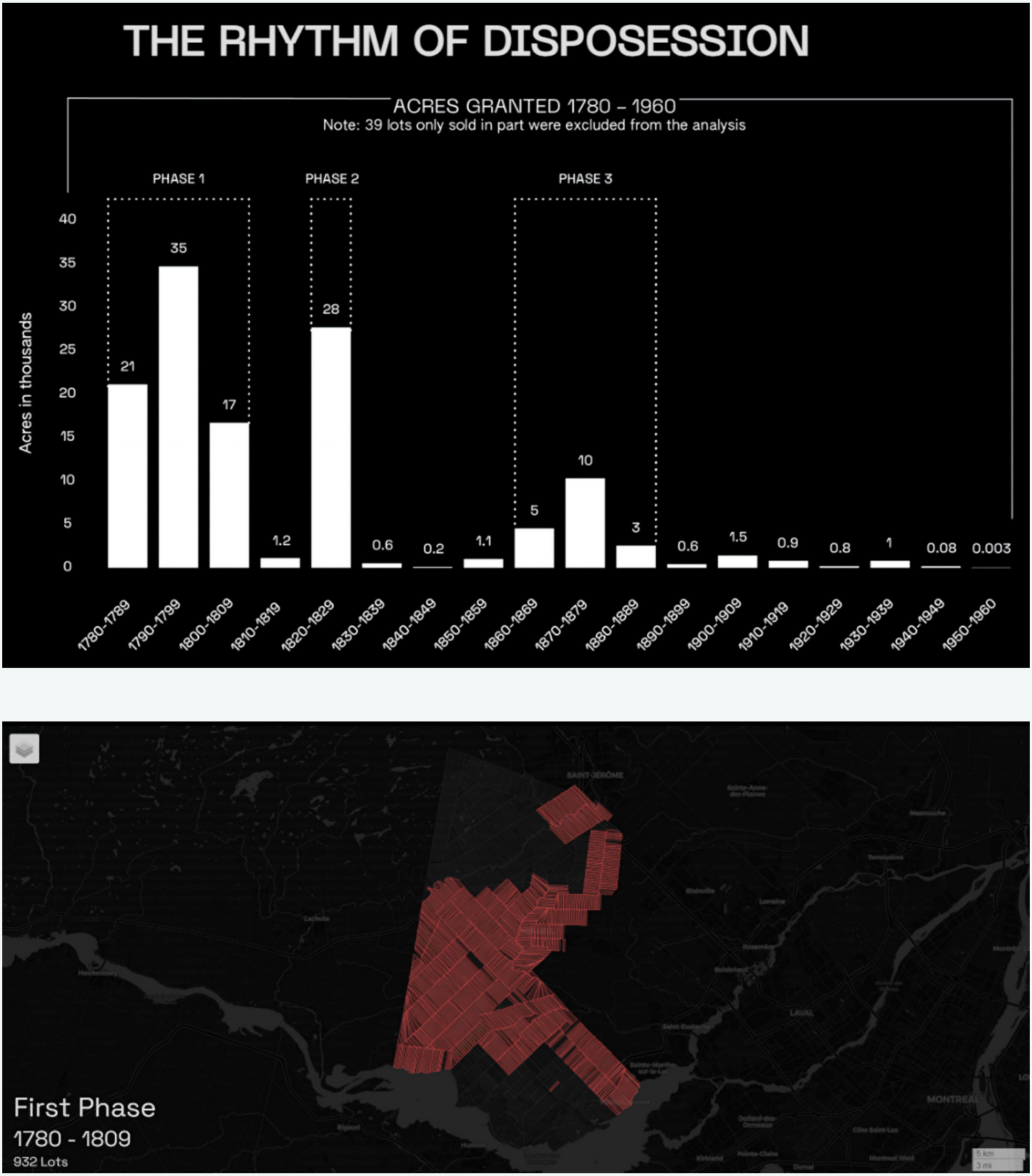


Figure 3. Archival data on the website is communicated in multiple ways. By looking at the graph we can see that Pierre Brazeau was granted land within the first wave of settlement, in which the Sulpicians granted a total of 73,000 acres to settlers in only 30 years. The map allows users to visualize what 73,000 acres look like on the territory.

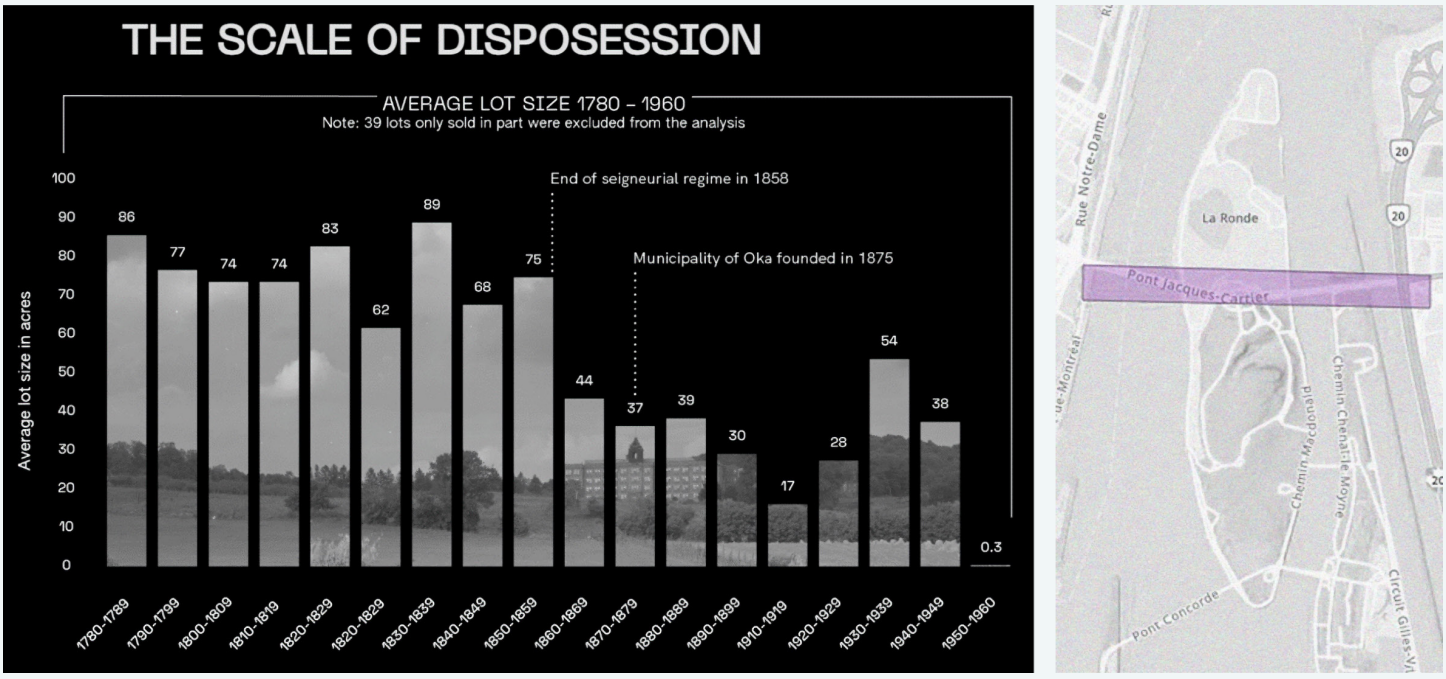


Figure 4. By superimposing lot 137 on the Jacques Cartier bridge in Montréal, we are able to grasp the scope of dispossession; how much land was attributed to just one man like Pierre Brazeau. The graph contextualizes the sizes of the lots within the seigneurial regime. By using both visualizations we can better understand how the Seigneurie rapidly spread across the land.

land were taken from the Kanehsata'kehró:non (Figure 3). Lot 137 was among them. We can also see that land dispossession did not occur uniformly over time. Instead, settlement happened in sharp bursts, each lasting approximately between 10 and 30 years (Denieul-Pinsky 2024). These bursts can be identified across three distinct phases in the historical record (Figure 3).

The website links each phase of settlement to a map that allows users to zoom in to a subset of the data and investigate each of the parcels. Pop ups are linked to each parcel on the map, providing comprehensive details on its acquisition history, and the name of the priest complicit in the process. Tying the information on this map with the information we have of this period, we learn that Pierre Brazeau, like most settlers in the Seigneurie from 1780 to 1809, was a French farmer. Lot 137 is in an area called "la mouvance," the fertile regions around côte St-Joseph, côte de la Baie, and les Éboulis, extending northwards (Dessureault 1979).

Although the size of land parcels granted to settlers varied over time, discernible patterns emerge when considering two distinct eras: pre- and post-seigneurial regime. During the seigneurial regime from 1780 to 1860, settlers cultivated vast expanses of land. Brazeau's lot measures 73.64 acres, typical for lots granted in that period. To provide some context, this lot is approximately the area of 56 American football fields, or roughly the space taken up by the Jacques Cartier bridge in Montréal (Figure 4).

By clicking "view full map" users are prompted to freely explore the archival dataset. By formulating a query to identify the lots owned by Pierre Brazeau across the entire time scale of the dataset, we can see that lot 137 was one of six lots Brazeau had acquired. If I change my query to include Etienne Montgolfier, the Sulpician priest responsible for granting land to Brazeau, the map sheds light on Montgolfier's extensive power and influence in the region throughout his tenure as the superior of the Sulpicians in Montréal (1759–1791). Montgolfier granted 243 lots of Indigenous land over the course of 32 years (Figure 5). Switching to a satellite base map reveals what is on these lots today. The cadastre lines from the eighteenth century still appear, etched onto the land like scars. The lots have not moved or changed shape; they have merely been subdivided.

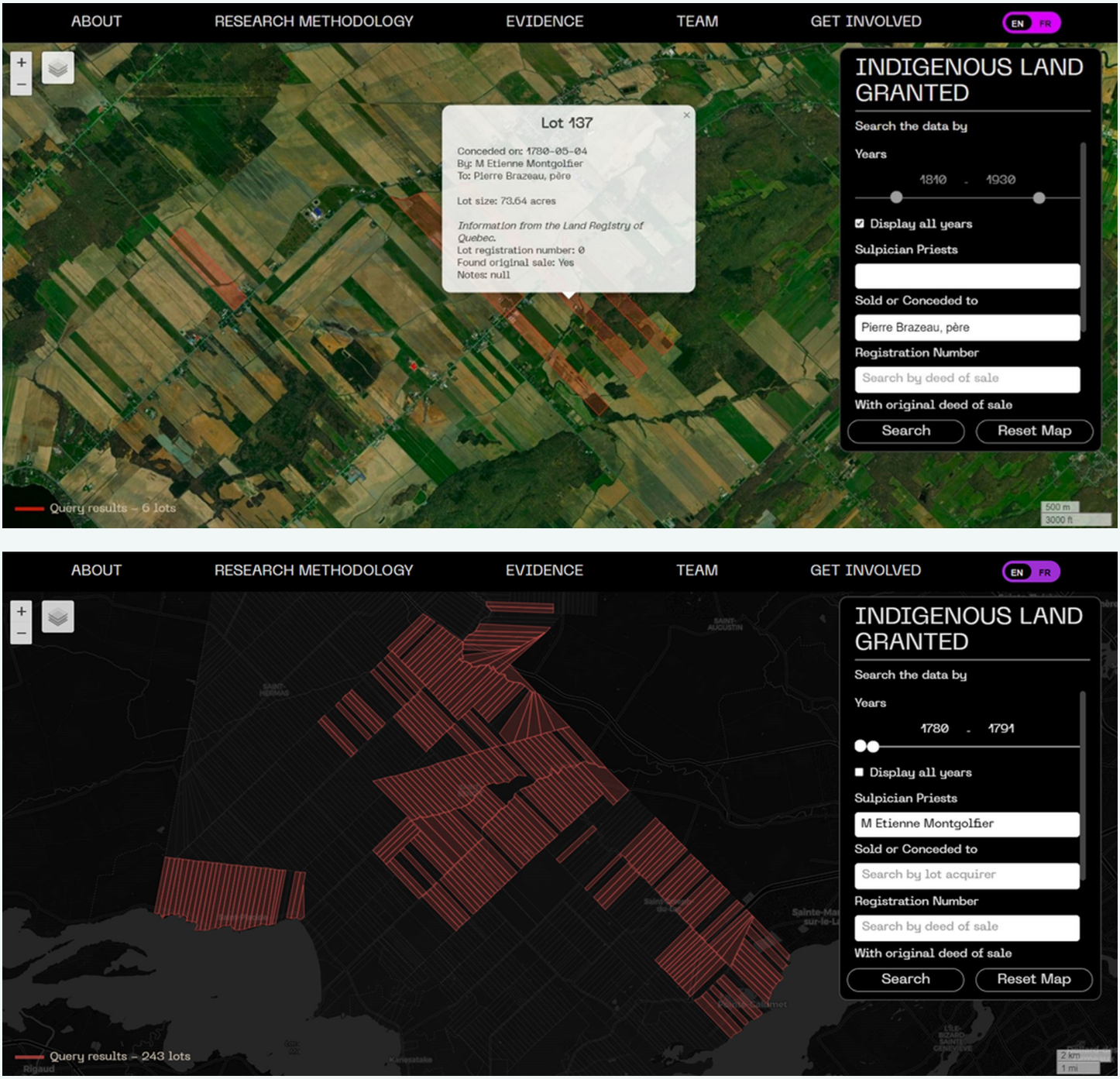


Figure 5. The example above shows the six lots attributed to Pierre Brazeau, lot 137 among them. The example below shows the 243 lots the Sulpician priest Etienne Montgolfier distributed to settlers from 1780 to 1791.

III. CHANGING POLITICAL CONTEXT

As the *Kanehsatà:ke Land Defense mapping project* was about to be published, the political context in Kanehsatà:ke drastically changed. G&R, a recycling facility established by members of Kanehsatà:ke's own community and tied to organized crime, started dumping toxic waste on the community's lands for economic gain (Peloquin 2023; Bergeron 2023; Crête 2024). The impact on the mapping project was twofold.

First, the Land Defender had to reframe the systemic issues plaguing their community in terms of environmental racism instead of land dispossession. They put in place a

coordinated campaign against G&R's dumping, one that required different kinds of mediation and therefore different kinds of maps. When I interviewed[1] a political campaigner working with the Land Defender about the situation, they explained "the media and political conversation around Kanehsatà:ke is currently entirely focused on the issues of safety and contamination. That is, in my view, what is stopping [*the Kanehsatà:ke Land Defense mapping project*] from being a useful tool today." They reflected, "when we started this project and the affiliate research, we didn't fully appreciate how challenging the internal situation in the community was. And it has gotten worse through the pandemic and post-pandemic." This viewpoint aligns with the current media narrative suggesting that the 1990 Oka crisis has disrupted governance and security in Kanehsatà:ke, allowing corruption and organized crime to wield significant, if not complete, influence in the area, to the detriment of the community (Curtis 2022; Richardson 2023; Crête 2024).

Second, the target audience for the *Kanehsatà:ke Land Defense mapping project* could no longer be reached, as the situation put strain on the relationships between Oka and Kanehsatà:ke and residents became very scared to associate themselves with the Land Defender and their work. "The people of Kanehsatà:ke have not felt safe for multiple generations now" wrote an anonymous group of Kanehsata'kehró:non in a letter circulated amongst journalists and politicians in May 2023. They cite dangerous criminal activity "including automatic gunfire in broad daylight," the dumping of the equivalent of 160 swimming pools of toxic waste, and land "being stolen piece by piece by land developers and assimilated Mohawks treating Kanien'kehá:ka Homelands as if they were all for the taking." There is a growing sentiment within the community that greed and lawlessness have taken hold in Kanehsatà:ke, with its core institutions either unwilling or unable to intervene. Relationships between residents of Kanehsatà:ke which were already fragile became even more so, when the Land Defender learned that the Band Council approved the G&R facility without ever consulting their community and kept quiet about all negotiations with the government related to its cleanup. The Land Defender's political campaigner put it bluntly: "right now, given the lawlessness, the government, the media, many people in the community believe that if you gave the land back, it would go to the gangsters."

They further added that "just because we have a tool doesn't mean that we can undo 300 years of history." According to the political campaigner, for the *Kanehsatà:ke Land Defense mapping project* to be effective, there had to be an opening to start a conversation about land rights, creating a setting where the map could meaningfully address broader issues like land dispossession. "In this case, you can think of public relations like making a contribution to an existing conversation," they said. At the moment, the map's utility remains hindered by the absence of bandwidth by land defenders to fight on every front at once. They are focused on fighting lawlessness, environmental pollution, and more internally managing the widespread fear within the region.

To carry on the *Kanehsatà:ke Land Defense mapping project* into the future, the Land Defender allowed me to identify and engage with other relevant audiences, assess our options, and report back, in order to explore how the mapping project might remain relevant and useful to them. This maintenance task was exploratory, with the goal of imagining how a database compiling cadasters and land patents could play a role in supporting Kanehsata'kehró:non sovereignty and governance. Although the Land Defender had the ultimate authority over the mobilization and direction of the map, it was my responsibility to anticipate how the *Kanehsatà:ke Land Defense mapping project* could evolve to align with the Land Defender's aspirations and objectives. These objectives were neither predefined nor the product of my own assumptions, but rather emerged in informal discussions with the Land Defender, their political campaigner, and their media strategist. "You've described this as the map maker. You're not just responsible for making the artifact, but also for giving it life. So now do that," said the political campaigner.

IV. MOBILIZING THE MAP ON SOCIAL MEDIA

The first objective we set with the Land Defender was to prepare the *Kanehsatà:ke Land Defense mapping project* for a possible launch on social media, targeting "traditional allies" who are typically mobilized by threats to Indigenous land rights. I knew that simply launching the map without a well-crafted communication

1. Semi-structured interview conducted on February 9th, 2024. The political campaigner will remain anonymous to protect the Land Defender's anonymity.

strategy could result in it not reaching this audience. To address this, I sought an interview[2] with the Land Defender's media strategist. Given their expertise in activist communications, especially in helping activists build their capacities in the digital space, I believed their insights would be useful for effectively mobilizing the *Kanehsatà:ke Land Defense mapping project* on social media to draw attention to and coalesce citizen engagement around the issue of Kanehsata'kehró:non land rights.

The *Kanehsatà:ke Land Defense mapping project* could help support Kanehsata'kehró:non struggles for justice, the media strategist assured me: "You're definitely touching on something that is part of activist decolonial education here and also awareness raising and maybe pushing people to act on these issues." However, from an activist communication perspective, the current format of the *Kanehsatà:ke Land Defense mapping project* needed to drastically change.

First, I was advised by the strategist to simplify the map, make it visually striking, and let it draw people in: "Most people watching have no idea who the Sulpician priests are anymore. It's just one level of information that is unnecessary for a top line." The *Kanehsatà:ke Land Defense mapping project* had to be diluted into a very digestible, visual hook—a shareable piece that entices users to go and look at the deeper layers of research. The challenge, in the words of the media strategist, is "present[ing] the data visually in a couple of different ways that would be simplified and evocative without necessarily seeing all the layers of information which can be overwhelming to activists."

