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*Edited by Charles Travis, Deborah P. Dixon, Luke
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COWBOYS, COD, CLIMATE, AND CONFLICT

Navigations in the Digital Environmental
Humanities

*Charles Travis, Poul Holm, Francis Ludlow, Conor Kostick,
Rhonda McGovern, and John Nicholls*

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Introduction

The digital engages five broad research strands emerging in the humanities: firstly, the creation of web-based collections, archives, and text-encoding initiatives; secondly, the reading and analysis of electronic hypertexts; thirdly, the application of geospatial and discursive mapping and coding technologies; fourthly, approaches deploying gaming and 3D immersive visualisations; and fifthly, the explosive growth of big data, social computing, crowdsourcing, and networking opportunities (Holm, Jarrick, and Scott 2015). Digitally enabled syntheses between old (books, archives, maps, paintings, film, etc.) and new types of media (qualitative analysis software, geographic information systems [GIS], social media, gaming and virtual reality platforms, etc.) are becoming increasingly salient to the study of human-environmental relations. In turn, research and teaching initiatives coalescing under the umbrella of the DEH are beginning to address three interrelated phenomena characteristic of the 21st century: the digital revolution, global warming, and sociopolitical agency related to environmental change (Travis 2018). In this milieu, the “new human condition,” to crib a phrase from the political philosopher Hannah Arendt (1961, 59), finds that “the world we have come to live in . . . is much more determined by [humans] acting into nature, creating natural processes and directing them into the human artifice and the realm of human affairs.”

Concerns of the DEH include, firstly, how we come to *know* – with masses of information becoming increasingly available in diverse forms and platform – and secondly, how we *work* – in collaborative, “glocally” scaled endeavours that integrate physical and virtual environments which are changing techniques, workflows, and the ontology of research and teaching practices – and thirdly, how we *understand* – as cybernetic tools and methodologies provide radically new insights into and integrations of “old analogue,” “new digital,” and “natural archival” types of data. These concerns inform the three DEH case studies featured in this chapter. The first offers a geo-literary *eco-digital* geo-hermeneutic on 19th-century US expansion and environmental degradation in the American West; the second offers a “data canon” *precis* on the North Atlantic

“Fish Revolution” between 1500 and 1800; and the third features computer-automated readings of ancient astronomical diaries to analyse ancient relations between climate and conflict in the Fertile Crescent kingdoms of Babylon and Assyria.

Larry McMurtry’s Literary Geography: Eco-Digital Geo-hermeneutics (Charles Travis)

This project engages a panoramic literary geography of the 19th-century American West depicted in a tetralogy of novels by the Texas author Larry McMurtry (1936–2021) collected under the title of the *Lonesome Dove Chronicles* (2010). Humanities geographical information systems (HumGIS) applications were deployed to explore McMurtry’s literary perceptions and representations of the American Southwest and Rocky Mountain West during the expansion of the United States in the 19th century. The *Larry McMurtry’s Literary Geography (LMLG)* project funded by the University of North Texas Libraries at McMurtry’s *alma mater* draws on the *Portal to Texas History* digital data collection to perform an *eco-digital* geo-hermeneutics on his collective works.¹

McMurtry’s saga on the closing of the American West, McMurtry borrowed character tropes from Miguel de Cervantes’ (1547–1616) *Don Quixote* (1605–1615) to depict the lives of Augustus “Gus” McRae, a raconteur from Tennessee, and his stolid partner, Woodrow Call, and recount their days as filibusters, Texas Rangers, and cowmen. McMurtry observes that the “crazy old knight and the peasant pragmatist” comprised “an essential pair” and were “the ultimate source of Gus and Call” (McMurtry 2008, 10). The duo’s rambles through the American Southwest and Rocky Mountain West regions during the expansion of the United States in the 19th century were inspired in part by Charles Goodnight (1836–1929) and Oliver Loving’s (1812–1867) pioneering cattle drive from Texas to Montana in 1866. The *Chronicles* spans five decades of western historical and cultural geography, despite chronological slippages between the four novels that comprise it. It commences in the 1840s with *Dead Man’s Walk* (1995), then spans the 1850s–1860s in *Comanche Moon* (1997). Its titular novel, *Lonesome Dove* (1985), ranges from the late 1870s, and *The Streets of Laredo* (1993), the *Chronicles*’ concluding work, is set in the 1890s.

By navigating the online 3D Google Earth tours of the four novels on the *LMLG* project page, one can journey with Gus and Call as Santa Fe filibusters, and Texas Rangers and join their cattle drive from Texas to Montana (Figure 1.1). Reading the *Chronicles* while navigating the Goggle Earth tours illuminates an observation Annie Proulx (2008, 8) made in *Dangerous Ground: Landscape in American Fiction* on the experience of a “viewer/writer/reader” of a text who

stands metaphorically in both the unwritten and the written landscapes, enters the territory on the page the same time it is created in the mind – a profound involvement with place through real three dimensional landscapes and the described and imagined landscape.

By zooming in and out on the Google Earth tours, a reader can hop from Mexico City to the Rio Grande in south Texas and jump to the west of the Pecos River and the Great Plains in the Oklahoma and Kansas Territories. One can traverse the Palo Duro Canyon, the arid *Llano Estacado* (Staked Plains) of west Texas, cross the Powder River basin of Wyoming and ford the Missouri River to the lush pastures of the Milk River Valley in northwestern Montana. The historian John Lewis Gaddis (2011, 48) notes that the most distinctive characteristics of Russian novelist Leo Tolstoy’s (1869) epic *War and Peace* (*Война и миръ*) are “the great shifts of scale that



Figure 1.1 Homepage of the *Lonesome Dove* Google Earth tour.

Source: The Portal to Texas History and Charles Travis.

take place within it.” Tolstoy, Gaddis writes, “zooms out . . . to show us great armies sweeping across Europe, and the back in to focus on . . . the ordinary soldier’s point of view,” concluding “Google Earth, for all its own zooming in and zooming out, has nothing on Tolstoy.” The *Chronicles* encompasses similar shifts in scale, and though accepting Gaddis’ point, reading McMurtry’s work in concert with the Google Earth tours, one can undertake an *eco-digital* geo-hermeneutic journey across the Great Plains and Rocky Mountains.

Proulx (2008, 7) defines a “deep landscape novel” as a work “in which the story that unfolds can only happen . . . where it happens.” The *Chronicles* adheres to Proulx’s classification and “deep mapping” concepts juxtaposing textual, virtual, and actual landscapes that provide heuristics to integrate literary, cultural, and historical geography with HumGIS methods and literary and textual studies and conduct this chapter’s *eco-digital* geo-hermeneutics on McMurtry’s works. By incorporating a “reflexivity that acknowledges how engaged human agents build spatially framed identities and aspirations out of imagination and memory,” deep mapping techniques deployed in the creation of the Google Earth tours (Figure 1.2) illuminate “how the multiple perspectives constitute a spatial narrative that complements the prose narrative traditionally employed by humanists” (Bodenhamer, Harris, and Corrigan 2015, 20; Travis 2020a, 2020b).

By navigating across the tours’ remotely sensed landscapes, readers can hermeneutically transpose the *Chronicles*’ apocalyptic sunsets, raging rivers, majestic cloud-filled horizons, dew-laden mornings, alkaline badlands, buffalo skull pyramid racks, and grasshopper swarms on the digitised environments produced by a Landsat/Copernicus satellite lens. In addition, one can locate in the tours where deadly biblical scale dust, hail, and lightning storms kill one cowhand and a poisonous nest of moccasin vipers kills another – boys just on the cusp of manhood, never to partake of the ritual pleasures of life in the saloons and bordellos of Ogallala, Nebraska, a place Gus describes as the “Sodom of the Plains” (McMurtry 2010, 1313). In this regard, McMurtry’s

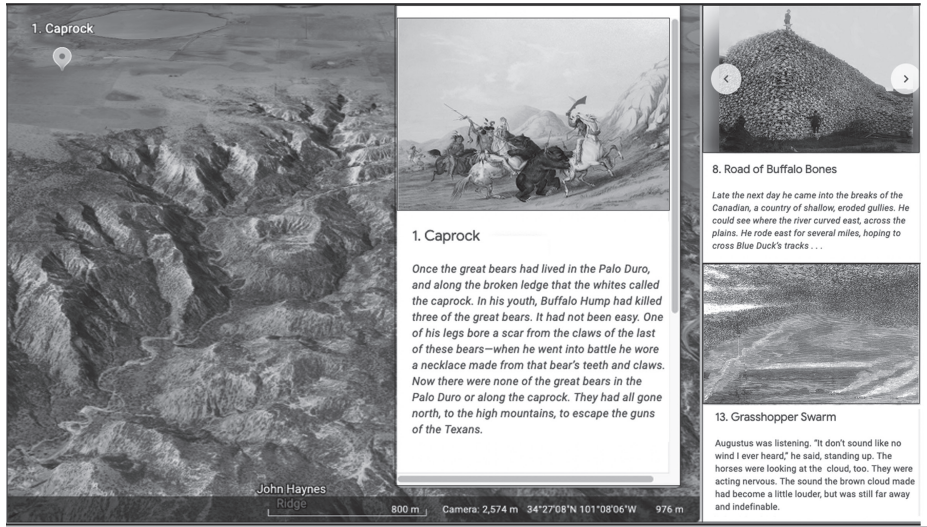


Figure 1.2 3D Google Earth tours of a Comanche bear hunt on the edge of the Llano Estacado, Road of Buffalo Bones in the Canadian River basin, and Great Plains grasshopper swarm, featured on *The Larry McMurtry's Literary Geography* project page.

Source: Larry McMurtry and Charles Travis.

Chronicles, like Cervantes' *Don Quixote*, "does not disentangle the story from the history, but points its telescope at the ill-defined frontier itself" (Wardropper 1965, 5). Contemplating the settlement of the United States west of the Mississippi River, McMurtry (1990) observes,

To understand the westward expansion, one needs not merely the explorer and the scientist, but the artist as well. From the beginning artists were part of the enterprise – and a vital part of it, for it was the artists, rather more even than the explorers or the scientists, who ended up selling the West to the East. To a great extent that there was a West of the imagination – and this was the West that most Americans knew – it was the artists, not the pioneers, who created it.

McMurtry's writing weaves together Gaelic and Indigenous "folklore and American frontier history" and storytelling to depict transgressions of "physical, psychic, and geographical borders" symbolised in the "Western" as "a simple adobe wall, an otherworldly dimension, or a mountain chain" (Quintelli-Neary 2004, 44). It is not a stretch of the imagination to hear echoes of the seventh-century Irish epic *Táin Bó Cúailnge* (*The Cattle Raid of Cooley*) in McMurtry's storylines. In the *Chronicles*, the Mexican-American War (1846–1848) and American Civil War (1861–1865) manifest as distant thunder over the narrative horizon of its four novels. The US Army and Plains Indian Wars (1865–1890) and General George Armstrong Custer's denouement at Little Big-Horn (1876) are also depicted peripherally.

In contrast, McMurtry's fictive renderings of the freebooting 1841–1842 Texan–Santa Fe and Mier Expeditions (*Dead Man's Walk*), the Texas Ranger–Comanche Wars with the Penateka war chief Buffalo Hump between 1850–1870 (*Comanche Moon*), Goodnight and Loving's 1866 pioneering cattle drive (*Lonesome Dove*), and the rise of the Railroad Barons in the 1880s–1890s (*Streets of Laredo*) provide period detail, if not pedantic history. In the *Chronicles*, McMurtry

(2010, 1203) depicts one of Gus' rueful reflections on the "closing" of the Western "frontier" as a panoramic coda:

In the north, the Army had finally taken the fight against the Comanches away from the Rangers and had nearly finished it. . . . After the [American civil] war, the cattle market came into existence and the big landowners in south Texas began to make up herds and trail them north to the Kansas railheads. Once the cattle became the game . . . he and Call quit rangering. It was no trouble for them to cross the river and bring back a few hundred head to sell . . . they had roved too long, Augustus concluded. . . . They were people of the horse, not of the town; in that they were more like the Comanches than Call would ever have admitted.