Figure 6. One version of the shrinking map of Palestine, juxtaposed with the new version of my own map. *Shrinking Palestine, Expanding Israel* by **Visualizing Palestine**.

To visualize land dispossession in the *Kanehsatà:ke Land Defense mapping project*, I had originally opted for a visualization emphasizing the increase of colonial settlement rather than the decrease of the Kanehsata'kehró:non land base. The rationale behind that decision was (1) to mirror connections that others have drawn between

2. Semi-structured interview conducted on December 20th, 2023. The media strategist will remain anonymous to protect the Land Defender's anonymity.

settler colonialism and phenomena like bacterial infections (Veracini 2014) or gentrification (Ellis-Young 2022); and (2) to avoid representing Kanehsata'kehró:non lands with solid boundaries (Thom 2009). Basing the map on this shrinking polygon could mislead audiences into believing that Kanehsata'kehró:non lands were confined to that area.

However, the media strategist's experience made me see another perspective: "the whole seigneury system and all that, that's for people like journalists, teachers, that have the time and appetite to go deeper . . . most people just share the takeaway like, say, a shrinking map and they will never go and look at the deeper levels of info." The decision to create another map, focusing on the decrease of the Kanehsata'kehró:non land base rather than an increase in colonial settlement, was guided by a strategic intention to capture the attention of a broader ally network.

We also discussed integrating the map in the contemporary social media information-scape. Recognizing the competitive nature of social media attention, the media strategist suggested rendering the data in the *Kanehsatà:ke Land Defense mapping project* in formats that draw parallels with other well-known concerns in the news. They pointed out that "some of the most powerful content I've seen go around us, specifically from Indigenous folks in Canada is talking about the parallels between Palestine and their experience." A map emphasizing the shrinking Kanehsata'kehró:non land base would be more likely taken up in current global discussions and alliances if it is designed to be in dialog with other maps, in this case maps of Palestinian land dispossession from 1947 to present. The objective was to facilitate the *Kanehsatà:ke Land Defense mapping project*'s accessibility, encouraging people to share and interact with it. "The key to help sharing," the media strategist explained, "is to give people something easy for them to post." To achieve this, I converted the online map to a static image which could be easily shared, and simplified the visual representation to include only two colors representing settler lands and Indigenous lands, mimicking a very popular shrinking map of Palestine (Figure 6).

The media strategist felt that this would in theory be helpful, but also suggested that, in addition to a simplified map that tells the story in seconds, the *Kanehsatà:ke Land Defense mapping project* should probably also exist on a website as a repository of all the data and information for the media. "The map, as a resource for media is definitely important . . . it's a place where journalists can go and see that the research was done," they concluded.

The last important thing to think about, according to the media strategist, was how to expand the project's impact through replication. Although the *Kanehsatà:ke Land Defense mapping project* website has pages to guide viewers on how to map the contents of its archives using georeferencing and spatial analysis tools, "we don't expect people to go and self-educate on a site with a lot of information." Teachers are an interesting audience that could facilitate the replication of this research, the strategist reflected, and recommended targeting influential teachers who align ideologically with the cause and leveraging these individuals as conduits for disseminating the *Kanehsatà:ke Land Defense mapping project* among their extensive networks of like-minded colleagues across the country. There would be "just one step more of packaging" to turn this easy-to-absorb teaser image into some kind of teaching aid and hopefully inspire others to replicate this in their communities. "This would be an amazing interactive learning tool for us to assign to a class to have a look through" said the media strategist. Fortunately, it just so happened that I had presented the map during a guest lecture in a course on digital mapping at Concordia University.

V. MOBILIZING THE MAP AS A PEDAGOGICAL TOOL

This is how the *Kanehsatà:ke Land Defense mapping project* found its way to a new audience among undergraduate students enrolled in a course entitled "Geomedia and the Geoweb." In the course, students experiment with different steps in the mapping process from data collection to map publication. Through two focus groups,[3] I aimed to determine whether the project could inspire students both to replicate its methodology and to understand and support the concerns of the Land Defender already doing the work of fighting land dispossession on the ground.

The conversation around the *Kanehsatà:ke Land Defense mapping project* was semi-structured. Following a presentation of the project, each student was given a set of

3. Focus groups lasted one hour each and were conducted on November 13th, 2023.

reflection questions, which varied from those that asked for general "gut reactions" to the website as a whole to ones that invited more specific comments on optimizing the map and its presentation (design, user experience, etc.). I asked them things like: "What idea(s) or feature(s) of the map/website do you like? What idea(s) or feature(s) of the map/website do not appeal to you? What else, if anything, do you think someone seeing this website might find confusing and want to know more from the people who developed this idea to help them understand it better?" These questions were first answered individually before being collectively discussed as a group. The group discussion was an opportunity for me to address the students' comments and feedback, and to guide our collective reflection to explore and clarify any points of tension that emerged. The focus groups were made up of 27 and 19 students, respectively. Though this is by no means a representative sample of the general population, these discussions yielded some valid points which are interesting to relate here.

Some were already familiar with the historical context, expressing sentiments such as "I feel informed but not surprised, considering my knowledge of the past," or "I knew about dispossession but didn't know to what extent." On the other hand, those less acquainted with the subject matter found the experience eye-opening, with observations like "I was surprised to learn how the land promised was just given away so easily," and "I learned about more atrocities from the Catholic Church, ones which haven't been broadcasted to the public." The diverse range of responses underscored the *Kanehsatà:ke Land Defense mapping project's* effectiveness both in reinforcing existing knowledge and introducing new perspectives. Students unanimously agreed that the visual representation was impactful. Comments like, "seeing the land fractured into so many parcels was daunting," "I was surprised to see the amount of lots that were sold," and "I learned about how large these lots were," reveal that the map was able to effectively convey the rhythm, scope, and scale of dispossession to some of the students. The design and technical aspects of the map were also well received: "I'm impressed by the detail and presentation of the research. It reminds me of a variety of *New York Times* geospatial investigative articles as well as some forensic architecture investigations and presentations," said one student.

The discussion then turned to the *Kanehsatà:ke Land Defense mapping project*'s shortcomings. Though the students felt they had learned something about land dispossession through a quantitative analysis of the data, they felt—according to one student—that "emotionally, it didn't hit super hard because of the lack of human accounts." "Numbers on their own can be desensitizing," one said. To their point, land patents are by nature reductionistic and bureaucratic. Land registries do not invite people to reflect on the stories behind each land transaction. In the *Kanehsatà:ke Land Defense mapping project*, I had repurposed the cadasters and the land records to advocate for Indigenous land rights but ended up reproducing the reductionism, and erasure that was built into those records. How do you bring the land in the center of the map when all we have is numbers? The risk of working with land patent records is reinforcing capitalist valuations of land even as you seek to counter them. This has also been a criticism of the *Land Grab Universities* project tracking the wealth transferred to universities across the United States through the dispossession of Indigenous land (McCoy et al. 2021).

"The fact is you will never get the full explanation," I explained, "because we purposefully designed the map to align with the research objectives set by the Land Defender." A quantitative analysis is a deliberate act to show what happened without betraying the full content of Kanehsata'kehró:non dispossession experiences. In a context where Indigenous people are invasively and insensitively over researched (Tuck and Yang 2014), the map in a very real sense works like a barrier; it is designed to be a closed door. By steering the research up the power ladder and focusing on those who caused the harm (the Church and the State), the Land Defender asserted control, both over how the impact of land dispossession was measured, and how it was framed.

Moreover, a quantitative analysis isn't in and of itself antithetical to Indigenous methodologies (Schultz and Rainie 2014; Walter and Suina 2019). Rather, the detrimental impacts of quantitative analysis stem from the fact that historically "quantitative researchers engaged in virtually no collaboration with Indigenous people with respect to the categories used to organize the information they proposed to collect, the specific questions asked, the communities from which the information was drawn, and the eventual interpretations derived from their efforts" (Andersen and Kukutai 2016, 59). In our case, valuable information was gleaned through a quantitative surface analysis. It produced a "counter-cadaster" which the Kanehsata'kehró:non can deploy to benefit their community. The tension

between the desire of the Kanehsata'kehró:non Land Defender to keep the research focused on the perpetrators (the Sulpician priests), and the students' craving for more human, intimate accounts hints at the challenges of working with Indigenous research frameworks in Western academic institutions. It begs the question of whether it is possible to infuse a more human aspect to a map of Indigenous land dispossession without it becoming "a spectacle of individual pain for settler consumption" (Garneau 2016, 34).

It is also noteworthy that the two objectives explored so far—the use of the map on social media and its role as a pedagogical tool—have led to distinct potential pathways for the *Kanehsatà:ke Land Defense mapping project*. To engage an ally network, the media strategist advised simplifying and repackaging the map to encourage widespread sharing and replication. In contrast, students felt that the map could be complexified to provide more multi-layered perspectives, potentially by being presented alongside art, music, or documentary film.

VI. MOBILIZING THE MAP WITH QUÉBÉCOIS HISTORICAL ASSOCIATIONS

During the data collection phase of the *Kanehsatà:ke Land Defense mapping project*, I had worked to identify data types that could be valuable to the Land Defender—in this case ecclesiastical cadasters and land patent records. In the maintenance phase of the mapping project, I needed to anticipate interactions with communities outside the project's original scope and consider whether to adapt our archival geospatial repository to accommodate these new communities. There came a moment when the Land Defender asked me to investigate a prominent land developer who acquired a significant amount of land following the Oka crisis. The objective was to expand the *Kanehsatà:ke Land Defense mapping project* to trace all transactions involving the land developer's properties, going beyond the initial land theft in the seventeenth century to understand the full sequence of transactions that led to their current holdings (also known as the chain of titles). To tailor the *Kanehsatà:ke Land Defense mapping project* to fit this objective, I needed to place the map in strategic locations to reach people compiling notarial documents or conducting genealogical research in order to encourage them to share their data.

To achieve this, I interviewed[4] Patrick Charbonneau, a friend I had made while collecting land patents in the initial phases of the *Kanehsatà:ke Land Defense mapping project*. I first discovered Mr. Charbonneau through his blog, where he provided valuable insights into navigating the Sulpicians' archives. Our ensuing discussions led me to the "Patrimoine Laurentides" association, a collective of genealogy and local history enthusiasts dedicated to compiling data on old properties, including land patents. Since then, Mr. Charbonneau and I have regularly kept in touch, sharing resources, exchanging strategies, and talking about life in general. Research on Indigenous-settler alliances highlights the potential of enlisting these "non-traditional" partners (Grossman 2017; Wanvik and Caine 2017; Hillis et al. 2020). Reflecting on this, I considered Mr. Charbonneau's advice particularly relevant for exploring how the *Kanehsatà:ke Land Defense mapping project* might engage Québécois history enthusiasts who would not normally be receptive to Indigenous land rights, either because they are opponents or because they are not too concerned by these kinds of issues. For the purposes of clarity, I have translated his comments from French to English.

"Québécois historical associations might have the data you are looking for," Mr. Charbonneau told me, "but reaching them requires many trade-offs and you have to consider whether it's worth it." He started by saying "a big challenge, in my opinion, is that your target audience, the people who are most interested in doing this kind of research, are the ones who are least able to learn the tools needed to do it." Hobby genealogists are typically retirees whose skills and comfort using digital tools are likely limited (Tsai et al. 2015). This limitation, Charbonneau noted, isn't necessarily educational. He cited his parents, who were among the first university graduates with degrees in computer science, yet now scramble to incorporate new technologies in their daily lives. This perspective diverged significantly from what I had previously heard from the Land Defender's media strategist. When I asked whether they believed the map should also exist in a tangible form, the strategist had shrugged and answered, "every oldster has Facebook now." Anderson and Perrin (2017)

4. Semi-structured interview conducted on February 8th, 2024.

have noted that while more seniors in America are using cellphones and accessing the internet, adopting and navigating these technologies is still challenging for them. As I am writing this, the mapping tool is quite simple to navigate in the sense that it was designed as an interface users can browse through to perform simple predefined requests. It is a static resource, like consulting a book in a library—certainly no problem there. But if the objective is to make it sustainable, maintain it, and potentially expand it, then for Mr. Charbonneau, that's a whole different story: "Yes, today, you can simply go in, connect, look up a name, click on it, and view some data. That's easy. But that does not really reflect the dynamic potential of your project . . .. For that, other people need to be able to use it and develop it."

The fact that the *Kanehsatà:ke Land Defense mapping project* was not built with the idea that anyone could add entries is the biggest obstacle to the sustainability and expansion of the map, according to Mr. Charbonneau. Evolving the *Kanehsatà:ke Land Defense mapping project* towards collaborative or crowdsourced versions would require a specific infrastructure with a login or submission system and a review and validation process (Shahamati et al. 2022). Moreover, streamlining the archival data collection process poses another set of questions. As Mr. Charbonneau put it, "How do you do it so that it's minimal effort for you? Because you don't want to type all that out by hand. At the same time, you don't want to import tons of unreliable data. How do you validate it?". And even if the *Kanehsatà:ke Land Defense mapping project* became open to contributions, the fact of the matter is that this map is about territorial dispossession. Would anyone living on the territory, seeing their great-great-grandfather's name in the records, be motivated to link themselves with that part of history? Similar efforts underway by African American communities to retrace relatives in the slave trade (Gates 2014) or asking for the return of land that was historically taken in government seizures (Burch 2023) have not benefited from much involvement by those of European descent. As Mr. Charbonneau says, "it's not the slavers' families who are trying to understand what happened."

Expanding the national narrative to include other historical experiences and alternative visions of the past has been highly debated within the historical community in Québec and Canada (Moisan et al. 2020). There is also an emotional risk that the research might be discredited by more conservative historians, for whom research on land dispossession within contemporary land claims is acceptable, but who view it as moralistic and militant to frame this research within the context of the story of Oka, Mirabel, St-Jérôme and how people came to live there. To be sure, certain aspects of the *Kanehsatà:ke Land Defense mapping project* disrupt powerful Québécois nationalist frameworks, exposing the settler colonial "logics of elimination" at their core (Wolfe 2006). These aspects often don't fit well into established historical interpretations and are sometimes seen by historians of the area as inappropriate in a "neutral" and "objective" research context.

While I could find more funding to create a collaborative mapping infrastructure that would enable genealogists to contribute new archival information, Mr. Charbonneau suggested an alternative approach: "A government organization such as the National Library and Archives of Québec (BAnQ), while not wealthy, might have more resources to dedicate to the longevity of the project." However, for the Land Defender, this partnership was not viable because the BAnQ would likely make the *Kanehsatà:ke Land Defense mapping project* archival geodatabase open source. This had been the case for Christian Dessureault, a Québécois history professor, who in the years following his PhD thesis had partnered with the BAnQ to digitize and host a database containing thousands of notarial inventories in the Montréal region from 1791 to 1840.

In this scenario, a partnership with the BAnQ would make accessible archives of great civic value, given the Sulpicians' role as seigneurs of the island of Montréal for 200 years. At the moment, the accessibility of these records is limited, with the Sulpician priests acting as gatekeepers. Open geospatial data could create opportunities for new research collaborations with a national historical institution, leading to more involvement from the historical community and more data collected for the *Kanehsatà:ke Land Defense mapping project,* which was the Land Defender's need at the time. However, partnering with the BAnQ would also jeopardize the Land Defender's control over how the data is stored, shared, and reused. Even though the *Kanehsatà:ke Land Defense mapping project*'s database is sourced from archival records that are already in the public domain, both the Land Defender and I view our database as containing Indigenous data (Russell 2005; Rose-Redwood et al. 2020). Therefore, the Land Defender believed it was important to restrict the mobilization and translation of the *Kanehsatà:ke Land Defense mapping project's* data to the public and to establish access and control

mechanisms to prevent any repurposing of cadasters and land patents that do not explicitly address Kanehsata'kehró:non land rights.

Although no research partnerships materialized with the BAnQ or Québécois historical associations, I used this outreach opportunity to compile a list of potential partners and archival databases in their possession that might be of interest. If the Land Defender decides to expand the *Kanehsatà:ke Land Defense mapping project* into a collaborative effort, we will need to establish procedures for working with others who may wish to access or contribute notarial documents in the future. This includes outlining the actions we will take if agreements and commitments are not honored (O'Brien et al. 2024). In this case, the fire keeper might also be considered as the gate keeper (i.e., the person someone should contact if they want to use or add some data).

CONCLUSION: BEING THE FIRE KEEPER FOR THE *KANEHSATÀ:KE LAND DEFENSE MAPPING PROJECT*

In this paper, I have aimed to demonstrate how the role of a fire keeper can serve as a valuable perspective for examining the concrete actions involved in the ongoing maintenance of a mapping project conducted from within academia, with an Indigenous land defender. This lens is particularly relevant to understanding how map maintenance tasks align with Indigenous Data Sovereignty (IDS) principles and feminist approaches to care.

Maintenance is often seen as boring or routine, and sometimes it can be. However, in my experience, it was a dynamic process that introduced new people and perspectives into my mapping practice. To remain respectful and responsive to the complex and sometimes opaque social dynamics in Kanehsatà:ke after the G&R crisis, I sought new engagement opportunities outside the community. Through ongoing conversations with the Land Defender, I identified new target audiences and assessed how they could contribute to achieving the Land Defender's objectives. This included interviewing the Land Defender's political campaigner and media strategist—each of whom possessed deep contextual knowledge—but also engaging with non-traditional allies, like university students and a Québécois history enthusiast, who, despite their lack of initial context, could assist in replicating and expanding the *Kanehsatà:ke Land Defense mapping project*.

Like Mattern (2018) and Young (2020), I think of maintenance as making, not merely preserving things. Maintenance is a creative act which leads to new artifacts. It requires flexibility and adaptability in how we think about and address issues, rather than sticking to rigid or predefined solutions. I was struck by the diverse and sometimes radically opposed directions proposed for the map. While the information on the *Kanehsatà:ke Land Defense mapping project* needed to be smoothed out and simplified for social media, the opposite appeared to be true in the classroom. University students found the quantitative approach to land dispossession off-putting and asked to hear more human, multilayered perspectives. To encourage public participation and replication, the online map could be re-designed, both to cater to tech savvy teachers and/or retired history enthusiasts. While the Land Defender chose not to follow through with some connections, like those with Québec historical associations, it is important to acknowledge that these same groups provided crucial support early on by sharing copies of archival materials that the Sulpician priests had refused us access to (Denieul-Pinsky 2024).

Maintaining geodatabases and mapping tools is an ethic of care (Lucchesi 2022). In collaborative mapping projects, maintenance involves actively monitoring the evolving dynamics of situations, collaborators, and communities, and making sure that the project's communication, vision, presentation, content, and direction adapt accordingly (Graziani and Shi 2020). Without this ongoing care, mapping projects risk becoming outdated, misaligned, or worse: harmful to the communities they are supposed to serve. As the fire keeper for the *Kanehsatà:ke Land Defense mapping project*, my primary responsibility was maintaining a strong, trusting relationship with the Land Defender. Regular presence and engagement outside the formal mapping context were essential for building trust and understanding the Land Defender's evolving needs and vision.