In his epic poem *Cycle of the West* (1919–1941), Nebraska poet laureate John G. Neihardt (1881–1973) portrayed the industrial re-territorialisation of the Great Plains from an Indigenous perspective:

In all this wild beginning; saw with fear
Ancestral pastures gutted by the plow,
The bison harried ceaselessly, and how
They dwindled moon by moon . . . (2018, 315)

Neihardt's poem cycle imparts "the last great fight for the bison pastures of the Plains between the westering white men and the prairie tribes" as "the struggle for the right of way between the Missouri River and the Pacific ocean" (Miller 1928, 125). Though Indigenous subsistence hunts did contribute to winnowing the massive herds, in particular the culls of American buffalo hunters, in search of hides and the incidental "sport" of easterners who shot the animals for amusement from passing trains, dwarfed the bison harvests of the Great Plains tribes. Ironically, the explorer Charles Frémont stated that bison trails should direct the US transcontinental railway in the Rocky Mountain West, arguing "that the buffalo was the best engineer, because he found that the great herds when going North for the winter crossed the upper passes, following the line of least resistance" (Rogers 1905, 272). McMurtry's *Chronicles* intertextually echoes the biogeographical destruction of the North American species lamented in Neihardt's verses. During a cattle drive, Gus is stopped in his tracks by the desolation in the Canadian River basin wrought by hunters and the industrial east's market for "buffalo coats":

[He] was amazed to see an enormous pyramid of buffalo bones perhaps fifty yards from the water. The bones were piled so high. . . . Down the river a quarter of a mile there was another pyramid, just as large. . . . He saw five pyramids of bones between the crossing and Aus Frank's camp, each containing several tons of bones.

(McMurtry 2010, 1567)

Another example of McMurtry's biogeographical eye is his depiction of a massive grasshopper swarm on the Great Plains. The extinct Rocky Mountain locust (*Melanoplus spretus*) once covered the West in leviathan swarms until the end of the 19th century. One famous Nebraska sighting in 1874 was estimated to range 198,000 square miles in size, weigh 27.5 million tons and speculated to comprise 12.5 trillion insects (Garcia 2000). In McMurtry's cattle-drive novel *Lonesome Dove*, the Hat Creek crew find themselves on the Great Plains in high summer when they spy a towering dark cloud looming on the horizon. The grasshopper swarm, vivid and

tactile in McMurtry’s depiction, revives memories of 19th-century extinctions like the passenger pigeon:

The sound the brown cloud made had become a little louder, but was still far away and indefinable. Suddenly Augustus realized what it was. “Good lord,” he said. “It’s grasshoppers, Lorie.” . . . The cloud covered the plain in front of them from the ground far up in the air. It was blotting out the ground as if a cover were being pulled over it. . . . The hum they made as they spread over the prairie grass was so loud Lorena had to grit her teeth. . . . The cowboys who saw the cloud while on horseback were mostly terrified. . . . The sunshine glinted strangely off the millions of insects.

(McMurtry 2010, 1657)

The historical geography described in the *Chronicles* maps out the expanding borders of the United States from the 1840s to the 1890s. During this period, the statistical cartography of the US Census Bureau (Figure 1.3) enumerated the lower 48 states, and the Indigenous and colonial *conquistador* trails of the West were transformed into an industrial webbing of railway lines, telegraph wires, and steamboat routes which contributed to populating and re-territorialising the natural and cultural landscapes of the once North American frontier.

Socially, McMurtry compares *Lonesome Dove* to George Eliot’s (1819–1880) provincial British Midlands novel *Middlemarch* (1871–1872), set in 1831 during agricultural and parliamentary reforms dominated by the “technological and empiricist practices of an expanding capitalism” and ensuing industrial re-territorialisation. *Middlemarch*, historically contextualised by emerging English railways, the accession of King William IV and the passage of the Whig-sponsored 1832 Great Reform Act by the British Parliament, is also in a period that finds railway surveyors mapping rural landscapes meeting violent resistance from local farmers (Breen 1993, 48; Walton 1994).

In turn, the *Chronicles* counter the east-to-west geographical teleology under pinning the spatial historiographies of American expansion. The historian Patricia Limerick (1992, 1022) called for a revision of “east-to-west process” geo-historiographical model of US exploration and settlement by recognising the prior presence of Indigenous communities and the northward,

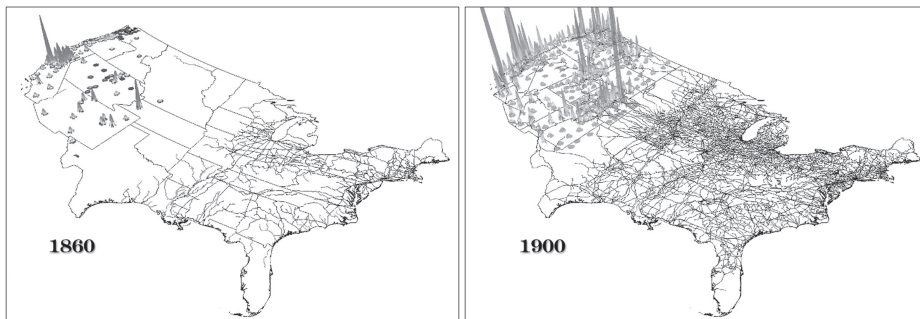


Figure 1.3 Railway and urban population expansion in the American West, 1860–1900.

Source: United States Census Bureau Data 1860 and 1900, sourced from Steven Manson, Jonathan Schroeder, David Van Riper, and Steven Ruggles. *IPUMS National Historical Geographic Information System: Version 14.0* (Database). Minneapolis, MN: IPUMS. 2019; Railroad Networks 1870–1890. *Jeremy Atack, “Historical Geographic Information Systems (GIS) database of U.S. Railroads and Steamboat Routes for 1860, 1900.”* Maps: Charles Travis.

southward, and eastward migrations of peoples from Mexico, Canada, and Asia. The Google Earth tour mappings of McMurtry's tetralogy illustrate (Figure 1.4 a and b) that the geographical arcs of the *Chronicles* run on a south-to-north axis from inside Mexico to the Canadian border rather than along the traditional east-to-west axis portrayed in John Gast's (1842–1896) 1872 painting *American Progress* or by historian Frederick Jackson Turner (1861–1932), who asked the audience of his 1893 address *The Significance of the Frontier in American History* to

[s]tand at Cumberland Gap and watch the procession of civilization, marching single file – the buffalo following the trail to the salt springs, the Indian, the fur-trader and hunter, the cattle-raiser, the pioneer farmer – and the frontier has passed by. Stand at South Pass in the Rockies a century later and see the same procession.

(Turner 1893)

However, Herbert Bolton (1870–1953), Turner's student, viewed US history from a hemispheric perspective in *The Epic of Greater America* (1933). Arguing that traditional historiography obscured subjects that "seemed secondary," Bolton contends that through a "borderland" heuristic lens, such narratives become "outstanding and primary" and vital to understanding the cultures that created the United States (1933, 473–74). In regards to American *tabula rasas* concerning the West and frontier, Limerick states, "The notion of a pristine wilderness is deservedly in tatters; the discoverers now appear as late arrivals in an already fully occupied and much affected landscape" (1992, 1022). She recommends "to think of the West as a place – as many complicated environments occupied by natives who considered their homelands to be the center, not the edge" (1987, 26), in addition to a physical landscape that is "actual, material, and substantial – something in the soil, a set of actual places . . . holding layer upon layer of memory" (2000, 28).

Furthermore, Walter M. Kollmorgen (1969, 216–17) notes that the "early range cattle industry of the West" depicted in *Lonesome Dove* "had its antecedents in the pastoral activities of Spanish America and, more remotely, in the *meseta* of Spain," the high Castilian plateau of La Mancha, where Cervantes set his novel *Don Quixote*. Gus and Call, as American reincarnations of the Errant Knight and Sancho Panza, illustrate Bolton's remapping of the West as a "meeting place and fusing place of two streams of European civilization, one coming from the south, and the other from the north" (Hämäläinen and Truett 2011, 341).

The geonarrative trajectory (Figure 1.4) of the *Chronicles* ranging from Mexico City in the south to Montana's Milk River Valley in the north parallels Bolton and Limerick's perspectives, as well as Pekka Hämäläinen's observation that "the rise of Plains Indian horse cultures along an orientation of grasslands, which meant that the northward spreading frontier crossed several climatic belts" (2003, 835) and its temporal setting intersects with the period during which the Industrial Revolution in England was catastrophically unsettling the agrarian and labour market economies of the British Isles. Prime examples include the Scottish Highland Clearances in the 18th and 19th centuries in the shadow of the 1746 Jacobite loss at the Battle of Culloden and the 1848 Irish Famine. Marguerite Quintelli-Neary (2004, 22) observes that such events caused the "despised races of the Celtic fringe" from "Wales, Ireland and Scotland" to migrate to America. Many headed West, beyond the boundaries of the Anglo-centric East Coast of the United States. Woodrow Call, who claims fierce allegiance to his American identity, is a member of this Celtic/Welsh/Gaelic "fringe" diaspora and is reminded by Gus, "You was born in Scotland . . . I know they brought you over when you were still draggin' on the tit, but that don't make you no less a Scot" (McMurtry 2010, 1144). McMurtry, a scion of a modest cattle-ranching family based in Archer City, northeast Texas, drew inspiration for the *Chronicles* from his first-hand experience with cattle, family memories, and genealogical lore, recalling:

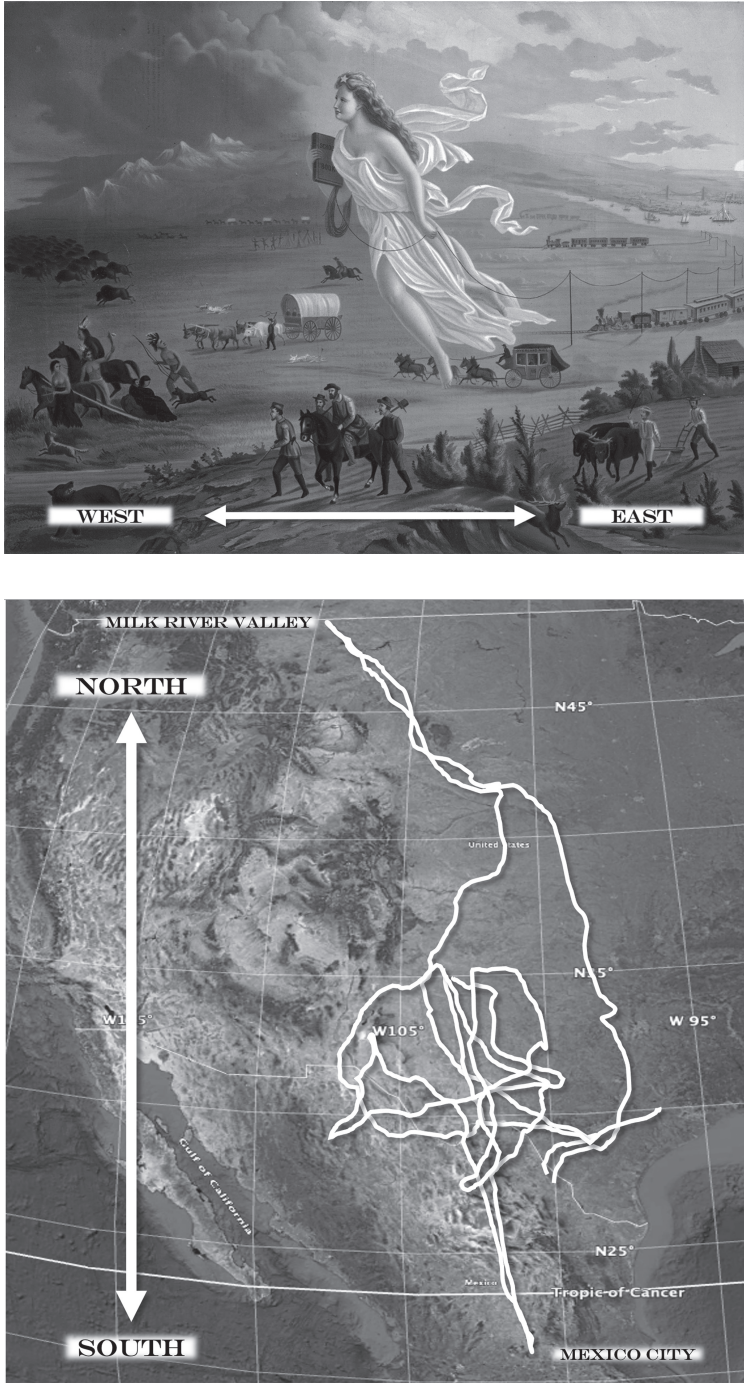


Figure 1.4 (a) *American Progress*, 1872, by John Gast, east-west axis geonarrative teleology. (b) Composite of *Lonesome Dove Chronicles* north-south axis geonarrative teleologies: *Dead Man's Walk*, *Comanche Moon*, *Lonesome Dove*, and *Streets of Laredo*.

Sources: Wikimedia Commons and Charles Travis.