Regrettably, the time invested in building trusting relationships and aligning goals is rarely funded (Krüger et al. 2021). It is important to change maintenance standards,

O'Brien and colleagues argue: "foundations, agencies, universities, and other institutions that fund the creation and maintenance of repositories must appropriately support the transformation of repositories to implement CARE" (2024, 21). This is particularly relevant for mapping projects with Indigenous communities, where commitments often extend beyond "traditional" academic timelines (Lucchesi 2020) and potentially beyond "the working life of an individual researcher" (O'Brien et al. 2024, 2). In this case, activities like phone calls, attending protests, and informal meetings over breakfast or lunch, though essential to maintaining the *Kanehsatà:ke Land Defense mapping project*, were not accounted for in my initial research proposal. These relational maintenance tasks required time and resources, which needed to be allocated at the beginning of the project, not retroactively at the end (Krüger et al. 2021; Shahamati et al. 2022). Although the Land Defender, the political campaigner, and I carefully planned the release of the *Kanehsatà:ke Land Defense mapping project* with clear objectives and a good sense of who our target would be, these preparations couldn't help us overcome the obstacles and challenges we faced when the political and media context in Kanehsatà:ke shifted to focus on illegal dump sites and organized crime.

So, what if researchers spent less time making maps, and more time investing in the relationships that shape them? Taking on the role of the fire keeper for the *Kanehsatà:ke Land Defense mapping project* became an exploration of options rather than a rush to deliver an output. By "pressing pause," the Land Defender and I intentionally "slow[ed] down and ma[de] time and space for reflexivity in our workflows, our collaborations, and our mappings" (Kelly and Bosse 2022, 400). We made sure not to publish hastily but rather "to cocreate information from a place of rest and in relation with all things that affect the work we put forward" (O'Connor et al. 2023, 63). Emphasizing process over product, the maintenance work led to valuable insights for the Land Defender and for me, the mapmaker.

For the Land Defender, having a fire keeper on their team was crucial for maintaining control over the future direction of the *Kanehsatà:ke Land Defense mapping project*. The fire keeper helped anticipate what would be needed for the map to be mobilized in specific spaces—whether on social media, in classrooms, or within Québécois historical associations—for specific purposes, such as informing, contesting, liaising, or expanding impact. Through interviews conducted by the fire keeper with potential target audiences, the Land Defender was able to make strategic decisions about how the *Kanehsatà:ke Land Defense mapping project* should be deployed and which objectives and audiences, if any, would best support the reclamation of Kanehsata'kehró:non lands while also protecting their geospatial and archival intellectual property.

As the fire keeper, working with the Land Defender allowed me to reflect on my approach to mapping colonial archival records and the values embedded in these visualizations. I observed how the map could either reinforce or challenge colonial legacies. While the Land Defender had the final say in decision making, I understood that they should not have the burden of doing all the work themselves just by virtue of their experience. Throughout the mapping project, I learned which were my responsibilities and which were the Land Defender's.

A crucial aspect of my role was assessing the benefits and trade-offs of each map evolution. I had to first consider: was the archival data still secure and under Indigenous control? I realized that my initial impulse to digitize historical documentation on Indigenous land dispossession was more complex than anticipated. Simply making archives accessible online through interactive maps does not guarantee their relevance or usefulness. There is a delicate balance between sharing historical facts and respecting the Land Defender's conditions. Access should be safe and respectful, and compromise neither ownership nor control (Kukutai and Taylor 2016). Moreover, research shows that open geospatial data portals are often underutilized globally (Quarati et al. 2021), and organizations may invest in open data more for appearances than for genuine value creation (Temiz et al. 2022).

Secondly, I had to consider: does the proposed map evolution affect the accuracy or quality of the data? Using the map as a teaching tool could help educators address topics related to colonization and inspire students to undertake similar projects. However, I learned that a detailed user guide would be essential to ensure that the list of names, dates, and locations collected are repurposed into designs that respectfully convey their significance to an audience perhaps unfamiliar with viewing these records through the lens of Indigenous land dispossession.

As I have argued throughout this paper, it is the fire keeper's responsibility to maintain the map and the geodatabase in their care. The end of a funding cycle does not have to mean the end of the relationship. Instead, it could be an opportunity to plan for the archiving of the database or the potential transfer of the fire keeper role to another Indigenous or non-Indigenous person designated or approved by the Land Defender. Although I can stay on as the fire keeper and provide maintenance work for free due to my existing resources and privilege, I recognize that this approach is not a universal solution for the broader issue of maintaining tools for activists. I share my experience here in order to connect with others facing similar challenges and offer insights that may be relevant to their situations. Echoing Graziani and Shi (2020), Leal et al. (2021) and D'Ignazio (2024), this experience has left me with many questions about the role of academics and technology in supporting activist efforts. My experience with the *Kanehsatà:ke Land Defense mapping project* has shown me that the long-term maintenance of maps may hinge less on technical evolutions and more on cultivating stable and trustworthy relationships. My hope is that the fire keeper concept will be taken up by other cartographers and community workers both as a helpful role in projects that use mapping as a tool for advocacy and as an entry point to reflect on the possibilities and challenges of building and sustaining mapping tools for Indigenous communities from within academia.

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Map Projections *Don't* Have to be Hard

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INTRODUCTION

Discussing the years following the end of World War II, Raisz (1948) suggested in his *General Cartography* that this war had brought a new awareness of global problems and ushered in a new interest in cartography. He argued that this world-wide perspective also required greater attention be paid to the importance of map projections. While World War II concluded 80 years ago, global problems persist today, and an awareness of map projections is still relevant. However, despite Raisz's call for attention, public understanding of projections has not necessarily advanced since then.

Arguably, this lack of advancement is because, as Kessler and Battersby (2024) lament, map projections are hard—for many. Some of the reasons are that projections are inexorably tied to mathematics, their formulas contain mystifying parameters, distortion across the mapped area is misunderstood, and mapping software generally treats projections like black boxes (e.g., "project on the fly"). Coupled with these ideas is the acknowledgement that the projection literature is equally daunting to those not well versed in mathematics or the jargon associated with the field.

By extension, teaching projections is also hard. I have spent more than twenty-five years doing so, experimenting with approaches to improve student comprehension of projections in general and more specifically the projection process. Based on my experience, a fundamental point of student confusion rests in the difficulty of grasping how the projection process works, as well as how the choice of parameters controls the arrangement of the graticule and, ultimately, the distribution of distortion across the mapped area. To address this confusion, I developed an assignment that immersed students in the geometric construction of projections, instructing them in how to draw the graticule arrangements shown in Figure 1 for the (A) central cylindrical, (B) perspective conic, and (C) gnomonic projections. This assignment provided students with first-hand experience of using simple drawing tools (i.e., paper, pencil, ruler, protractor, and compass) to visualize the

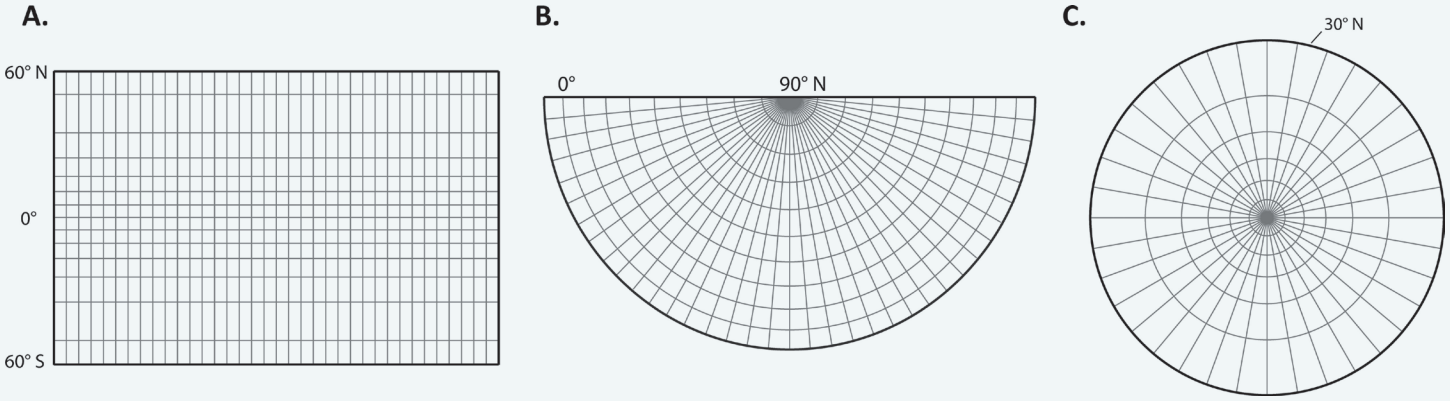

Figure 1. The graticule arrangement for the (A) central cylindrical, (B) perspective conic, and (C) gnomonic projections that will be geometrically constructed. The graticule spacing is 10°. The projections are not shown at the same scale.

projection process of transforming the round Earth onto a flat sheet of paper.

By following this assignment, students will accomplish three objectives that will help increase their comprehension of projections. First, students will explore the role that manual geometric construction methods play in plotting lines and curves representing meridians and parallels on projections. Second, students will visualize how simple geometrical relationships influence the graticule's appearance and final map scale. Third, students will connect projection parameters (e.g., the choice of a standard parallel) with how those parameters control the projection process. Once completed, students will recognize that projections *don't* have to be hard. In fact, this assignment will foster a new understanding of how elementary and fun projections can be.

ELEMENTS OF THE GEOMETRIC CONSTRUCTION PROCESS

Historically, projections were classified as either perspective or non-perspective (Deetz and Adams 1944). Snyder (1981) states that perspective projections "usually involve the geometric projection of points on the earth's surface onto a plane with all lines of projection passing through a common intermediate point . . . the perspective map simulates the earth as viewed from any point in space or from within the earth" (149). Non-perspective projections cannot be described as such. The process of manually plotting a perspective projection is often referred to as "geometric construction." Table 1 lists several well-known projections that are perspective.

The perspective projection process involves three elements: a reference globe, a projection plane, and a point of projection. The reference globe is a conceptually reduced version of Earth set to a size that will produce a map at the final desired map scale. In Figure 2, the reference globe is shown along the bottom of the figure with the poles at the top and bottom. The projection plane (the horizontal line) is tangent to the reference globe and will receive the tracings of the parallels and meridians. Depending on the desired graticule arrangement, this plane could also be secant to and passing through the reference globe. The point of projection can be thought of as the viewing point from which Earth's lines of latitude and longitude are projected. The point of projection can be positioned at various locations with respect to the reference globe (at a finite or infinite distance from the projection plane). In Figure 2, the point of projection is (A) at the center of, (B) on the opposite side of, and (C) at infinite distance from the reference globe. Based on the relationship between these three elements, the arrangement of the graticule can be controlled. For example, in Figure 2, the point of projection creates unique spacings of lines of latitude, producing the gnomonic, stereographic, and orthographic projections.

Azimuthal
General vertical perspective Gnomonic Stereographic Orthographic *Other Variations:* Lowry (1825) Fischer (1850) James (1857)
Conic
Perspective conic *Other Variations:* Braun (1867) Lidman (1876)
Cylindrical
Central cylindrical *Other Variations:* Gall "stereographic" (1885) Lambert cylindrical equal area (1772)

Table 1. Common perspective projections.

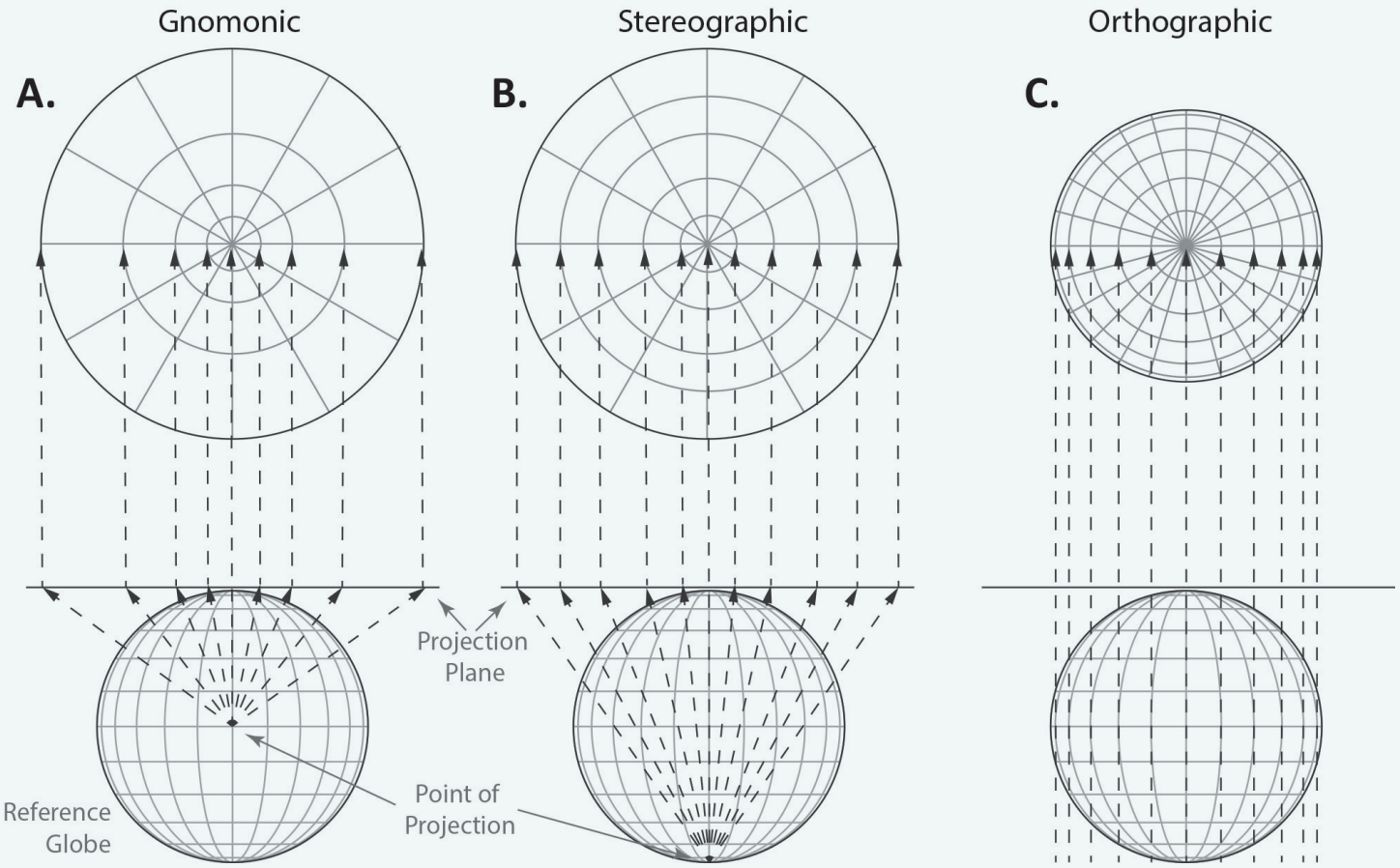

Figure 2. A comparison between different points of projection and the resulting arrangement of the graticule for the (A) gnomonic, (B) stereographic, and (C) orthographic projections. Adapted from Figure 8.3, in *Thematic Cartography and Geographic Visualization*, 4th edition. Slocum et al. 2023, CRC Press.

THE GEOMETRIC CONSTRUCTION PROCESS

This assignment geometrically constructs three projections (perspective cylindrical, perspective conic, and gnomonic) through the basic process described above, in which lines are drawn directly from a reference globe to a projection plane (a tangent 2D surface) forming the lines representing parallels and meridians (Figure 1). The perspective cylindrical will be centered along the equator, the perspective conic will be centered along 40° north latitude, and the gnomonic will be centered on a pole. To prepare for the construction process, the next section describes the scaling of the reference globe according to the final map scale.

SCALING THE REFERENCE GLOBE

The following three steps are needed to set the reference globe's size. First, we will start with the perspective cylindrical projection to determine the desired length of the line representing the equator. Second, based on the length of that line, we compute the representative fraction for the final map scale. Third, we calculate the size of the reference globe. Having determined the size of the reference globe for this projection, that same size will be used for the perspective conic and gnomonic projections so that their graticule arrangements can be visually compared according to the same map scale.

Step 1: Determine the Length of the Equator

The length of the equator can be set to any value that is commensurate with the dimensions of the sheet of paper that will receive the graticule. Here, we will assume an 11″×17″ sheet. From a mathematical standpoint, realize that drawing the equator at a specific length for the cylindrical projection sets the overall map scale. However, from a construction standpoint, the length of the line drawn to represent the equator will necessarily control the number

of lines of latitude north and south of the equator that will appear (a longer equator line results in fewer lines of latitude fitting on the paper). I recommend setting the equator's length at 36 cm (≈14") which will allow parallels up to and including 60° north and south of the equator to be plotted.

Step 2: Determine the Final Map Scale

Equation 1 shows a simple mathematical relationship that can be used to solve for the final map scale, expressed as a representative fraction (*RF*). The *RF* is a ratio between a distance measured on the map (the *map distance)*, and the equivalent measurement on Earth's surface (the *earth distance*).

$$RF = \frac{map\ distance}{earth\ distance} \quad (1)$$

The 36 cm line representing the equator is the *map distance*. I previously established this 36 cm line to control the number of lines of latitude appearing above and below the equator. However, one can also set the length of line representing the equator to a predetermined overall map scale or RF. The corresponding *earth distance* is derived from Earth's mean equatorial circumference, which is 40,075,017 meters.[1] To simplify the calculation by using like units (cm), next we convert the circumference to 4,007,501,700 cm. Substituting these values into Equation 1 yields Equation 2, and an *RF* of 0.000000008983153277. Then, we take the reciprocal of the value, expressing it conventionally as 1:111,319,490 (Equation 3).

$$0.00000000898315277 = \frac{36\ cm}{4{,}007{,}501{,}700\ cm} \quad (2)$$

$$RF = 1{:}111{,}319{,}490 = (0.00000000898315277)^{-1} \quad (3)$$

Step 3: Calculate the Size of the Reference Globe

Having determined the *RF* (1: 1:111,319,490), we calculate the size of the reference globe. Earth has a mean radius of 6,378.137 km.[2] Substituting this value into Equation 1 as *earth distance* along with the *RF*, we get Equation 4. After converting the radius to its centimeter equivalent, we can rearrange to solve for the *map distance* (the radius of the reference globe) in Equation 5. The result in Equation 6 shows that a reference globe will have a radius of 5.73 cm. At this scale, all three projections will individually fit onto separate 11"×17" sheets of paper.

$$0.00000000898315277 = \frac{map\ distance}{6{,}378.137\ km} \quad (4)$$

$$map\ distance = 0.00000000898315277 \times 637{,}813{,}700\ cm \quad (5)$$

$$map\ distance = 5.73\ cm \quad (6)$$

THE CENTRAL CYLINDRICAL PROJECTION

The central cylindrical perspective projection has no known origin, but the transverse aspect was developed by Welch in the first half of the 1800s (Snyder 1993). Geometrically, the construction projects the globe onto a tangent or secant plane from a point of projection on the equatorial plane opposite a given meridian. In our case, we will geometrically construct the projection so that the point of projection is placed at the center of the reference globe and the projection plane will be tangent to the equator. Four steps are needed to complete this construction, illustrated in Figures 3A–3D. During the construction process, measure as accurately as possible and draw your lines with care.

1. Draw the reference globe so that its perimeter falls along one of the 8.5"×11" paper's short edges. Mark off 10° divisions along the reference globe's perimeter (Figure 3A). This interval creates a 10° parallel spacing in the final projection. Other parallel spacings can be created by marking the globe at a different interval. Position the reference globe so that its 0° mark (the tangent point) touches the left edge of the 11"×17" sheet of paper (Figure 3A). This tangent point marks the location of the equator.

2. Project individual lines from the center of the reference globe (the point of projection) passing through each 10° interval marked along the perimeter of the reference globe and intersecting the left-edge of the 11"×17" sheet of paper (Figure

1. Value from NASA's **Goddard Space Flight Center**.

2. Value from NASA's **Goddard Space Flight Center**.

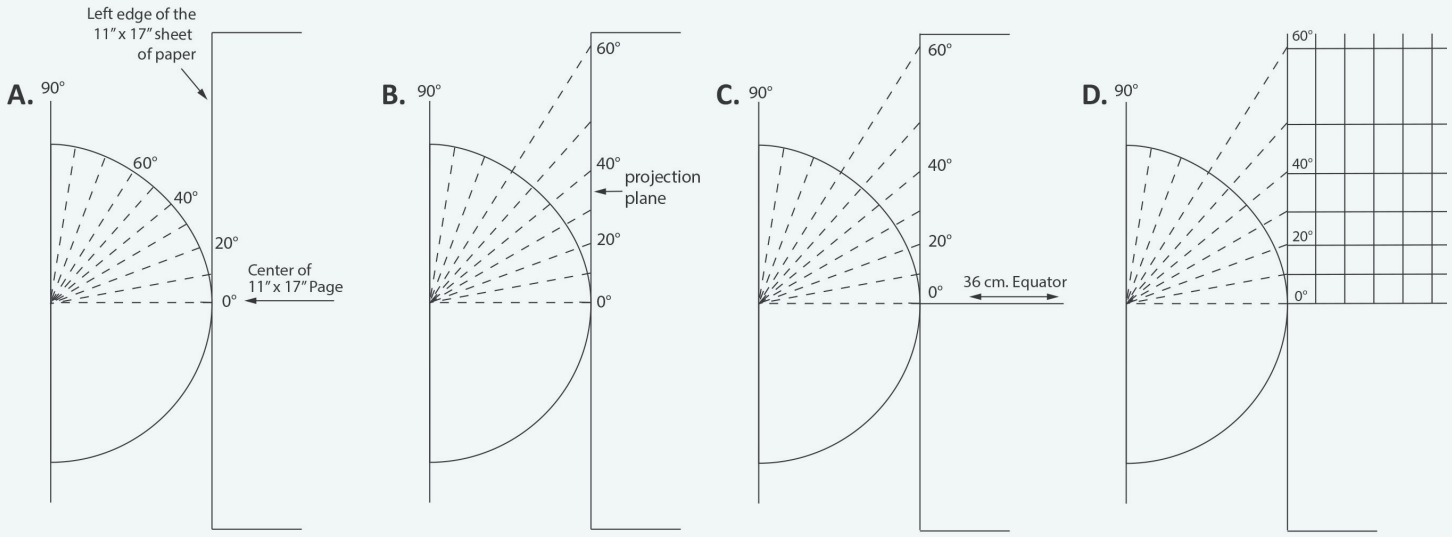

Figure 3. Four steps showing the geometric construction of the perspective cylindrical projection, using a 10° graticule spacing.

3B). Mark and labels these 10° intersections which indicate the position of the parallels.

3. Extend a horizontal line from 0° across the 11"×17" sheet of paper, representing the equator. This line should be 36 cm long from the tangent point (Figure 3C).

4. Draw the parallels and the meridians.

   a. At the marks previously located along the left edge of the 11"×17" sheet, draw horizontal lines representing the parallels north of the equator. Each line will be parallel to, and the same length as, the equator. Once completed, repeat the process for the parallels south of the equator.

   b. To draw meridians, recall that our equator is 36 cm long, and covers the 360° circumference of Earth. To match the 10° spacing of the lines of latitude for this projection, we will also plot meridians at a 10° spacing. Given the total range of meridians to be 360°, a 10° spacing would require that 36 meridians be plotted. Plotting 36 meridians along an equator that is 36 cm in length would require that each meridian be spaced 1 cm apart. Armed with this information, construct each of the 36 meridians as lines perpendicular to the parallels to represent these longitudinal distances. Figure 3D illustrates the initial drawing of the parallels and meridians north of the equator. See Figure 1A for the completed appearance of this cylindrical projection.

Note the spacing of the parallels on this projection. The spacing of the parallels increases from the equator poleward. For latitudes greater than 60° N/S, the line would be drawn beyond the top and bottom edges of the paper. In fact, the pole would be drawn at an infinite distance from the equator (i.e., the pole is projected along a path which parallels the tangent line).

A PERSPECTIVE CONIC PROJECTION

Next, we geometrically construct the perspective conic projection. This projection also has no recognized origin; although Snyder (1993) offers that Colles (1794) may have been the first to use the projection. While we placed the projection plane tangent to the reference globe at 0° in the central cylindrical projection, for the perspective conic, we position the reference globe to be tangent to a specific line of latitude. This line of latitude will become the standard line on the map, with no distortion. Arbitrarily, we use the fortieth parallel, but any other parallel would work, and would change the appearance of the graticule—mainly the spacing of the parallels. Five steps are needed to complete this task, which are illustrated by Figures 4A–4E.

1. Draw a reference globe with 10° intervals marked along its perimeter (Figure 4A). This division will create a graticule with a 10° parallel spacing. Note that the positioning of the reference globe with the 11"×17" sheet of paper is different than what appears in Figure 3A in two ways. First,

the reference globe is tangent to the 11"×17" sheet of paper at 40°, making 40° latitude the tangent point. Second, the 40° tangent point should be set about 2.5 cm below the top-to-bottom center of the 11"×17" sheet of paper. Label the tangent point as 40° and then number the other ten-degree distances, from 50° to 90° above this point, and from 30° to 0° (the equator) below it.

2. Project, from the center of the reference globe and passing through each of these previously labeled points, individual lines to the projection plane (Figure 4B). Once projected, label each point along the projection plane.

3. Construct the circular arcs representing the parallels (Figure 4C). Center a compass on the tangent line the point representing the pole (90°). Set the compass to the distance of the next parallel along the projection plane—80°. Draw an arc representing this parallel, centered at 90° and extending through a half circle (180°). Draw similar arcs for the other parallels at distances from the 90° point indicated along the projection plane. Draw as many circular arcs as will fit on the 11"×17" sheet of paper.

4. Mark off the distance of the meridians (every 10°) along the 40° parallel (Figure 4D). Since this projection is developed along the fortieth parallel, the spacing of the meridians must be set at a distance appropriate for this latitude. To determine this distance, use **this webpage** to compute the length of one degree of longitude along 40° latitude. On the webpage, enter 40 in the Latitude textbox and press the Calculate button. One degree of longitude along the 40° parallel is 85,394 meters (8,539,400 cm). Every degree will be 0.076 cm apart (Equations 7–8 show the calculations). Thus, drawing a meridian every 10° would require spacing them 0.76 cm apart (0.076 × 10), representing a spacing of approximately 854 km on Earth.

$$0.00000000898315277 = \frac{map\ distance}{8{,}539{,}400\ \text{cm}} \quad (7)$$

$$map\ distance = 0.00000000898315277 \times 8{,}539{,}400\ \text{cm} = 0.076\ \text{cm} \quad (8)$$

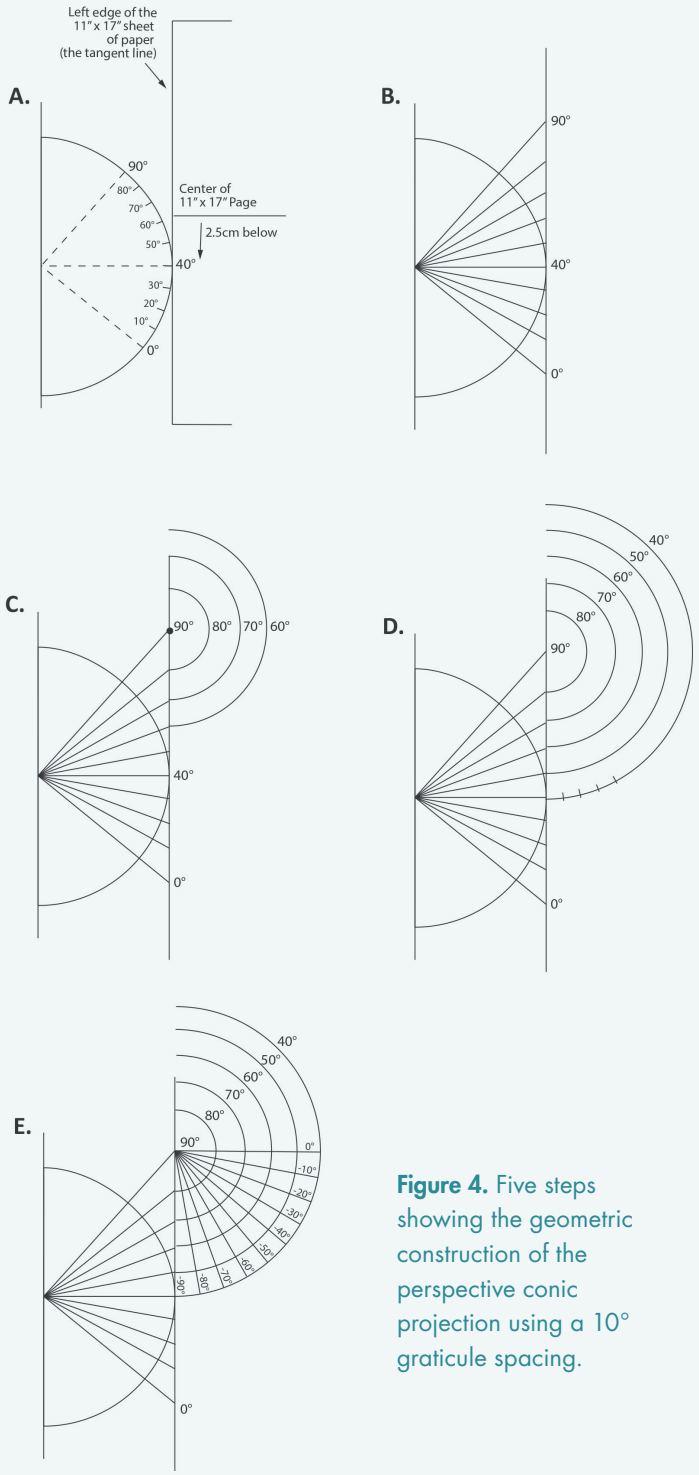

Figure 4. Five steps showing the geometric construction of the perspective conic projection using a 10° graticule spacing.

5. Mark these 0.76 cm distances along the 40° parallel. Then draw, straight lines from the pole through these marks constructing the meridians creating a 10° spacing (Figure 4E). See Figure 1B for the completed appearance of this conic projection.

THE GNOMONIC PROJECTION

Finally, the gnomonic projection will be constructed, which is one of the oldest geometric projections and was probably developed by Thales of Miletus, about 580 BCE (Snyder 1993). This projection is useful for navigational purposes, as it represents any great circle route anywhere on the projection as straight line. While the example provided here constructs the projection centered on a pole, Snyder (1949) provides a discussion of the geometric construction of the equatorial aspect of this graticule. The gnomonic projection represents less than a hemisphere. Constructing this perspective projection requires four steps (Figures 5A–5D).

1. Draw a reference globe at the center of the 11"×17" page. Next, draw a series of lines from its center creating 10° intervals that are marked along its perimeter (Figure 5A). Note that these intervals are numbered differently than what is shown in Figure 4A.

2. Draw a projection plane running top to bottom on the 11"×17" page, tangent to the reference globe at the 90° point. Extend lines from the reference globe's center to the projection plane (Figure 5B).

3. Mark the location of one of the poles on the projection plane, at 90° (Figure 5C). Draw, using a compass, a series of circles representing the parallels at distances from this point. Each circle is centered on 90° and passes through one of the distances marked along the projection plane.

4. Draw the meridians at a 10° spacing. Use a protractor to divide this circular network into thirty-six 10° segments along the outermost parallel. Starting at the pole, draw successive lines connecting the pole to the 10° marks along the outermost parallel, mapping the meridians (Figure 5D). See Figure 1C for the completed appearance of this gnomonic projection.

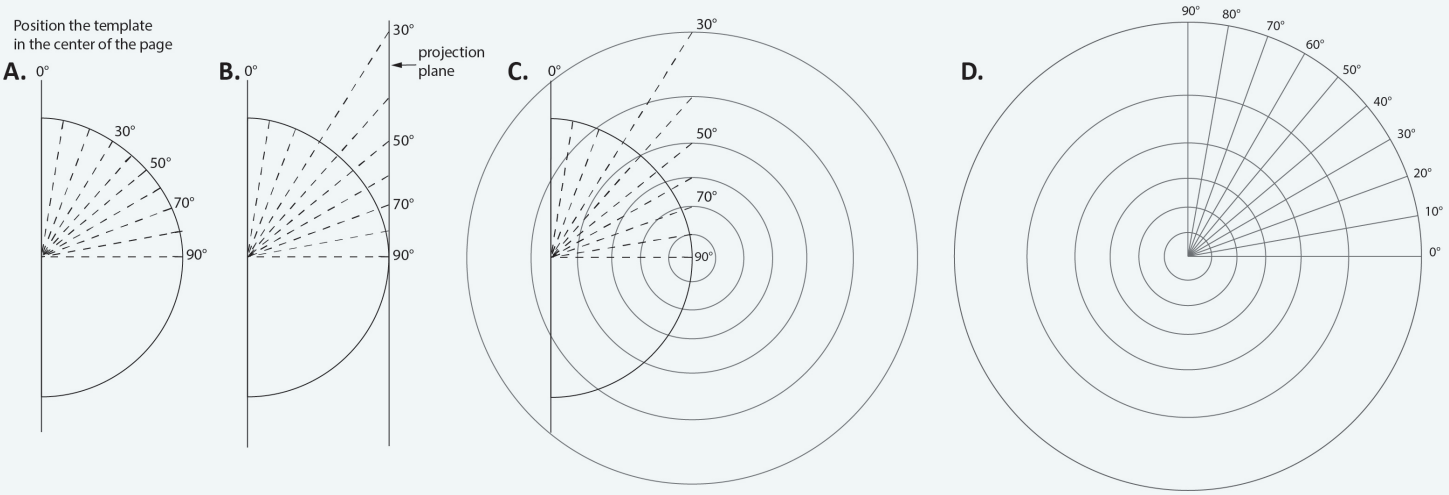

Figure 5. Four steps showing the geometric construction of the polar centered gnomonic projection using a 10° graticule spacing.

RESOURCES ON GRAPHICAL CONSTRUCTION OF MAP PROJECTIONS

Unfortunately, modern cartography texts do not discuss or provide instruction in geometric construction techniques. In a survey of projection content found in English-language cartography textbooks, I reported (2018) that references to geometric construction disappeared after 1970. Looking at textbooks before 1970, Raisz's *General Cartography*,[3] Robinson's *Elements of Cartography*,[4] and Birch's *Maps, Topographical and Statistical*[5] discussed

3. Inclusive of the 1st (1938) and 2nd (1948) editions.

4. Inclusive of the 1st (1953), 2nd (1960), 3rd (1969), and 4th (1978) editions.

5. Inclusive of the 1st (1949) and 2nd (1964) editions.

perspective projections, explained the geometric construction process, and illustrated that process. These authors focused on the familiar perspective cylindrical, conic, and azimuthal projections that are covered in this article.

Beyond textbooks, four map projection–specific books also highlighted geometric construction. Deetz and Adams's *Elements of Map Projection*[6] discussed and illustrated the construction process of the three projections presented in this assignment in addition to the stereographic and orthographic, Hinckley (1942) presented a summary of a variety of projections constructed geometrically. Of particular interest in this work is the construction of the gnomonic projection on three cubes. Hoffmeister (1946) provided a well-illustrated and descriptive commentary on the construction process for both the general classes of perspective projections and oblique aspects of the orthographic and stereographic projections. McDonnell (1979) included a discussion and examples of geometric construction of perspective projections. Additionally, numerous worked examples of constructing projections through simple trigonometry calculations are included. Investigating how simple trigonometric functions can be used to draw more accurate graticules for other projections would be a logical next step in understanding the projection process and how the parameters in these functions influence the appearance of the graticule. In a more recent text, Fenna (2007) includes a chapter titled "Shine a Light: Litteral projections" where the geometric construction process of perspective projections is illustrated and discussed in considerable detail.

REFLECTION

I, like many of my colleagues who teach cartography, have transitioned from manual techniques to computer-based methods. While this transition has been exciting, my experience shows that students equally enjoy and benefit from "hands-on" assignments. From my perspective, part of the "hands-on" appeal of geometrically constructing projections is that students visually experience and control how the projection process unfolds. This manual exercise is in contrast with having students click through a computer interface, while not knowing how the projection process unfolds. Presumably, if students derive enjoyment by working through this assignment, a positive learning experience may result. In fact, research offers some insights into how "fun" can be a part of the learning process. Lucardie (2014) reported that having fun and experiencing enjoyment throughout the learning experience were motivators to learn domain knowledge and skills. In addition, fun and enjoyment were key elements that encouraged students to concentrate, and thus better absorb the material. Erickson (2020) reported that students reported greater situational interest, motivation, and engagement when they participated in hands-on activities compared to those who were in a more traditional lecture-based learning environment. While I have no scientific evidence to support the idea that this particular geometric construction assignment improves learning about projections, I can state emphatically that students genuinely enjoyed working with the manual drafting tools to construct projections. They have expressed to me, in their end of the semester course evaluations, that they enjoyed working with this assignment as a break from the computer-based assignments, and would like to see more "hands on" work.