Before I was out of high school I realized I was witnessing the dying of a way of life – the rural, pastoral way of life. In the Southwest the best energies were no longer found in the homeplace, or in the small towns; the cities required these energies and the cities bought them. . . . The cattle range had become the oil patch; the dozer cap replaced the Stetson almost overnight. The myth of the cowboy grew purer every year because there were so few actual cowboys left to contradict it.

(McMurtry 2006, 11)

Like Cervantes' depiction of the Plains of La Mancha, McMurtry parses the cultural and physical geographies of the American West, Southwest, and Rocky Mountain regions through the cracked lenses of myth, fiction, and history.

The NorFish Project (Poul Holm and John Nicholls)

The lack of quantitative assessment of the early modern fisheries has caused fishery scientists and historians to seriously underestimate the impact of pre-modern fishing efforts and total landings of two main commercial fish species: North Atlantic cod and Northeast Atlantic herring. This was the hypothesis of the NorFish project (Environmental History of the North Atlantic Fisheries, 1500–1800) (Holm et al. 2019), which employed big data analytics, deep chart mapping, and historical ocean productivity, modelling on the basis of multinational, multi-archival research (Travis and Holm 2016; Travis et al. 2020; Rankin and Holm 2019). In the end, NorFish published data concerning 25 fisheries containing more than 6,000 landing records (of

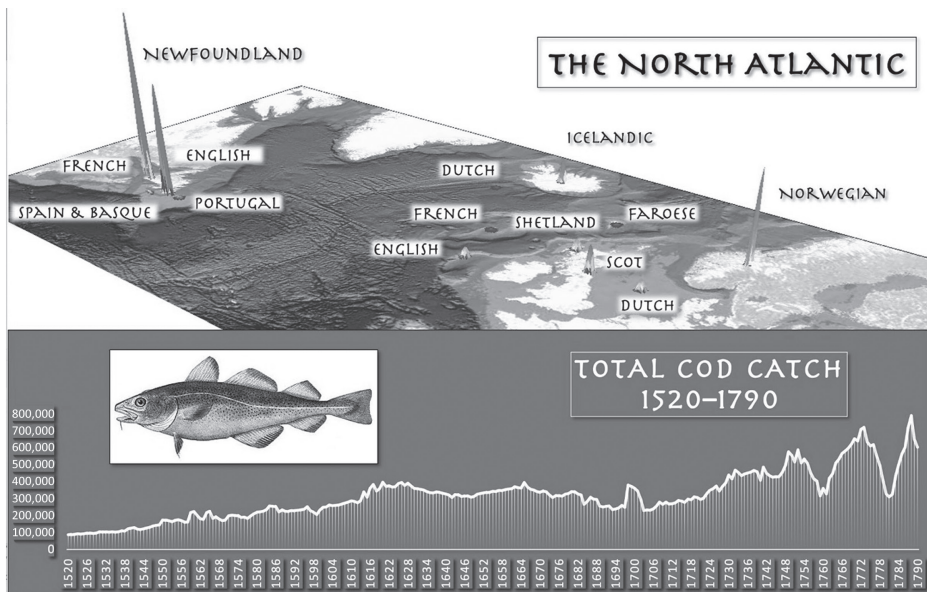


Figure 1.5 North Atlantic cod harvest, 1520–1790. Spikes in 3D visualisation symbolise the number of cod harvested by country per location during the period.

Source: P. Holm et al. 2021. *Extractions of North Atlantic cod and herring, 1520–1790*; cod image, *Wikimedia Commons*. Graph and 3D visualisation: Charles Travis.

typically ten or more variable attributes) in addition to a historical cartography and qualitative document database on the site Figshare (Holm et al. 2021). The project adopted a multidisciplinary, humanities-led approach to establish a robust quantitative framework of maritime extractions, supplies, and prices while also chronicling and parsing the subjective preferences and political motivations of actors who took part in the early modern Fish Revolution across the North Atlantic.

Employing DEH methods, NorFish discovered that marine extractions during the early modern period, c. 1520–1790, vastly exceeded previous assumptions. The project found that North Atlantic fisheries for cod and herring were of an order of magnitude comparable to levels measured during the Industrial Revolution, challenging notions of relatively unimpacted pre-industrial-age marine ecosystems. We identified two periods of Accelerated Marine Extractions (AME) respective episodes between 1540–1620 and 1750–1790, when growth rates of fish landings were higher than human demographic growth. These periods of AME point to the contribution and impacts of fish supplies on the expansion of early-modern societies (Holm et al. 2021). Quantifying data extracted from historical sources, such as archival records, documents, and cartography, in addition to scholarly publications, is a multifaceted task. The NorFish team was composed of multilingual historians (Scandinavian, German, Flemish, French, Spanish, Portuguese, and English), as well as archaeologists, biologists, geographers, and a mathematician. All NorFish researchers produced data requiring curation by a full-time data manager. In a landmark development, data on French and English, Northwest Atlantic cod fishing and catches were rigorously analysed and processed. In turn, data derived from combinations of archival materials, existing scholarly articles and academic datasets revealed large gaps created by missing and/or unknown data points. To obtain viable estimates of actual catches, a novel capacity trend method (CTM) was created. The application of CTM filled gaps in port records by extracting a simple progression extrapolation (variable trend) from aggregated annual effort values of primary ports to fill missing data on secondary ports and determine complete annual capacity trends with transparent levels of detail and accuracy (Nicholls, Allaire, and Holm 2021). Subsequently, CTM may be used to analyse other historical data series that have patchy coverage across time and space.

While historians focus on deriving meaning, insights, and facts from qualitative and quantitative information, a data manager seeks to impart a scientific taxonomy upon extracted data by applying meticulous planning, verification, and formatting to transform raw data into thematic datasets. Data are only as good as the quality of the research that led to their discovery and are meaningless unless accurately cited and sourced. The project identified various types of data outputs that had to be constructed into viable thematic datasets and series and rendered compliant with the NorFish data management framework. At the basic level, the Dublin Core (DubC) standard was employed to formulate data strings into a static foundation of named fields that were clearly defined and rooted in data management conventions. The NorFish cartography data was handled in such a manner, enabling complex data strings to be established in simple, well-defined terms (e.g. Travis et al. 2020; Rankin and Holm 2019). Similarly, the documented outputs of the project, including large online databases, were formatted into DubC standard structures to ensure transparency and simplicity.²