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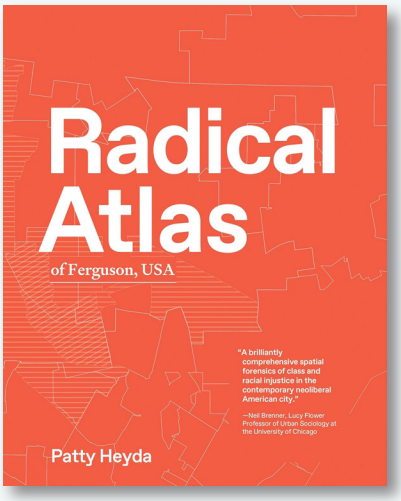

RADICAL ATLAS OF FERGUSON, USA

REVIEW 1 OF 2 FOR THIS TITLE

By Patty Heyda

Belt Publishing, 2024

312 pages, 107 maps

Paperback: $34.00, ISBN 978-1-953368-75-1

Review by: Shriya Malhotra, Independent Researcher

Patty Heyda's *Radical Atlas of Ferguson, USA* exemplifies what is arguably an increasingly necessary form of critical cartography, particularly so in an era where inclusive, crowd-sourced, and participatory mapping has been gaining traction by tapping into people's everyday personal and communal experiences. I, myself, see this atlas as an example of what Ruth Wilson Gilmore has called "activist scholarship" (2022, 448).

The city of Ferguson is located in what the atlas often refers to colloquially as *North St. Louis County* or *North County*: the northern part of the county of St. Louis, Missouri. This previously obscure, predominantly African-American suburb of St. Louis came to prominence in August of 2014, when Michael Brown, an eighteen-year-old African American man, was killed by a white policeman. An outraged populace took to the streets demanding justice and accountability—in demonstrations that later devolved into rioting and looting. Physically, demographically, and spatially defined by an industrial past, the developmental trajectory of Ferguson highlights the racialized injustices faced by people of color. That history, and the present reality, provides the setting for *Radical Atlas of Ferguson, USA*'s immense, almost forensic, exploration of gentrifying suburbia—an exploration that leverages the revelatory power of maps and of information design.

The *Radical Atlas* demonstrates how Ferguson's built and social environments have been constructed upon core racial and power inequities, and it does so by bringing together disparate narratives, indicators and variables visualized as maps and diagrams. Once a typical, middle-American landscape—a first-ring suburb of a major US city—Ferguson can also be taken as a paradigmatic example of how endemic, foundational inequities led both to the killing and to the subsequent unrest.

Heyda and her team aim to show how a seemingly benign suburb embeds and obscures systems of violence, racial segregation, and financial disenfranchisement, while also shielding those systems and their agents' actions from scrutiny and legal consequences. The atlas does so by organizing maps under categorical subheadings, each accompanied by a "mobilize" section offering actionable responses. In doing so, it brings home a much larger point: that racism's myriad manifestations are embedded in policy and designs that influence urban spaces.

Since the 1970s, urban design and planning in the United States has been substantially influenced by neoliberal economics—wherein public policy is directed by the concerns of private wealth and free market ideology—resulting in certain, typically racialized, segments of society being confined in compounding cycles of exclusion, inequality, and poverty. The consequences are visible in America's built, social, and economic environments. As Gilmore herself puts it in the **Antipode Foundation** film ***Geographies of Racial Capitalism with Ruth Wilson Gilmore***: "capitalism requires inequality, and racism enshrines it."

Mapmaking may not be the mode of response that first comes to mind when one considers racial justice, but Black intellectuals such as **Ida B. Wells and W. E. B. Du Bois** have, historically, used cartography to reveal to the general population the often hidden economic injustices rooted in race, and to communicate the realities those injustices create. By contrast, the more recent and visible practice of redlining—of drawing maps that explicitly identified and excluded (again, often racialized) neighborhoods from access to the financial services required to secure housing—is well known as a common tool in the hands of the agents of racial injustice. It is this latter technique, first developed in the 1930s, that is most widely seen as the primary relationship between maps and race.

Radical Atlas of Ferguson, *USA* questions this assumption of an exclusionary correlation between race and cartography, and succeeds in turning it on its head. The challenge to power using maps is catalyzed by the fact that, in recent years, civil society groups have had better access to spatial analysis and mapmaking tools that help to identify metrics for justice and equity. Through visual analysis of the urban form, as well as through an examination of assorted variables of design and planning, the maps in this atlas demonstrate how urban development has been used to justify and advance agendas of power and control. In particular, these activist maps reveal how "layers of racial capitalism were entangled with scenes of cookie-cutter houses, strip malls and suburban politics" (15), and, more broadly, how the seemingly mundane built environments of suburban USA encode a form of hidden violence through exclusion.

This intent—to illuminate the complicity of economics, policy, and urban design, and to encourage "recognition, accountability and resistance" (9)—is laid out by the author in her "Introduction," which notes how this atlas represents an attempt to "remap the city as a political economic construct to understand how and why inequality is structured into the built environment, and how and why such limited improvement persists" (11). Teddy Cruz and Fonna Forman further remark in their "Foreword" that by identifying and visualizing the geographies of inequality, Heyda and her associates allow the assorted themes to be examined to reveal the "layers of violent contradiction inflected on space and people by the extra-local priorities of capital and its agents" (8). Collectively, the maps—and in particular the actionable sub-sections on mobilization—comprise a form of activism that, in my view, achieves the goals of its authors.

The *Radical Atlas of Ferguson*, *USA* project was not commissioned by any group or organization, but it does espouse a point of view. Patty Heyda led the atlas project as part of a course at the University of Washington in St. Louis, where she is currently a professor of architecture and urban design. Over 100 visuals, including photos, charts, and maps, were created with support from her students and research assistants.

As part of its introductory materials, the book provides an "Atlas Guide" (28–29) that "orients the reader to the exact frame, scale, and location in the region of each map" (18). The information underlying the maps is extensively documented near the end, in the "Sources" section.

Data underlying the atlas maps were gathered using a wide variety of methods—onsite observation, digital search engines, media interviews, news accounts, reports, scholarly research, and the transcription of historical, analog information—with a primarily focus on the situation in and around Ferguson between the years 2014 and 2023. Many of the maps overlay and combine disparately sourced data on a variety of themes, in order to highlight intersections and interrelationships between topics—including some that might at first seem unrelated—and illustrate the proposed correlations. Any spatial data that were adapted or spatialized from news articles or public or nonprofit reports are fully cited on the map and also listed here. Source citations for all spatial and statistical data, whether adapted or spatialized from news articles, public or nonprofit reports, are documented, by chapter and map, in the thirty-one page "Sources" section (272–303).

The atlas is organized into five chapters, each covering a specific theme or research category. "Territory" reviews contestation and separation; "Space" looks at material forms of neoliberalism to explore weaponization and violence; "Opportunity" examines systems of exclusion and privilege; "Politics" examines governance sectors including public and private; and "Justice" reviews human rights, freedoms, health access, and the environment. Each chapter is broken into thematic sections that are supplemented by infographics, photographs, and maps, and is headed with a brief preface, setting out the hypotheses to be expounded.

Two detailed visual timelines—"Privatization of public policy" (Figure 1) and "Civil rights & policy reactions, 1960–2020" (Figure 2) introduce and contextualize the

impetus for the project. The former "shows the shift from federally sponsored social programs (in blue) to public-private trickle-down models favoring business growth and private wealth accumulation (in orange)" (12) and the latter shows "Civil rights gains [and] reactive policy protecting access to wealth and power" (24). Between them, the timelines illustrate chronologically how neoliberalism has resulted in inequality by perpetuating structural poverty through its programs and policies.

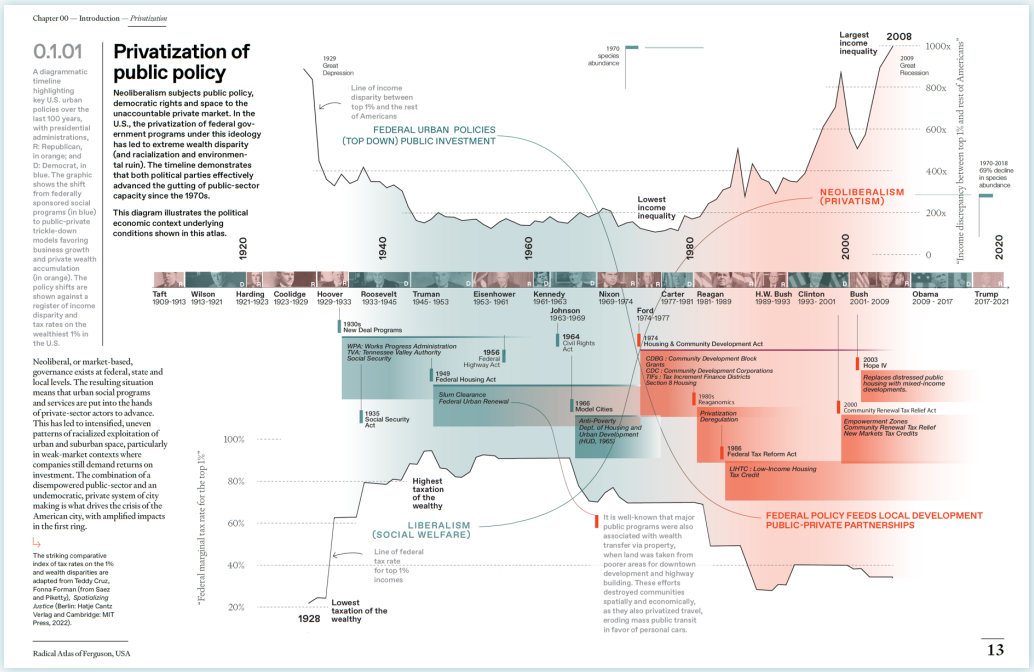

Figure 1. 0.1.01, Privatization of public policy (12–13).

By making visible the ways in which privatization has acted to the detriment of marginalized communities in and around Ferguson, the subsequent maps reveal inherent contradictions in city planning, policy, and design by showing how tax incentives, housing codes, urban planning design, and policing can both affect and often increase racial-based inequalities.

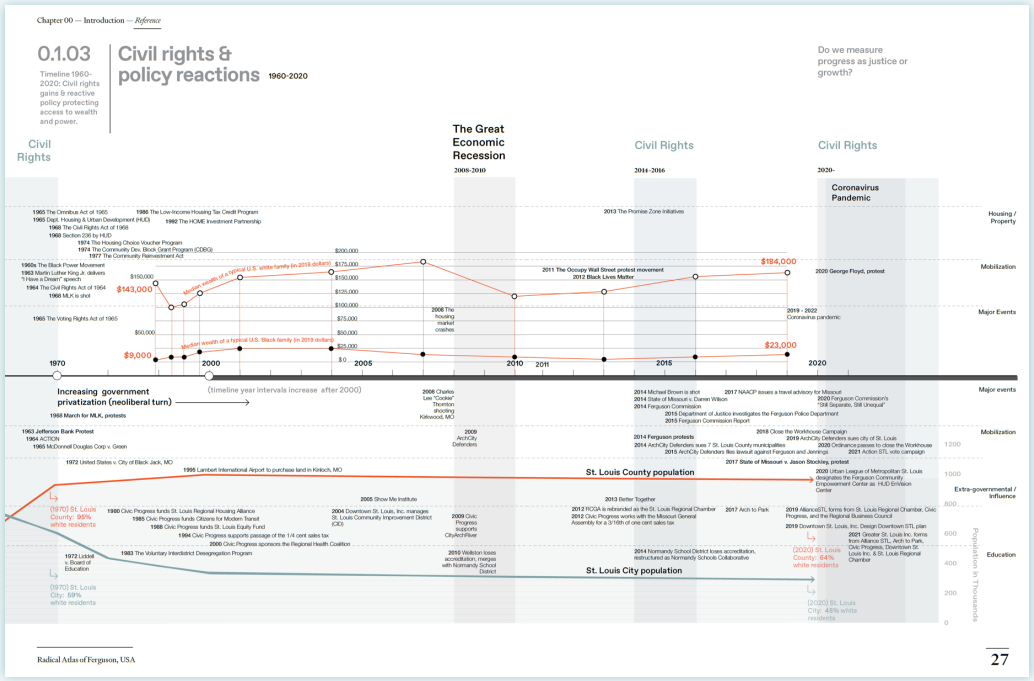

Figure 2. 0.1.03 Timeline of civil rights & policy reactions, 1960–2020 (26–27).

Chapter 5—entitled "Justice"—is particularly strong. It focuses on social and human rights through sub-sections on "Liberty," "Health," and "Environment." Maps in the "Health" section show how environmental justice necessitates racial justice, as well as necessitating investment in policies that are more equitable in their redistribution of wealth equity. The "Liberty" section offers an overview of the predatory criminal justice system, "where police and courts in North St. Louis County profit off of poverty as a mechanism for making up austere municipal revenue shortfalls" (218). Through these maps, the cyclical nature of poverty and the ways in which it is compounded and enmeshed with inequality becomes clearer.

The maps in the *Radical Atlas* have the potential to inform the construction of more accountable frameworks for urban research and design intervention by exposing

crucial, but often missing or suppressed, information. In addition to identifying and making pertinent patterns visible, they also identify specific areas for intervention and improvement—often annotating them with explicit interpretive guidance. For example, the "Development" section of the "Politics" chapter examines neighborhoods that need investment to help improve residents' lives, by offering maps of food deserts (Figure 3, 178; Figure 4, 179) that reveal which communities have easy access to healthy foods, which do not, and how the solution lies in quality and not simply quantity. A comment on map 4.C.19 (Figure 3) notes that the construction of a large grocery store in the middle of a food desert offers "helpful surface level, not structural, changes" (178). Another map points out that there remains a "persistent mismatch of jobs, education and income in Berkeley, MO, [a city adjacent to Ferguson] despite it being home to two major Fortune 500 companies" (192). Similarly, a map on page 216, showing the locations where **Arch City Defenders**—a local coordinating organization for pro bono legal advocacy—has filed lawsuits has a note telling us that the group "works to hold accountable those in power, to stop the criminalization and profit off of poverty in the region" (217). These cartographic annotations lend credible depth to the visuals.

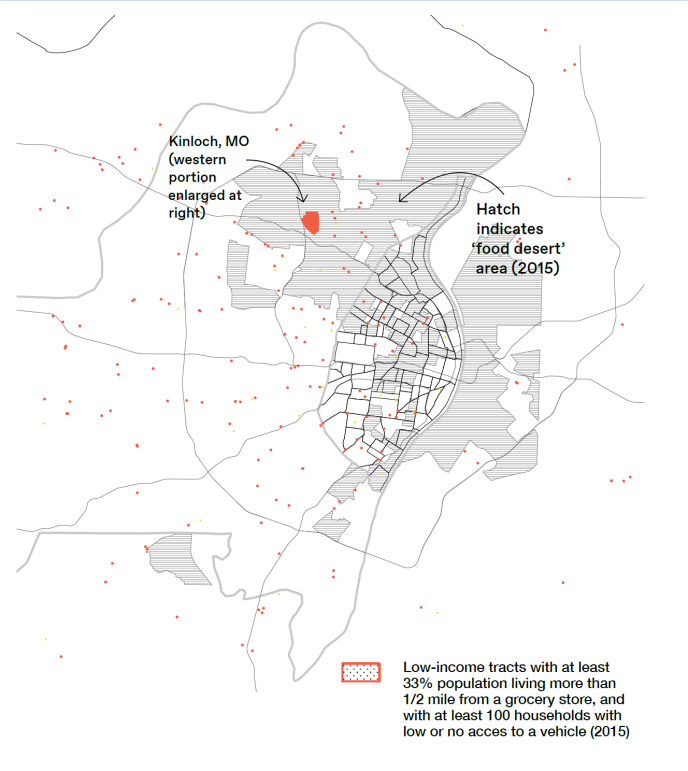

Figure 3. 4.C.19 Food desert (178).

The maps in this atlas are designed to explicitly debunk some very well-entrenched narratives and to advance more equitable distributions of justice by spurring a rethink and repositioning of established "systems of race and power" (18). To do this, the *Radical Atlas* offers the reader a heavy load—almost an overload—of rigorously objective visual information while at the same time unabashedly espousing a clear political advocacy counter-agenda of its own. Still, although a large part of the atlas makers' goal is to problematize entrenched assumptions, at least some of the *Radical Atlas* maps might be thought to play a bit fast and loose with conflating correlation and causality, and, in the process, stretching the

Figure 4. 4.C.19 Food desert, western portion of Kinloch, MO (179). This map makes clear the reality of an inaccessible resource located in a food desert. Most of the households in the western portion of Kinloch do not have access to vehicles, or to adequate public transportation, and are therefore reliant on local retail food outlets. In practice, this means small, nearby corner stores with limited inventories and often higher prices. The large—and perhaps economically efficient—regional distribution center is not accessible to retail customers; no one can shop at the facility.

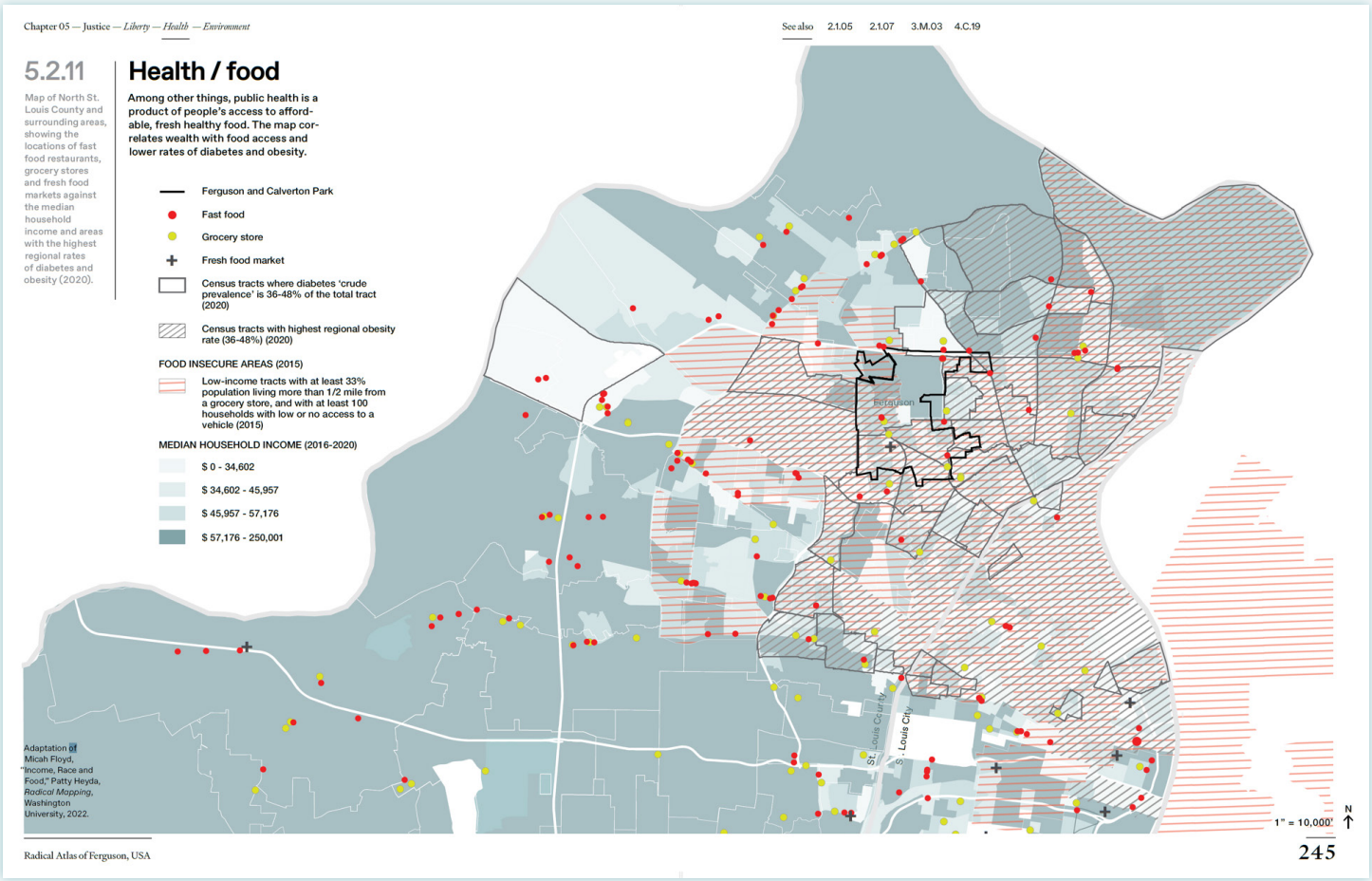

Figure 5. 5.2.01 Health / food (244–245).

reader's credulity a bit far. Similarly, in some of the graphics, the limits of design—both graphic and information—and of cartography, become evident. In some instances the mapmaker's design choices tend to over-simplify the reality they purport to depict, while some of the graphics are simply a bit hard to understand. Creating simple, accessible, and persuasive graphics of a complex, nuanced situation is not easy, and a graphic that is not easily understood will often be ignored or misinterpreted by a reader. In at least a few of these maps there is a risk that either the graphic or the rhetorical aspects, or both, might overwhelm or confuse at least some of the atlas' readers.