In addition, NorFish generated a large number of multidimensional datasets with spatio-temporal and taxonomic elements. Interspersed with and contextualised by relevant quantitative and qualitative datum fragments, these sets contributed information for the project's various peer-reviewed publications. The DubC standard was applied to these sets to enable data to reach its full and relevant research potential. The addition of specific species data in

taxonomic fields meant that the refined and robust Darwin Core (DwC) standard could be superimposed on these datasets. DwC incorporates a rigorously validated taxonomic perspective into DubC, enabling clear metadata to be established and underlying data to be formatted to optimal effect. A positive by-product of applying such criteria was that it conforms to de facto standards for representing marine species data, attracting inclusion in the United Nations Educational, Scientific and Cultural Organization's Ocean Biodiversity Information Systems (UNESCO OBIS) big data platform. As the largest public domain resource of marine animal species biodiversity in the world, the UNESCO OBIS includes 80 million individual records from over 4,250 datasets, including well over 150 million measurements and facts.³ Furthermore, this criterion complements and supplements the Oceans Past Initiative (OPI) legacy History of Marine Animal Populations (HMAP) data store, making OPI a major provider of historical datasets.

A rigorous process of formatting, testing and verification was required to produce each DwC-ready dataset. The NorFish data was placed in correct pre-defined fields, several of which were exclusively created and required to ensure interaction with the larger DwC environment. For NorFish, named data fields were matched exactly to data gathered from meticulous research. Lists of data then had to be verified manually and computationally. Visual checks were carried out to account for any obvious errors or omissions. This was followed by having the data run through established DwC "R" programmed sequences to test various elements, such as the correct use of taxonomic naming conventions, viable coordinate locations, and temporal reliability. Following any corrections and revisions that may have been necessary, the NorFish DwC data were entered into an Integrated Publishing Toolkit (IPT) established by the Global Biodiversity Information Facility (GBIF). The data then followed yet another series of verifications and checks before being harvested into the OBIS database.

While this level of detailed scrutiny provided clean data, it was also necessary to generate supporting documentation so that the datasets could be accurately contextualised within their historical settings. These documents provide anyone who accesses NorFish datasets with a full description of the data fields but also provide datum sources and brief historical backgrounds for clarity. Published academic articles and outputs from the NorFish data canon routinely reference these datasets, which are integral to understanding the conclusions reached by the NorFish project (Nicholls, Allaire, and Holm 2021).

The comprehensive documentation of historical North Atlantic fisheries enables future researchers to ask questions previously considered unanswerable. An example of the enduring value of NorFish's data is a newfound clarity on changes in fish consumption preferences from the late medieval to the early modern period. The most important human benefit of elevated marine exploitation during this period was increased food security. The annual consumption of herring and cod almost doubled during the 16th-century Fish Revolution, reaching from 2.9 to 5.7 kilograms per capita by 1790. Indeed, total seafood consumption in West Europe averaged 10 kilograms by 1790, but with significant regional differences. This amount stands in comparison with the global average fish consumption of close to 10 kilograms in 1960. Access to the cheap, dried protein offered by herring and cod was critical to food security in pre-industrial societies. Dried or salted fish kept well and was generally less expensive than beef during spring months when grain and meat stocks ran low. Consequently, its increased availability likely played a significant role in the demographic rise of modern Western Europe.

The NorFish project's mixed-methods approach highlighted geographical shifts in fishing from east to west, finding that herring was increasingly sourced from the North Sea

rather than the Baltic, while cod was harvested more predominantly from the Northwestern Atlantic rather than its Northeastern waters. Geopolitically significant, this reorientation was also discovered, occurring at regional levels, with fluctuations found in the Irish and Celtic Seas, the Danish North Sea fisheries, the Baltic and the North Atlantic islands. As fish shifted from being an expensive and limited resource in the late Middle Ages to a relatively cheap and abundant commodity by early modern times, environmental and societal changes ensued.

The Fish Revolution of the 1500s impacted demographics, politics, and market-driven economies, with the strategic importance of the trade becoming evident to all major Western European powers. Inverse effects of war and peacetime were reflected in fish stock increases during periods of conflict as fishing slowed or halted. NorFish concludes that the “Great Fishing Experiments” of the First and Second World Wars saw similar respites that increased Newfoundland cod stocks during the Napoleonic Wars. Warfare largely mirrored downturns in fishing and upturns in stocks. From the 1630s until the Treaties of Utrecht (1713–1714) – a period of protracted wars – fish stocks rose as fishing fleets were pillaged or destroyed, leading to lower catch landings. Fishing crews were often taken captive, with their vessels appropriated for naval refitting and warfare. Volatility was the norm, with piracy and conflict in full sway. Fish markets outside of European theatres of conflict fared slightly better, such as the Newfoundland, Caribbean, and Iberian trade triangle, but cargo interceptions and attacks on fishing grounds were commonplace. Despite these dangers, rising prices sometimes encouraged fishing crews to risk going to sea. Peace brought a steady rise in fishing efforts as relative periods during the 16th and 18th centuries witnessed elevated marine extractions and ensuing prosperity.

Impacts of climate change, as documented by fall in temperatures and increases in storms late in the 17th century, more than likely had a negative impact on fishing efforts as fish stocks fell due to the reduced abundance of zooplankton in the oceanic food chain. Additionally, predator-prey phenomena and volcanic eruptions may have contributed to the geopolitical contexts of fisheries. The phenomenon of oscillating production levels between Northwestern and Northeastern waters may potentially be explained by biophysical changes across the North Atlantic. These questions will now be addressed on the basis of solid evidence by the funded for a six-year period through 2027 by the European Research Council.⁴ In this sense, NorFish is proof of concept that assembling a global environmental history of humans and marine resources with contributions from various DEH methods can indeed be undertaken.

The CLICAB Project (Francis Ludlow, Conor Kostick, Rhonda McGovern)

The Climates of Conflict in Babylonia (CLICAB) project is an interdisciplinary venture that considers evidence from natural and human archives using quantitative and qualitative methods to pursue two central hypotheses. Firstly, climatic changes, including periods of extreme weather, influenced patterns of violence and conflict in the ancient Near East, thereby playing a key role in this formative region and era of world history. Secondly, the nature of any linkage between climate change, violence, and conflict varies through time and space according to evolving socio-economic, political, cultural, and broader environmental contexts. To test these hypotheses, the CLICAB project has focused upon the kingdoms of Assyria and Babylonia (centred in present-day Iraq and Syria) during the first millennium BCE, with four aims.

First Aim: Reconstructing Assyrian and Babylonian Hydroclimates

Written sources available for these Fertile Crescent kingdoms are rich with relevant observations, so producing new climatic reconstructions from such documents has been the project's first aim. Limited access to important environmental data due to regional conflicts and hydropolitics over water access (associated with dam building) have obstructed record-keeping and promoted secrecy. As a result, records from ancient Babylon may provide longer and higher-quality time series of variables, such as monthly Euphrates River levels, than do modern era data sources (Yilmaz 1995; Vörösmarty, Fekete, and Tucker 1996; Slotsky 1997; Lein 1998; Kirschner and Tiroch 2012; Huijs, Pirngruber, and van Leeuwen 2015). Ancient measurements were preserved in “astronomical diaries” created by Babylonian court astronomers who systematically recorded daily celestial and meteorological phenomena between the eighth and first centuries (Haubold, Steele, and Stevens 2019). With few exceptions, the meteorological content of these diaries has not been assessed for environmental reconstructions (Huijs, Pirngruber, and van Leeuwen 2015; Sigl et al. 2015; Ludlow, Kostick, and Morris 2022). Categorisation and extraction of this data for the first four centuries BCE, the period in which surviving diaries are most heavily concentrated, forms the foundation of CLICAB's climatic reconstructions.

More disparate sources, including annals and chronicles (e.g., Luckenbill 1924; Grayson 2000 [1975]; Glassner 2004; Budge 2009 [1902]), inscriptions (e.g., Piepkorn 1933; Nissen 2003), administrative records, personal and official correspondence (e.g., Parpola 1987; Lanfranchi and Parpola 1990; Moran 1992; Hunger and Cole 1996; Parpola 2014), astrological reports (e.g., Hunger 1992), and even some literary texts, such as epics and the Sumerian city laments (e.g., Vanstiphout 1980), yield important data on the incidence and perceptions of meteorological and related environmental phenomena, in addition to incidences and responses to societal stressors, such as epidemic disease, subsistence crises, migration, and conflict (e.g., Kleber 2012; Radner 2015). While such sources cannot offer systematic observations as found in the diaries, collectively they offer greater chronological and geographical span and scope, allowing the creation of a “master chronology of extreme weather, conflict and societal stress” for the first millennium. CLICAB has to date surveyed 18 (of 21 presently available) online volumes of the *State Archives of Assyria*, a landmark series that has published many such sources.⁵ Overcoming challenges in using such materials requires methods from the field of historical climatology, which sits at the intersection of climatology and environmental history (Pfister 2007). The field's methodological advances have involved identifying, categorising, and assessing the historical reliability of written descriptions of relevant phenomena and quantifying such information for the purpose of reconstructing past climates. Even if not explicitly using the term DEH, STEAM research by Ludlow and Travis (2019) and the “consilient” approaches of Izdebski et al. (2022), and others adopt such methods.

Although computerised content analysis applied to an ever-growing body of digitised historical sources can empower all work in the humanities, automated close and distant reading methods can also promote detachment from the source material and its historical-geographical context, potentially undermining credible interpretations.⁶ However, this is not limited to the digital age; for example, Thomas Short's *A General Chronology of the Air, Weather, Seasons, Meteors, Etc.* (1749), an infamous early modern work in historical climatology, was critiqued for paying too little attention to the reliability and independence (or “witness status”) of its sources. Indeed analogue or digital reconstruction biases are often compounded by inclusions of misdated, duplicated, exaggerated, misidentified, fabricated, or otherwise dubious reports (Bell and Ogilvie 1978; Ogilvie and Farmer 1997).

While historical climatologists now widely stress the need for the assessment of source reliability using methods from critical philology and literary textual and source analyses, a persistent lack of practical guidance and case studies to meet this need exists. In addition, positivist stances of many historical climatologists on determining source reliability rarely acknowledge indeterminate cases, in addition to the subjectivity and potential for error on the part of the assessor. In creating a chronology of extreme weather reports from the medieval *Irish Annals*, Ludlow (2010) established a simple scale of *apparent reliability* (AP) reflecting this reality. Allowing readers to see all potentially relevant reports annotated by the AP scale rather than silently excluding those reports deemed unreliable opens avenues for further analysis if a report proves to be genuine or receives independent corroboration, in addition to providing insight into how chroniclers perceived and interpreted natural phenomena.

Informed by this work, CLICAB has designed a schema for coding and extracting the content of the astronomical diaries and more disparate sources. Enhanced by DEH-relevant textual analysis and encoding tools, the schema provides the means to reconstruct precipitation, cloudiness, atmospheric opacity, and wind direction (Figure 1.6) alongside ancient Euphrates River levels and other regional hydroclimatic variables. It was also recognised that climactic records could be considered “politically sensitive” as celestial and terrestrial phenomena such as comets, eclipses, earthquakes, storms, floods, and droughts were considered potential omens in the Ancient Near East that might portend fortune or misfortune for rulers and their societies.

It was thus posited that such phenomena might influence what court astronomers recorded in the diaries, potentially impacting the completeness and type of content recorded. For example, after the Neo-Babylonian Empire fell to the Persians in 539 BCE, rulers such as Darius III and Xerxes were known to have decommissioned temples and removed priests and scribes in a deliberate snub to the Babylonian way of life and a shift away from “cuneiform culture” (Robson 2019).

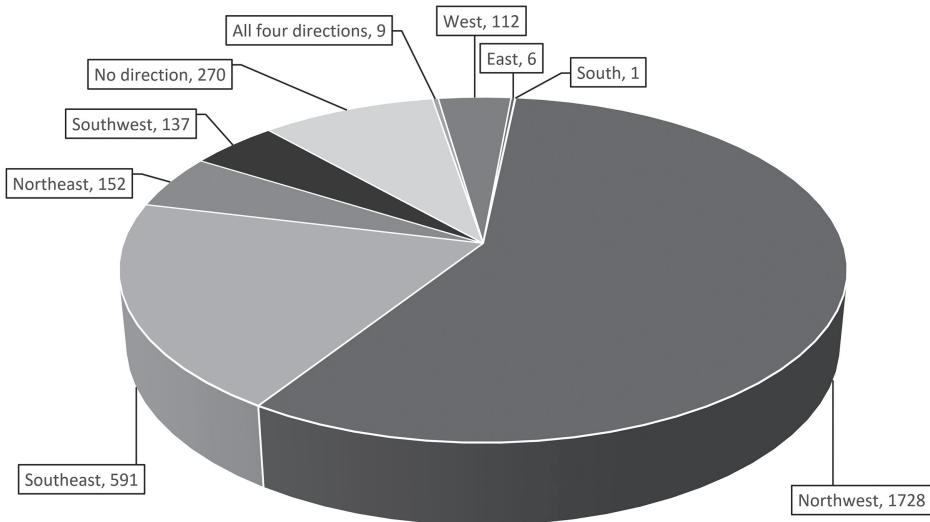


Figure 1.6 *Wind Direction Observations, Astronomical Diaries 652–61 BCE.* exemplifies the meteorological data abundantly reported in the surviving diaries, with this figure following the categories offered by the astronomical diaries themselves.