Nevertheless, the book is a fantastic example of activist scholarship and of communication and information design through maps. As a collection, these maps offer relevant and contextualized representations of pertinent socio-economic information while challenging dominant power structures. As an exercise in mapping the politics of inequality, it is a substantial contribution to cartography—particularly as an example of forensic, grassroots, and critical cartographies leveraging the power of maps for activism oriented towards social justice. Although targeted mainly at an audience of students and faculty in architecture and urban planning programs, and at people engaged directly with urban policy, this visually appealing compendium is useful for anyone interested in mapping for social justice, or in exploring the role of visual and spatial analysis enabled by new research tools that support grassroots, critical, and collective cartography.

That said, there exists some room for criticism. One question concerns the title: what is it, exactly, that makes this *Radical Atlas* "radical"? There is no question that Heyda is exploring a complex situation, and is providing a cogent and coherent statement and analysis framed in a manner radically at odds with that espoused by the dominant power structures, but does that make the cartography, and by extension, the atlas itself, radical? It could be argued that it represents what Mark Denil (2011) has called "a cartography of radicals and not a radical cartography" (2011, 19). While a cartography of radicals is in no way

illegitimate, we should remember that "a politically or socially challenging map should not be mistaken for a cartographically challenging map" (2011, 19).

The absence of interviews is another noticeable weakness. While the atlas exhibits an admirable visual multidimensionality, it doesn't always manage to show depth, complexity, and interrelationship of many issues—something that could potentially be captured by allowing people on the ground to speak for themselves—and comes off as a bit of an academic exercise.

Urban planning and development have historically, in the United States, been underpinned by systemic racism. With these maps, Patty Heyda presents a fantastic good example of alternative uses of cartography—one recalling Laura Kurgan's work (2013) surrounding racialized incarceration. This sort of mapping project, similar to initiatives like those of the Forensic Architecture group, reveals how structural racism underpins much of the American system, resulting in harm and (barely) hidden violence. *Radical Atlas of Ferguson*, *USA* is an invaluable showcase for the potential of critical cartography for grassroots activism and radical social justice: "By mapping Ferguson through layers of spatio-political complexity and contradiction, the atlas unravels stories that underline how and why the event [the 2014 murder of Michael Brown] and its urban responses came to be, with glimpses of how and why people are so resilient and creative in the face of such systemic oppression" (17). These maps illustrate how long standing urban planning practices have entrenched poverty and racial inequality spatially and physically into the built environment—and the atlas succeeds in identifying areas for intervention and change, realms necessitating social justice, and the intersections of variables such as poverty, race, class, and health.

I personally enjoyed reading and reviewing this atlas because I have always loved maps: as informative works of art and design, for how they work, what they reveal, what they indicate about power and how they attempt to deal with changes in space. This atlas is ultimately an ambitious experiment into the power of spatial analysis and sense making—something Cruz and Forman call "urban forensics" (9). Overall, it is a wonderful and important contribution—particularly with its examples of health mapping, which reveal how a multitude of factors (including geography) contribute to community well-being. It effectively builds upon what Gilmore refers to as "engaged scholarship" and "accountable activism," something she says

> Always begins with the politics of recognition . . . plenty of bad research is produced for all kinds of reasons, and plenty of fruitless organizing is undertaken with the best intentions. Activist scholarship attempts to intervene in a particular historical-geographical moment by changing not only what people do but also how all of us think about ourselves and our time and place, by opening the world we make. (2022, 447–8)

As part of this genre of work, the *Radical Atlas of Ferguson*, *USA* offers readers the optics to begin working towards systemic change and justice.

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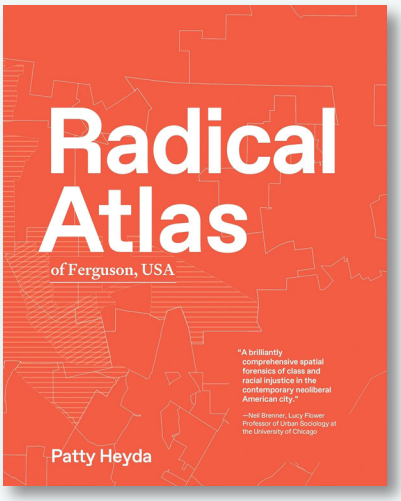

RADICAL ATLAS OF FERGUSON, USA

REVIEW 2 OF 2 FOR THIS TITLE

By Patty Heyda

Belt Publishing, 2024

312 pages, 107 maps

Paperback: $34.00, ISBN 978-1-953368-75-1

Review by: Aimée C. Quinn (she/hers/ella), Northern Arizona University–Yuma

The *Radical Atlas of Ferguson, USA* is a gut punch; a heart-wrenching exposé filled with over one hundred maps telling the shameful story of America's urban blight. The power of these maps—coupled with short, decisive prose—explain how urban growth was manipulated and regulated to create a space of political antagonism and racial violence in a major Midwest metropolitan area. Today, Ferguson, Missouri is synonymous with the 2014 murder of Michael Brown, a Black man, at the hands of a white police officer; and with the riots that followed. The atlas author, Patty Heyda, is a noted professor of architecture specializing in "erasure urbanism," or the "**processes that erode urban, democratic, and lived space**." She uses her skills in spatial forensics to challenge her readers to recognize and address the long-standing, systemic issues consistently impeding the well-being of minority residents. Heyda employs a variety of maps and images to weave a complex and often sub rosa story about how one place came to be long denied basic public amenities like parks, daily postal service, or safe spaces for children to gather—things many people in American cities take for granted.

The story told by this atlas; that so many urban planning and other professionals, alongside generations of office holders, worked so closely together over the course of decades to systemically oppress generation after generation of a disadvantaged underclass—and dissembled about it year after year—simply to further and entrench the interests of a privileged elite; is one that I, myself, find unimaginably outrageous. Hedya's exposé rips aside the polite veils the powerful usually draw over such conspiracies—it shouts the quiet part out loud.

Spatial forensics offers an essential framework for analyzing the power dynamics underlying urban development; it focuses on the gap between the intended goals of urban design and its actual systemic outcomes by illustrating many of the varied contradictions that can infest contemporary city planning practice. Heyda's use of this methodological approach allows her to critically examine the intricate interactions between institutional actors—including urban planners, architects, and political administrators—and the lived experiences of urban residents.

The maps' spatial analyses forensically deconstruct the mechanisms by which municipal infrastructural systems—tax policies, housing and building codes, regulatory enforcement, and assorted administrative variables—systematically undermine the potential for holistic urban livability. These institutional frameworks technocratically shape urban design principles to prioritize metrics of administrative performance and economic productivity while deprioritizing resident-centered approaches. As a result, the lived experiences and needs of local communities are subordinated to narrow systemic objectives. This can, for example, be seen in the way administrative decisions concerning tax incentives (146) and housing codes (Chapter 2) systematically reinforced segregation and poverty. Similarly, policing strategies were structured to prioritize revenue generation over public safety concerns (229). The

frameworks erected by these approaches burden low-income residents, deepen distrust between the community and law enforcement, and consequently perpetuate a technocratic vision of urban development that marginalizes inclusive and human-focused design principles in favor of functional and economic imperatives.

In the atlas "Foreword," Teddy Cruz and Fonna Forman of **Estudio Teddy Cruz + Fonna Forman** write of their belief "that urban justice must begin with recognizing the contested spatial, political and cultural dynamics that reproduce injustice in the city, recontextualizing histories of racism and urban violence, and piecing together forensically the ways that historical macroagressions have been naturalized within the official processes of knowledge construction and urban development" and how "*Radical Atlas of Ferguson*, *USA* shares this aim" (8). "Urban violence" they write, "is rooted in social and economic inequality . . . that . . . is exacerbated by accelerating privatization and public disinvestment from already vulnerable communities," and that the urban forensics that underpin this atlas expose how "privatization, public defunding, social exclusion and urban violence are causally intertwined" (9). Cruz and Forman go on to observe that the need for just this type of urban forensics "is urgent today not only in war-torn zones across the world but also in mundane suburban landscapes, whose relentless banality masks histories of violence and exclusion." In reading this atlas, I found it hard not to think of other communities—such as Harlem, Compton, or Flint—that are suffering similar conflicts.

The atlas is divided into six chapters: "Introduction," "Territory," "Space," "Opportunity," "Politics," and "Justice"—with a list of maps before the Table of Contents and a list of Sources and Acknowledgments at the end. Each chapter is further divided into topical subsections, each containing one or more maps that serve to illustrate multiple aspects of the overall story of development and decline. The numerous color photos included alongside the maps enrich the atlas further. Heyda, utilizing data from a variety of open sources, worked with students and research assistants over a period of ten years verifying data and building each map. The team made "every effort . . . to use open, publicly available sources, to maintain the full accuracy of what is being shown, include correct dates and give full credit to the original source of the data." (272).

Each subsection of this atlas explores a specific topic in detail, and includes both explanatory notes on the situation and on potential solutions to the issues. Take Section 2.1.03 (56–61), "Subdivision and HOAs," in Chapter 2 ("Space") for example. The section opens with a map spread illustrating how planned residential districts and homeowner associations enforce governance rules that disproportionately penalize the low-income families that make up the majority of residents in Ferguson. Notes on the left explain that "subdivisions insulate property for wealth accumulation and / or to shut others out" and that "homeowners associations [HOAs] hoard control as they uphold a private system of hyper-localized taxation and rules that benefit only those within the HOA boundary" (56). Four large color photos particularize the situation on the ground (58–61), and also a suggestion that "more connected neighborhoods could be linked to robust public transit to reduce through traffic and make streets safer, while still fostering public life and easier commutes for school kids across and between subdivisions," (59) and helping to alleviate some of the isolation and desperation faced by these communities.

St. Louis County has eighty-eight separate municipalities, each of which has multiple subdivisions, all of which are overlaid with many administrative organizations empowered to levy taxes. The result is a mosaic of overlapping government agencies with numerous regulatory roles, each enforcing its own arrays of rules, defending its own bureaucratic turf, and regularly acting under the assumption "that the compact that government has concerning economic development is between the state and capitalist elites, not between the state and its entire population" (147). In this, it resembles Chicago and other large Midwestern metropolitan areas. Although the atlas maps "primarily include data from 2014 to 2023" (272), the examination of the area's political-economic construct is set against the background of the built environment expansion that began in the late 1960s and carried on through the 1970s. Ferguson is a prime example of state-sponsored income inequality brought about through public policy. Heyda's maps illustrate how these decisions made historic Ferguson into a place where the riots that broke out after the killing of Michael Brown were both predictable and inevitable.

Many atlas readers may be familiar with the notorious and horrific redlining maps that forced Black residents into hazardous areas (marked red on maps) or declining ones (yellow), facilitating and protecting white property accumulation in more desirable neighborhoods. Heyda also identifies something she characterizes as *floodlining*:

a "weaponization of the environment, where private developers inappropriately build affordable neighborhoods in flood zones to exploit access to cheap land and to extract returns" (88)—for example, the very neighborhood where Michael Brown was shot and killed.

Maps and analysis throughout *Radical Atlas of Ferguson, USA* draw from, expand upon, and update concepts Heyda had previously introduced in "Erasure Urbanism," a paper she contributed to the book *Architecture is All Over* (2017). She defines erasure urbanism as the systemic, planned erosion of place and space that ignores human costs and "sets the conditions for an uneven power grab" (21 footnote 30).

I am familiar with other atlases in this genre, such as Annelys de Vet's **Subjective Atlas of Palestine** (2007) and the **Atlas of ReUrbanism** by the National Historic Trust (2016), but I have never before encountered one designed and executed as well as the *Radical Atlas of Ferguson, USA*.

Every urban policy maker—and, in fact, anyone working in city or suburban planning or administration in any capacity—should have this atlas part of their required reading. I am so certain that this is one of the most important books of the year that I intend to gift a copy to every person I know.

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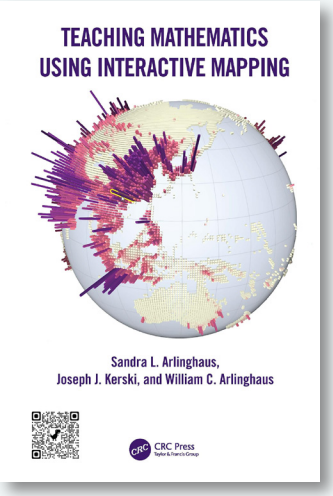

TEACHING MATHEMATICS USING INTERACTIVE MAPPING

By Sandra L. Arlinghaus, Joseph J. Kerski, and William C. Arlinghaus

CRC Press, 2024

249 pages (includes many maps & diagrams)

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Reviewed by: Michael Sparks, The Outlaw Ocean Project

In an era where literacy with data science, with artificial intelligence, and with other emerging technologies have become fundamental workplace requirements, the foundations of mathematical understanding have never been more crucial. *Teaching Mathematics Using Interactive Mapping* addresses this contemporary challenge by offering an innovative approach to mathematical education through the lens of cartography. Rather than following the traditional textbook format, the authors have crafted what they describe as a "buffet of approaches" (xii) designed to help instructors navigate and overcome common pedagogical roadblocks in mathematics education.

The book's premise rests on a compelling observation: that maps serve not only to show where things are but to explain why they are where they are. This spatial reasoning—that maps fundamentally take our vast, complex world and, through mathematical operations, shrink and distill it into navigable, understandable representations—provides an ideal platform for exploring mathematical concepts. The authors leverage this relationship to create bridges between abstract mathematical concepts and their real-world applications, aiming to transform traditional stumbling blocks into opportunities for student achievement.

Structured as an alternating series of "math" and "map" chapters, the text progresses from fundamental concepts like fractions and decimals through to more complex topics including central tendency, variation, earth measurement, coordinate systems, set theory, and hierarchical relationships. This organizational approach allows for multiple perspectives on each concept, creating what the authors term a "repetition from different vantage points" (xi) that promotes deeper understanding and eventual mastery. The text acknowledges that aligning the usual linearity of mathematical curricula with a non-linear presentation of mapping concepts creates inevitable gaps, but uses these multiple viewpoints as a strategy to bridge such discontinuities.

The text excels in its diversity of case studies and applications, drawing from an impressive array of data sources including national statistics, scientific agencies like NASA and the UN Environmental Food Programme, local governments, academic institutions, and private companies. This variety extends to data formats as well, with students encountering real-world examples in spreadsheets, images, GIS vector files, and PDFs—precisely the kind of diverse data ecosystem they'll navigate in their professional lives.

The authors demonstrate considerable skill in selecting illustrative examples that highlight the real-world significance of mathematical precision. One particularly effective early example (26–28) examines the impact of decimal precision in coordinate systems, showing how reducing decimal places in latitude/longitude coordinates progressively distances a point location (in this case, the Eiffel Tower) from its topologically correct position, providing a concrete demonstration of why precision matters. Another

compelling illustration comes through the book's treatment of the coastline paradox, which demonstrates how mathematical concepts intersect with both geography and international relations. The authors explain how the measured length of a coastline (or of any irregular border) increases as the measurement scale becomes more detailed—raising provocative questions about what constitutes the "true" length of a geographic feature. They skillfully connect this to historical events, citing Lewis Fry Richardson's research in the 1950s on the relationship between border length and warfare probability, which noted the intriguing case where Portugal and Spain reported significantly different lengths (987 km versus 1214 km) for their shared border. This kind of example (166–168), which links mathematical concepts to both geographic phenomena and human conflict, exemplifies the book's ability to spark curiosity and encourage independent exploration—a key goal of the text.

The practical applications are particularly compelling. A standout example (176–179) analyzes Paradise, California's 2018 Camp Fire using mathematical and geographical analysis to examine how terrain affected both fire spread and evacuation efforts. This case study powerfully illustrates how mathematical understanding can literally become a matter of life and death in disaster scenarios. Another compelling example walks readers through the day-to-day work of a GIS analyst, examining flood and landslide risks in Boulder, Colorado.

The book presents an ambitious vision for digital integration, offering web-accessible materials that require no logins or specialized mapping expertise. However, the implementation of this vision proves problematic. The book relies on lengthy, unwieldy URLs full of seemingly random characters that readers are unlikely to easily type correctly. A more user-friendly approach, such as a dedicated website with organized, easy-to-access hyperlinks to these valuable digital resources, would have greatly enhanced the book's practical value. While an eBook version addresses this limitation through clickable links, readers of the physical edition—the focus of this review—will likely find accessing the supplementary content frustrating.

The book's "buffet" approach sometimes results in superficial coverage of important topics. The treatment of trigonometry is especially disappointing—while the text presents graphs of all six trigonometric functions (sine, tangent, secant, and their co-versions), it fails to provide even basic explanations of what these functions represent or of their conceptual significance. This oversight directly conflicts with the book's mission of making mathematical concepts more accessible and understandable. There are also occasional editorial oversights, such as a reference on page 97 to a "traditional approach to that subject here (link)" where "link" appears as plain text rather than a URL.

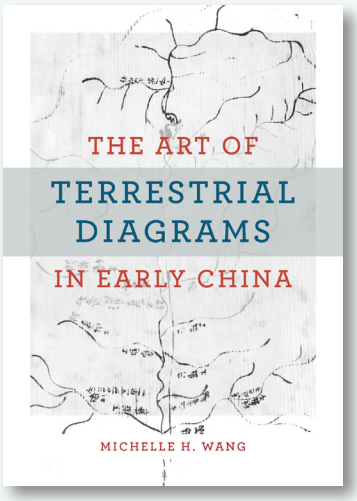
From a cartographic perspective, too, there were missed opportunities to delve deeper into the rich complexity of mapping itself. For instance, the book could have explored the mathematical foundations of more advanced cartographic concepts such as the relationship between coordinate systems and map projections. A fascinating example would be examining how the mathematics of the Universal Transverse Mercator (UTM) projection system divides the Earth into zones and applies complex coordinate transformations—a perfect real-world application of both trigonometry and coordinate geometry that would demonstrate to students how mathematical concepts underpin modern mapping systems. To be fair, the book does lightly touch on the UTM system, but it is a rich topic that could be mined more deeply. Moreover, the mathematical principles behind terrain analysis, such as calculating slope and aspect from elevation data, could have provided excellent examples of practical calculus applications. On the other hand, these more advanced cartographic concepts could form the basis for an expanded or follow-up edition, one that might bridge the gap between introductory mathematical concepts and the sophisticated computational geometry that drives modern geographic information systems.

As a resource for mathematics instructors, the book provides valuable starting points and novel approaches to teaching mathematical concepts. However, while it offers numerous real-world applications, the text's approach to student engagement varies in effectiveness and ultimately somewhat undershoots its potential. Some exercises, such as a compelling exploration of global population patterns (106–110), successfully demonstrate the power of spatial analysis through open-ended investigation. In this example, students compare population visualization methods, examining both 3D extruded grid cells and binned tessellations, while considering how different filtering approaches reveal distinct patterns in population density. Such thoughtful, exploratory exercises effectively demonstrate the practical value of mathematical concepts.

However, not all of the exercises and examples are anywhere as strong as this, leaving some sections struggling to address even the common student question of "when would I use this?" The book serves better as a source of teaching ideas than as a comprehensive solution to mathematics education challenges.

All three authors hold PhDs and have extensive teaching experience. Dr. Sandra Arlinghaus brings expertise in mathematical geography from the University of Michigan, Dr. William Arlinghaus contributes decades of mathematics teaching experience from Lawrence Technological University, and Dr. Joseph Kerski has worked across multiple sectors implementing geotechnologies in education. Given the authors' considerable academic credentials and wealth of classroom experience, the inclusion of concrete, ready-to-implement lesson plans would have significantly enhanced the book's practical value for educators. Sample lessons could have demonstrated how to effectively integrate the book's "buffet of approaches" into existing mathematics curricula while providing concrete examples of successful implementation strategies. It is worth noting that the authors seem to deliberately avoid targeting a specific learning level. Several of the book's short-comings stem from this unfocused approach and, perhaps, could be resolved by narrowing its aims to a particular education level.

Despite these limitations, *Teaching Mathematics Using Interactive Mapping* represents an important contribution to both mathematics and cartographic education. Its innovative approach to using cartography as a framework for mathematical understanding offers instructors new tools for engaging students and demonstrating the real-world relevance of mathematical concepts. While it may not serve as a standalone solution, it provides valuable supplementary material for educators seeking to enhance their mathematical instruction through spatial thinking and real-world applications.



THE ART OF TERRESTRIAL DIAGRAMS IN EARLY CHINA

By Michelle H. Wang

University of Chicago Press, 2023

256 pages

Hardcover: $55.00, ISBN: 978-0-226-82746-9

Review by: Ally Shah, Esri

The Art of Terrestrial Diagrams in Early China is a methodical exploration of the meaning, process, and mythology surrounding the artifacts known as *ditu*, a little-known form of spatial representation practiced in ancient China, predominantly in the centuries before the common era (BCE). The extraordinary artifacts examined in this book were uncovered in archaeological excavations of Chinese tombs at sites in Zhongshan, Fangmatan, and Mawangdui that can be dated to between the second and fourth centuries BCE. Their discovery and identification amongst the grave goods in these three ancient and widely separated tombs provides an opportunity to learn about these artifacts firsthand.

Author Michelle H. Wang holds a PhD in art history—specializing in the art and archaeology of China from the tenth century BCE to the third century CE—and her study of ditu draws upon the history of cartography as well as on the disciplines of art history, architecture, material science, religion, and philosophy. It is her particular interest in early notational systems that leads her to focus on what she sees as the trickiness of categorizing these artifacts.

Until their discovery in the 1970s and 1980s, the existence and nature of these map-like objects was known only from the derogatory and hearsay remarks of later commentators. On the one hand, the term "ditu"—compounded of "di," (terrestrial) and "tu," (diagram)—is the common (contemporary Mandarin) Chinese word for "map." On the other hand, ditu, collectively, represent a type of mapping significantly different from that of other early Chinese maps that have hitherto been available.

While much early mapping in China was focused on practical, military, or bureaucratic use, and leveraged sophisticated topographic and land survey techniques, ditu were often created in anticipation of, or following, the death of an individual of notable social standing. While some ditu offered instructions for the living on how to honor and support the deceased, others were intended for use by the deceased themselves and other persons they would presumably encounter in the afterlife. Ditu varied in their construction, ranging from inscriptions on wood boards to images cast in bronze, silver, and gold, with materials reflecting the social rank of the persons for whom they were crafted.

Are they *maps*, or are they *diagrams?* What would make them either one or the other? Does the difference matter? Why make a distinction?

Wang argues that "normative" maps in ancient China were tools of utility—constructed in conformation to explicit and rigid rules of scale, consistency, and use—while the ditu were instead tools of philosophical expression and embodiment, and thus more akin to art than to science. Because the ditu fall short of strict adherence to scale as the foundation of their logic, Wang maintains that they are marked out as fundamentally different in kind from

maps: that, in fact, they are not maps but are instead diagrams. In support of this, she cites examples of ditu from the Fangmatan and Mawangdui tombs where scale or consistency of pattern may seem present at first glance, but closer inspection causes this impression to break down (115). This breakdown of what Wang sees as the core characteristics of normative mapping definitively disqualifies ditu as maps.

Wang also recognizes that ditu offer a similar experience to the kinds of artworks and musical compositions that Alva Noë (144, citing Noë 2015) refers to as "strange tools"—works that function as a means by which individuals may experience a type of confusion that allows them to investigate themselves with new perspective. In Wang's view, ditu were the strange tools used by the people of that time and culture when setting off on their postmortem existence; a use that also distances the ditu from the common run of maps.

Furthermore, Wang goes to great lengths to distinguish artworks—including strange tool artworks—from maps. Denis Wood and John Fels, in their book *The Nature of Maps* (2008), use similar arguments to differentiate map from art. Wang's discussion dances between qualities of the creator's intention and method, the capacity of materials to represent the intention, and external realities (accuracy to the actual location being mapped). Readers of *The Art of Terrestrial Diagrams in Early China* will likely not come away with any simple formula for deciding what qualifies as a map. However, while there is a risk that this nuanced assertion might sidetrack the reader's attention, it should not be allowed to detract from Wang's salient point—to illustrate the value of ditu's capacity to connect real-world physical locations with cultural and religious concepts of place by inhabiting a liminal space simultaneously holding some of the characteristics she ascribes to maps and some of those she assigns to diagrams having artistic and expressive qualities.

Wang maintains that most people using maps make the same, or similar, distinctions. They presume that all maps adhere to conventions she calls normative, and characterizes as rational, mathematical, and Apollonian—that they aspire to be rigorously mathematical representations of real-world spatial locations that support and facilitate calculations in linear or areal units. She tells us that such conventions assert their power through material reality, in that the map user can confirm the map's conjectures by physically visiting the place it represents.

In opposition to this Apollonian (reasoned and ordered) characterization of maps, Wang positions diagrams as Dionysian (passionate, emotional, and instinctual)—that is, as visualizations representing knowledge and concepts that we cannot visit and confirm so easily. Diagrams, she writes, pick up where maps leave off, sidestepping mathematical regularity and blurring any boundaries that many map users would suppose exist between the subjective nature of personal experience and the objective, seemingly factual nature of the world in which we live. According to Wang, diagrams bend to the whims of their creators or commissioners—think of the abstractions that can be found in mind maps, theoretical maps of the universe, or the geometric diagrams of the heavens found in Buddhist texts.

It is with this fundamental struggle between the rational and the irrational that Wang introduces and frames her insightful exploration of these terrestrial diagrams.

The book's four chapters are dedicated to meticulously unpacking the contents of each of the three tombs—the third tomb, Mawangdui, gets two chapters—with special attention to the ditu they contained. Wang explores the historical and cultural context of each of the ditu; pouring over the materials and the production process of each in an exploration that tethers postulated postmortem realities back to the materials they are composed of: metal, wood, silk, and ink. Readers will delight in the numerous high-fidelity color images included in the book, allowing us to see the nuances of the ditu for ourselves, albeit partially obscured by the patina of centuries below ground.

Chapters 1 through 3 also acquaint us with the deceased occupant of each tomb—individuals whose culture and societal status influenced the creation of the ditu buried with them. In Chapter 1, we encounter the first tomb: the resting place of the powerful King Cuo of the fourth century BCE Warring States–era kingdom of Zhongshan, whose ditu instructs the king's staff in the afterlife to construct a grandiose burial tomb. Chapter 2 introduces us to the third century BCE tomb of a lowly Qin dynasty scribe whose burial artifacts include ditu of semi-factual lands adhering to bureaucratic formalities, along with a strange narrative of his resurrection. The resting place of

the chancellor of a city of strategic military significance is the topic of the third chapter. The ditu preserved there offer military advice and divinatory instructions for success in warfare.

Early on in her discussion, Wang draws a careful distinction between two types of ditu encountered in the tombs—*shenqi* or "articles of the living" that were created for real-world, tactical application, and *mingqi*, or "spirit articles," that were created for use in the afterlife—and she takes great care in identifying the purposes that the diagrams in each tomb served. Spoiler alert: the majority of diagrams and other grave objects considered in this book were custom-made for the deceased!

The *Mausoleum Diagram* (Figure 1) in Chapter 1, "Zhongshan and Plans for Life After Death," is the plan for the grand tomb of King Cuo—who died circa 313 BCE—and the location where it was to be constructed in present-day Sanji, Pingshan County, Hebei Province. The diagram is made of hardy stuff—cast in bronze and inlaid with gold and silver—and is representative, Wang tells us, of a category of artifacts that held a "planning" function for the deceased (as in plans to be enacted after death), placing it squarely into the category of mingqi (spirit articles).

For the *Mausoleum Diagram*, form follows function; and the function it serves is not that of tomb erection. Wang notes several reasons why the diagram's translation to a building would be challenging, one among them being the various materials used in the diagram's creation that would have thwarted any builder's attempts to extract scaled measurements to build the actual structure, due to limitations in the ability to preserve scale throughout the process of creating a clay mold and casting the bronze ditu. Wang writes, "Even a single centimeter of shrinkage either when the clay dries or when the bronze cools results in hundreds of meters of deviation in the dimensions of the site" (51). Furthermore, that shrinkage will vary across the entire ditu, rendering scale uneven. She notes, too, that details of

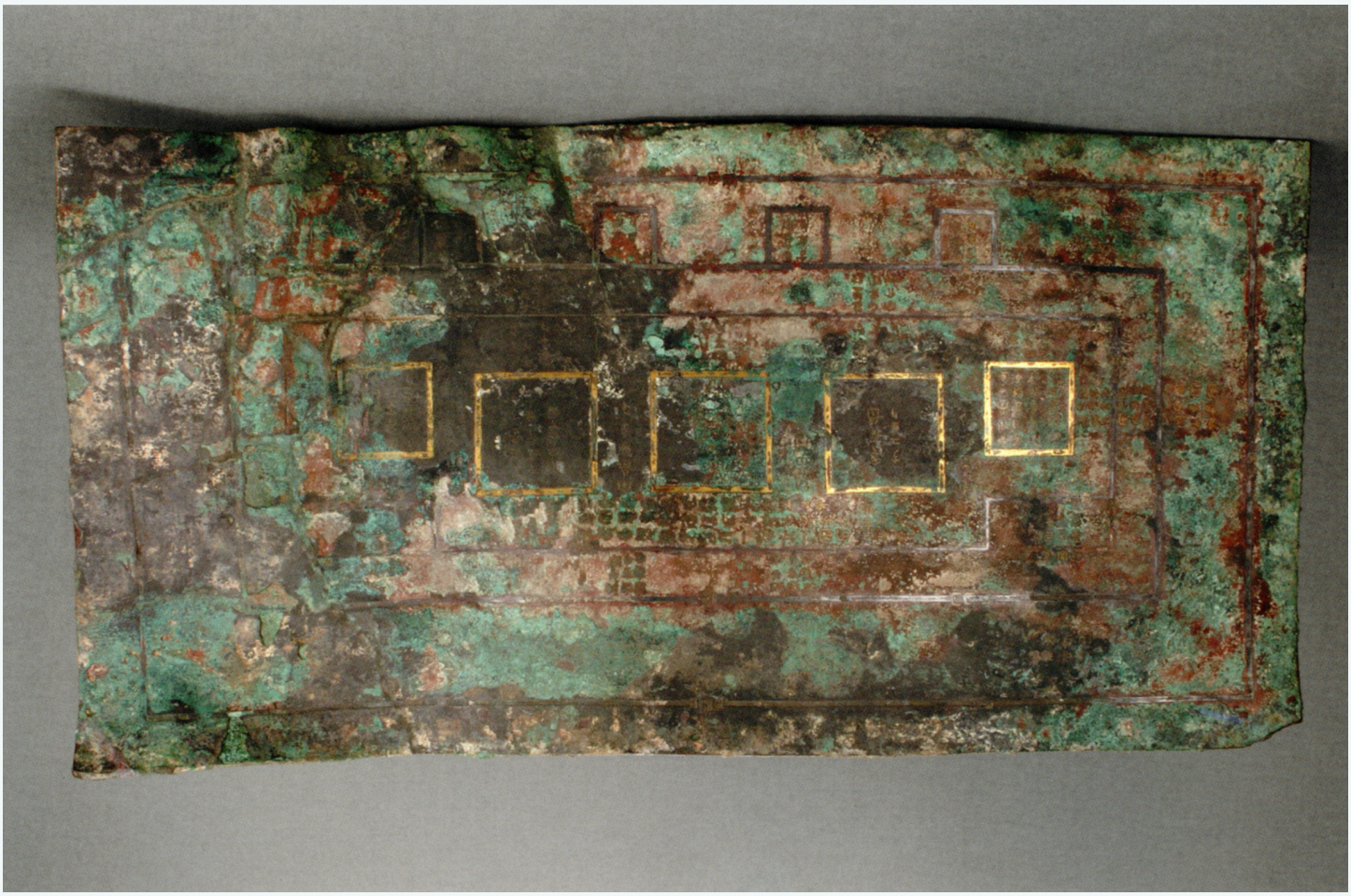


Figure 1. Mausoleum Diagram (Zhaoyu tu), ca. 313 BCE, excavated from Zhongshan tomb 1 in Sanji, Pingshan County, Hebei Province. Bronze with gold and silver inlay, 48 × 96 × 0.7–1.2cm. From Chapter 1, page 28.

construction are generalized beyond utility, yet still coherent in and of themselves. When it comes to the layout of chambers and hallways, Wang observes that these structures are positioned with an eye towards symmetry and ritual movement, rather than actual architectural practicality, thus rendering the layout symbolic, and the goal of the map as auspicious rather than constructionist.

Thus, Wang asserts, the viewer is asked to trust that the ditu's purpose will be achieved in an otherworldly, postmortem space that we in this physical space cannot confirm with our own eyes. These observations and theories exemplify Wang's unique perspective and talent—to leverage knowledge of material science and fabrication drawn from an art historical perspective—and immerse the reader in the time and culture within which the ditu were created.

The ditu from the Fangmatan tomb in Tianshui, in Gansu Province are examined in Chapter 2: "Fangmatan and the Bureaucratization of Space." These diagrams offered an assurance to the tomb's occupant—a lifelong, low-level governmental functionary—who may have feared that death would be overly chaotic, by indicating that the familiar bureaucratic processes governing this world would extend into the next. This reading is supported by a document written on seven long, thin bamboo strips, recounting a most uncanny story of "Dan" (a scribe who may have been the person buried in the tomb), who is temporarily permitted to return to the land of the living after the netherworld bureaucracy clears him of injustice suffered at the hands of the mortal justice system.

The last two core chapters—3 and 4—are perhaps my favorites. They explore the site in Mawangdui, located in Changsha, Hunan Province, which houses three Western Han dynasty (168–206 BCE) tombs. Artifacts from the third tomb include a pair of magnificently detailed ditu drawings rendered in ink on silk. Buried along with a chancellor responsible for a region of strategic importance to the Han empire, the *Garrison Diagram* and *Topography Diagram* (Figure 2), address military concerns and activities.

At first glance, these maps were thought to be shengqi (articles for the living), presenting a level of consistency that shows careful attention to spacing, form, and line that suggests they might have been used for actual, tactical military purposes. Nonetheless, Wang—citing scholars

Figure 2. Recreation of the Topography Diagram (Dixing tu), Western Han Dynasty, (206 BCE–9 CE), excavated from Mawangdui tomb 3. Original is ink and pigment on silk, 96 × 96 cm. From Chapter 4, page 113.

whose work complements her own examination (Hsing I-tien 2014; Yee 2001)—reveals the diagrams to be, in fact, mingqi—or "spirit articles"—highly stylized ornamental tessellations of the natural landscape favoring uniformity in shape, curvature, and proximity, (very much comparable to patterns seen in embroidery) which ultimately favors artistic form over function.

Chapter 4, "Mawangdui and the Art of Strategy," moves further out into the peripheries of the visible world and its interpretation, through examination of some of the other beautiful diagrams from the Mawangdui tomb. Some offer advice on prognostication for warfare purposes, conveyed through visual instructions for reading omens in clouds, rainbows, comets, and eclipses.

In this mingqi form of ditu, we find diagrams that morph into tools of prognostication, yielding meaning-making control to an individual's local circumstances. The underlying logic and conclusions to be drawn from each diagram are left to the observer—creating what, in 2007, Donald Harper called a "purposeful polyvalent map" that sets "observed phenomena into a larger scheme of significance" (Harper 2007, 169–189). In this case, the ditu function as a lens through which to view one's environment, appealing

to nature and begging the blessings of the cosmos itself. A careful reader will appreciate here that an observation made by Wang earlier in the book—that "humans are situated at the heart of any interpretation of heaven and earth" (12)—has come full circle.

In the book's closing section, "Coda: Tunnel Vision," Wang offers Massimo Vignelli's 1972 New York City subway map as a modern analogy to this conceptually abstract situation. She writes that Vignelli's highly stylized, abstracted map required riders to disconnect from real-world landmarks, and to travel through unknown spaces guided by simple geometric symbols in what could be seen as a ditu-like way—a way more extreme than what is commonly demanded by other maps. This leap was too much for many subway users, leading to a major revision that aligned the map more closely with above-ground coordinates. Protesting the changes, Vignelli responded, "Who cares? You're underground, or you're above, you don't even know where you're going" (76, citing Lloyd et al. 2012, 76). The author draws a parallel between this sentiment and the perhaps more extreme and magical logic of the ditu makers. The latter trusted that their creations would manifest traversable worlds for the deceased, guiding them to their next station in the afterlife, regardless of whether or not they knew where they were going.

I find that the framework Wang adopts for looking at these early Chinese ditu maps invites us to reconsider the origins of many of the foundational logic systems we use today, as well as the circumstances under which they arose.

In particular, I recognize Wang's interpretation of the ancient ditu as congruent with the hierarchy of needs introduced in Abraham Maslow's 1943 paper "A Theory of Human Motivation." Ditu were produced to provide a sense of safety in the face of death—a sense Maslow considered to be a fundamental human need. They also offered prestige to those who wielded them—prestige being another thing Maslow considered to be a goal towards which humanity inherently strives. Lastly, they served as creative inspiration to those who look beyond their immediate utility to wonder at their implications—showing that the ditu are indeed strange tools: abstract before charted, ineffable before spoken. Examining modern maps, we can find similar motivations and opportunities for reflection.

As someone with educational roots in both fine art and psychology, and who works in a company with deep ties to GIS and cartography, this book came as an unexpected delight. I imagined I might learn a few interesting things about early Chinese diagrams and mapmakers. Little did I know I would be taken on an expansive journey, exploring sense-making throughout history and the beautiful ways people have found to represent abstract notions in visual form.

Wang's writing can be dense and methodical at times, but I encourage readers to jump in and stay with it. The investigations in this book are thorough, and they clear away the dust of time to reveal the significance of these artifacts in the history of not only cartography but of philosophy as well. Emerging from each round of rigorous investigation, readers will recognize the work these strange tools enable; a vision that looks past the resplendent qualities found in each ditu and their connections to the external world, to the inner luminous landscape of creative human nature.

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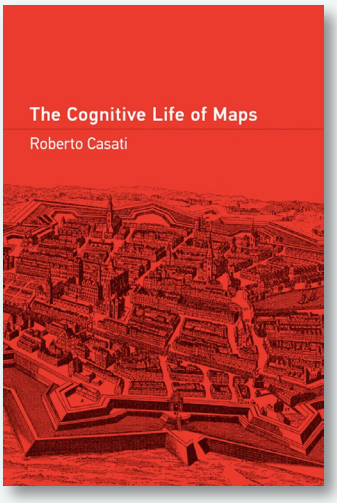

THE COGNITIVE LIFE OF MAPS

By Roberto Casati

The MIT Press, 2024

256 pages

Paperback: $45.00, ISBN 978-0-262-54708-6

eBook: $44.99, ISBN 978-0-262-37723-2

Review by: Lucy Haggard, The Nature Conservancy in Colorado

Let me make one thing clear, from my perspective as a cartographer: philosophers and cartographers think and talk about maps in fundamentally different ways. When I use the term "map," at least in the context of my daily work, I mean a geospatial representation of a real (or possibly fantasy) world. I think about features and their relative locations, about data and scale, and about graphic design and style. For the philosopher Roberto Casati, this definition is far too narrow. Much of his book, *The Cognitive Life of Maps*, is taken up with establishing what things are maps and what things are not, and it is this semantic exercise that largely makes his book a text by and for an academic, philosophical audience. Casati acknowledges frankly that he is not a cartographer (7) and explicitly notes that this sort of intellectual exercise is best understood within its respective context. He writes that: "Nobody 'speaks' in the language of propositional logic, and we do not expect anybody to teach geography or to find their way by using a formal map (please don't)" (50). The book's style and tenor, while not easy for the lay reader, are not inherent drawbacks to the points Casati makes—many of which resonated with my experience working in the modern GIS industry.

The book starts by walking through the two modes of cognitive operation that, according to the psychological literature, handle reasoning and decision-making tasks. While the geographically-inclined may find this to be a detour, it's a critical foundation of Casati's argument, so I'll recap it briefly here. Mode 1 (M1) relies on memory and rules of thumb, and delivers rough but locally acceptable results, while Mode 2 (M2) is "regulated by will and attention that operates slowly and stepwise, is taxing to memory, and delivers comparatively more accurate results than M1 in many cases" (12). To this pair, he proposes to introduce Modes 3 and 4, both of which involve the use of a "cognitive representational artifact" — something accessory to the thinker, such as a paper map or GPS device (28). In Mode 3 (M3) one engages in a navigational activity — for example, orienting and reading a paper map — while in Mode 4 (M4) one only cares about the solution or destination, and delegates the navigational process to some external device or process. An example of M4 would be "tak[ing] directions from a GPS-based navigation device by listening to the instructions dictated to you" (15).

From a philosophical standpoint, it is helpful to understand how these categories of neural processing influence the definition of "map," but if you are like me, your eyes will periodically glaze over and you'll keep circling back to reread the last few paragraphs. That said, I was intrigued by the idea of M4 cognition. Casati's example of plugging an address into Google Maps, tapping "start," and blindly following the directions reminded me of the "**This is your brain on GPS**" (August 15, 2024) episode of the *Outside/In* podcast. In the worst cases, placing all faith in M4 can go terribly awry, such as the time Google Maps rerouted dozens of drivers out of a dust storm by way of an unmaintained dirt road. Even banal use of M4, as the podcast finds, can change the way we think: unlike many species,

humans are not born with innate navigational skill, and like a muscle that weakens without continued use, our ability to navigate atrophies when we offload the task elsewhere. Understanding why and how our brains process information, from maps as well as other tools and concepts, may help us better understand how we move through and interact with the world.

Of course, navigation is a critical use for a map, and Casati dedicates Chapter 4 to the topic, in large part through exploring the bizarre map at the center of the short story by Jorge Luis Borges titled "On Rigor in Science". Borges writes of a 1:1 representation of space that is superimposed onto the space it represents (a mouthful, I know). It is functionally impractical—but only when our understanding of a map is limited to printed or electronic artifacts. "We usually think of maps as drawn on paper or computer screens. But, fundamentally, maps are representations that are . . . marked arrays" (125). Casati argues that utility markings spray-painted onto streets and sidewalks constitute a type of Borgesian map, as do trail markers. When using a Borgesian map, Point X on the map is in the same place as Feature X is in real life. Casati argues that "all maps are abstractions from Borgesian maps" (129), and what we do is to synthesize the information and repackage it into manageable formats like paper or GIS, artifacts Casati considers "ordinary maps" (79).

If a map is not just the final layout that I make in ArcGIS Pro, or its interactive and 3D counterparts, then what can a map be? Casati defines the concept as "representations where you can physically *locate on them* the *representation* of something's physical location [this can be spatial or temporal, according to Casati] in a *territory, in a certain systematic way*, and they are such that they have the *same dimensionality* of the territory they represent" (41, emphasis from the author). In the category of maps, Casati includes ordinary maps (i.e., what I create in my day job) along with concepts like clockfaces, fMRI scans, certain physical models, sound recordings, some lists, music notation, a line of people waiting for a service (also known as a queue), and "natural maps" (81) like star patterns. As he sees it, a table of contents is a map, while an alphabetical index is not. This is because features or concepts are organized in the table of contents by locational proximity, while elements in the index are ordered by other criteria (by, say, alphabetical order). Similarly, Casati considers fMRI scans—which record data about brain activity—as maps rather than pictures because the false colors in the image correspond to properties, such as blood sugar levels, rather than to an accurate visual appearance (98).

However, there are some components of Casati's definition of a map that differ from what us cartographers may intuit. While he includes the items mentioned above, as well as some map-like concepts — for example, movie sequences that represent real scenes — he expressly excludes railway "maps." It's here that the semantics of philosophy diverge from the lived experience of many laypeople, myself included. While the New York subway map is not geographically accurate, it does accurately maintain topological relationships; relationships that are, in the context of the subway system, every bit as significant as measured distance relationships might be in other situations. Because it allows a train rider to understand where they are in relation to stations and to the routes of other lines, and thus to navigate through space and time, I would argue that most people correctly consider schematic abstractions of train lines to be a legitimate map. Nonetheless, following Casati's argument about how and why maps are what they are, and aren't what they aren't, requires the reader to at least temporarily accept his definitions.

Many maps require their users to apply additional forms of cognition beyond M4, and although I ended up wanting to understand these further, the book does not explore them in depth. For example, while exploring the question of whether and how pictures are maps (the answer: yes, and no), Casati notes that maps can express multiple properties about the same location, but they're not particularly good at representing occlusion, such as when a bridge feature overlaps with a river feature (86). Nonetheless, I know that when we—and I am guessing that this goes for you, too—read a map, we "know" that the bridge does not in fact split the flow of the river, as it literally appears on a map to do, but that the bridge instead goes over the river. When did we learn this? Most of us probably couldn't say exactly, but it is clear that graphic map literacy (understanding that the symbolized bridge exists on a different graphical plane than the symbolized river) is the cognitive key to reading the map—it is how we "know" the relationship of the bridge to the river. Unfortunately, the author does not really engage with this aspect of map comprehension, focusing instead on his categorization of maps as ordinary, natural, Borgesian, or otherwise. Casati does, however, explore the cognition behind the cartographic practice of illuminating terrain from the upper left, which causes relief shadows to fall to the lower right. Using a

satellite image as an example, Casati points out that the natural illumination dictated by astronomical physics can cause us to misinterpret remotely sensed images, as they do not necessarily follow the illustrated convention (93).

While reading this book, I often found myself in a recurring thought pattern: at first I would consider a given concept absurd, but gradually—as I worked my way through Casati's discussion and came to better understand what he meant—I often found that I did not disagree. While his philosophical perspective on maps is, so to speak, a different and interesting snack for my brain to chew on, I would not say it is of particularly practical use for GIS practitioners. That said, it is clear that Casati has a deep respect for the process of making an ordinary map: "Metaphorically speaking, the work of a cartographer is like scratching the scratch-off layer of a lottery ticket and uncovering correspondences place by place. (Of course, cartography in practice is much more difficult than that.)" (60). In this sense, *The Cognitive Life of Maps* might not be a required read for cartographers or GIS practitioners, but it may just help a stagnant mapmaker think about their craft in unconventional and interesting new ways.

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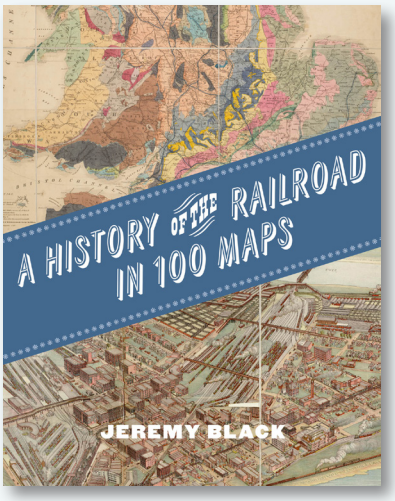

A HISTORY OF THE RAILROAD IN 100 MAPS

By Jeremy Black

University of Chicago Press, 2024

288 pages, 130 color plates

Hardcover: $40.00, ISBN: 978-0-226-83788-8

eBook: $39.99 ISBN: 978-0-226-83789-5

Review by: Daniel G. Cole, Smithsonian Institution

This book provides an eclectic mix of one hundred historical maps documenting the history of railroads around the world, across eight chapters. Each of the maps reproduced in the book, many supported with larger scale detail images, is accompanied by a discussion of their background and context.

An art nouveau–style poster advertising the Gotthard Railway network in 1902 and an 1876 map of the New York Central and Hudson River Railroad with a giant hand pointing out the world's first four track railroad grace the first two pages of the book; even before the title page.

In the "Introduction," the author grandly notes that "mapping rail is in part a history of maps and, in that, a history of map production, map use and perception" (8). Black also points out that the mapmakers had choices to make concerning what the maps would include and exclude. The two maps in this section are the *London Overground map – Autumn 2024*, with each of the different lines labeled with its name and assigned a color (10); and a map of the French national rail network in 1976 (13). These maps have no geographic reference, but with the latter map one can see the shape of France along with the hierarchy of the rail lines. The author finishes this section by claiming that the maps in this book "are reproduced in chapters *organised primarily on a chronological basis*, but within them the arrangement is thematic—principally in geographical terms…" (13, emphasis added).

Chapter 1, "Origins," begins with two illustrations: one depicting a locomotive overturning a mail coach in 1853 (15) and the other an engraving of the work involved in constructing a railway, its bed, and retaining walls (16–17). What follows are ten maps, dated from 1787 through 1859. Most of the maps, like *A Geological Railway & Canal Map of England & Wales and Part of Scotland* of 1843 by Charles Smith, are reproduced well. This is a lovely multi-colored map of geology, rails, and canals that is reproduced in full on page 21 and with closeups of the legend and two portions of the map on the following two pages. Two maps, however, John Gibson's 1787 *Plan of the Collieries…* (18–19) and the 1830 *Map of Canals and Rail Roads of the United States* (38–39) by H. S. Tanner, are overly dark and have poor contrast, and should have been adjusted in Photoshop. Another problem, one recurring frequently throughout this book, is that some of the maps presented fall across the binding gutter, obliterating those portions that fall into the gap. Since Black often has close-ups of portions of the maps, there is no good reason not to reduce the original maps' sizes or cut them prior to entering the gutter.

Chapter 2, "Spreading the New Age 1860–85," starts with the two paintings *American Progress* (1873) and *In the Nineteenth Century…* (1861): focusing on Manifest Destiny and manual labor, respectively (43–44). These are followed by sixteen maps, starting with J. H. Colton's easy to read *Map of Alabama…* (47), which prominently displays rail lines in the state classed as "In Operation,"

"Graded," and "Projected." It should be noted that while neither this map, nor six of the other maps in the chapter, overrun the gutter, there are nine that do cross it unnecessarily. The geographic range of maps in this chapter is wide, and includes the United States, Canada, Panama, Uruguay, Argentina, the Alps, Great Britain, Scandinavia, the Netherlands, and New Zealand. Four of the maps have close-ups depicted as well. For one contrasting example, Black provides both the 1863 and 1880 editions of the *Extent of Sweden's Norway's and Denmark's Railways* (74–75).

Chapter 3, "Geopolitics and War 1885–1918," begins with a two page photograph of work on the Trans-Siberian Railway (82–83) followed by *Stanford's Map of the Siberian Railway. . .* (1904) along with a close-up of its eastern half (84–87). Curiously, Black points out (104) that the map of New Zealand railways (105) labels South Island as Middle Island, but he does not explain when or why that name was used. Again, the problem of cross-gutter map placement occurs with twenty-six of the chapter's thirty-five maps. Although most of the maps in this chapter are relatively easy to read, only four have close-ups, and the readability of several others would have benefited from enlargements, especially the 1851 *New Map of Belgium* by L. Mols (146–147). The geographic range in this chapter includes maps of Asia, Africa, South America, North America, Europe, and Oceania, with scales varying from continent-wide railroads down to rail networks within cities, including three bird's eye views: Kansas City (108–109), Chicago (110–111) and Hull, England (120–121). One map of especial note is the 1894 flow line map, proportional to the freight carried, entitled *France: Railways* (146) by Paul Vidal de la Blache.

Chapter 4, "Alongside Road 1919–39," has seventeen maps (of which ten cross the gutter) collectively covering a wide range of areas and features roads like the Erie Railroad in the United States and the trans-European Orient Express. Both the Swiss map on pages 182 and 183, and the page-spread 3D view of the Alps immediately following, deserve close-ups; as they are, I couldn't tell where the railroads were on those maps. On the other hand, the enlarged portions of the Africa, Poland, Soviet, and Erie Railroad maps are very helpful.

Chapter 5, "War and the Air Challenge 1939–70," has sixteen maps (with ten crossing the gutter), and begins with three maps from World War II: *State of Damage of Rail Centres in Western Germany* (1945, 193), *Burma-Siam Railroad Installations* (1944 195), and *Site Plan for Auschwitz-Monowits* (1944, 196–197). Like the other chapters, the maps that follow cover a variety of countries and regions. Some, such as the 1966 *Major Rail Network* map by W. James Shaw (208–209) appeared in contemporary atlases. Others, like the mid-West to mid-Atlantic states map of the Pennsylvania Railroad, were promotional posters for travelers, and others yet were taken from reports. The promotional posters are typically pictorial in nature and illustrated rail lines as generalized curves or straight lines between stations.

Chapter 6, "Rail Developments 1970–Present," contains thirteen maps (again, with five spread across the gutter) and showcases depictions of rail in the Soviet Union, Malawi, East China, Greater London, Singapore, Illinois, the United States (Amtrak), Tokyo, Germany, and Belgium. It finishes with the *Channel Tunnel Terminal White City* map of 1974 (250–251). No close-ups are provided by the author in this chapter, except a blowup of the legend for the Soviet map, but even that is still too small to be readable.

Chapter 7, "Facing the Future," only has four maps: the Rail Baltica project connecting the Gulf of Finland to the Polish border; China's Belt and Road Initiative global infrastructure development project; the *HS2 Service Map* (2023) of plans to run fast trains between London and the Midlands in the United Kingdom; and the *RRTS Network Phase 1* map (2023) showing a project for the Delhi, India metropolitan area (since re-branded RapidX). All depict present-day existing infrastructure and future plans for rail development in different parts of Eurasia. The first three maps are generalized depictions of existing and planned routes, whereas the Delhi map has plenty of details on the rail lines, stations, and surrounding areas.

Chapter 8, "Rail and the Collective Imagination," contains eight rail maps, starting with one used with a board game from 1850 where players travel between London and Edinburgh (264–267); an 1889 poster map for the Orient Express (269); a (hard to read) pictorial map of the London Tube from 1922 (270–271); a "Map of Galloway for Use with *The Five Red Herrings*" the 1931 Dorothy L. Sayers murder mystery (272–273); a map associated with *The Railway Series*, a British series of children's books that eventually focused on Thomas the Tank Engine (1945; 274–275); and a set of advertisement posters from three

British railroads: *Midland Railway* (277), *England and Scotland East Coast Route…* (278), and *London and North Western Railway* (279). This chapter and these maps appear to me to be an addendum and could have easily been incorporated into the other chapters.

Overall, Black's book provides a survey of the one hundred and fifty year evolution of railroad maps that will be appreciated by railroad aficionados. While I have quibbles about the great number of times that maps fall into the book's gutter, those quibbles could have been addressed had the author (and/or publisher) provided a website on which readers could view, zoom into, or even (maybe) download, the maps in which they are interested. Ultimately, however, I cannot help but feel that while Black provides plenty of good historical and geographical context in his book, he could have provided more discussion about the maps themselves. As a result, it would be better to see this as a book about railroads that is supported by maps rather than a book about railroad maps.

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Robinson, Arthur H., Joel L. Morrison, Phillip C. Muehrcke, A. Jon Kimerling, and Stephen C. Guptill. 1995. *Elements of Cartography, 6th Edition.* New York: John Wiley & Sons.

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