Source: Rhonda McGovern (provisional data).

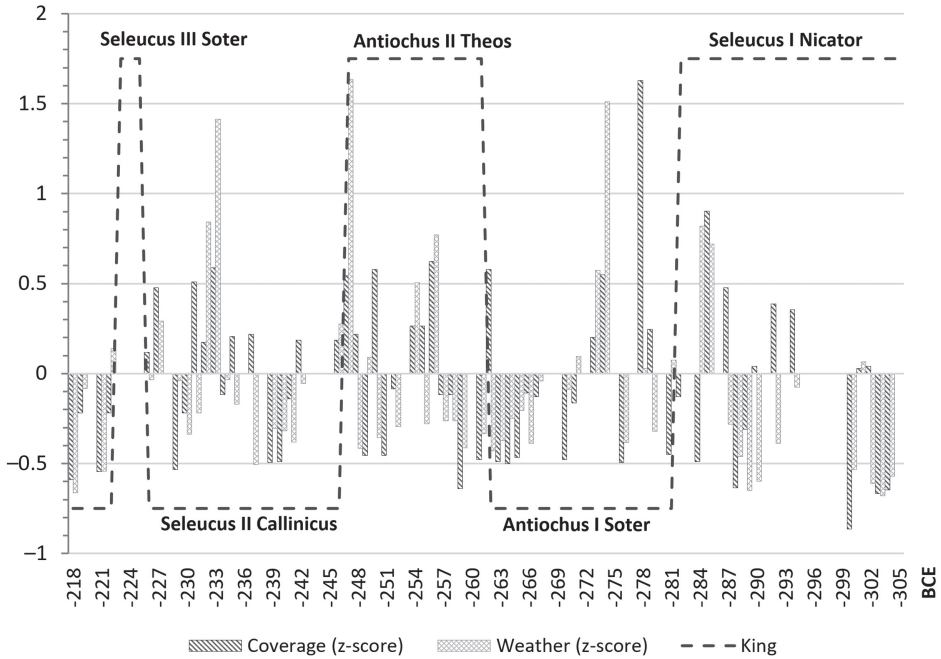


Figure 1.7 Standardised frequency plot (in z-scores on the vertical axis) for weather and total coverage (i.e., including non-weather reports) provided per year (305–218 BCE) from surviving astronomical diaries, alongside transitions between Fertile Crescent kings. Higher positive values signify greater coverage, and vice versa.

Plot: Francis Ludlow and Rhonda McGovern.

Thus, attention has been paid to the historical context in which the diaries were recorded, nuances in meaning, the likely intent of the diarists and their patrons, their intended audiences, and their general worldview. This is key to assessing the reliability of any report or observation and speaks to the issue of “representivity” in climatic reconstruction, which concerns how well any observed trends, such as in reports of heavy rainfall (or precipitation indices based upon combined reports of rainfall, flooding, drought, etc.), describe actual occurrences through time (Ludlow 2010, 2012). The possibility exists that derived trends will be distorted by multiple such factors, as well as the more obvious existence or lack of diaries surviving from certain periods. Such distortions can be potentially controlled statistically, and CLICAB has paid considerable attention to the coding of missing data, whether arising from lost diaries, damage to existing diaries, or silent changes in the type and volume of content even when diaries are available and apparently undamaged (Figure 1.7).

Second Aim: Assessing Associations between Climate, Conflict and Violence

Establishing whether extreme weather and abrupt climatic changes are statistically associated with violence and conflict in the first millennium BCE kingdoms of Babylonia and Assyria is the project’s second aim. CLICAB’s team holds considerable experience in categorising and quantifying violence documented in medieval Ireland and ancient Egypt (e.g. Ludlow and Manning 2016; Manning et al. 2017; Ludlow and Travis 2019), as well as societal stresses (e.g. famine, epidemic disease, political transitions, mass migrations) potentially generative or resulting from

violence and conflict as documented in medieval European, Near Eastern, and Chinese annals and chronicles (Ludlow et al. 2013; Kostick and Ludlow 2015; Sigl et al. 2015; Gao et al. 2016; Kostick and Ludlow 2019). A source-critical approach is again needed here to avoid either treating the material without due caution or erroneously dismissing it as unreliable.

In categorising and quantifying violence and conflict, the project also aims to capture valuable nuance from the sources concerning the scope and scale of war, civil war, and forced mass population transportations. The Neo-Assyrian kings (and those of other regional polities) undertook military campaigns on an annual basis to gather tribute, restore order, or expand their territories. To achieve a more meaningful insight into the scope, intensity, and impact of these campaigns, CLICAB is developing a simple schema to denote whether a given campaign was minor – the ruler marching armies to unreliable cities to collect revenue – or represented a massive upheaval such as when the major regional powers of Elam and Assyria attempted to decisively eliminate each other by mobilising significant resources. Our working schema is presently a simple ordinal scale of 1 to 3, following straightforward criteria that return similar decisions by different assessors. While it is possible to adopt a finer scale to capture more detailed variations of the campaigns (e.g. a scale of 1 to 10), when this was trialled, assessors made increasingly subjective judgements – with greater disagreement even when apparently adhering to the same criteria. The advantage of such quantification methods when complemented by qualitative practice is that they provide a bird’s eye view of change across times and places, enabling statistical comparisons with inherently quantitative climatic data sourced from natural archives.

CLICAB is also examining the use of sudden climatic “shocks” as “tests” of human response to reveal prevailing vulnerabilities and resilience. Dispersed through time, such shocks can let us examine whether and how responses evolve according to changing economic, political, and cultural contexts. An analysis based upon repurposing the superposed epoch analysis (SEA) method (used on continuous time-series studies of natural phenomena like tree-ring growth values) has already been undertaken by CLICAB. Discrete human events such as the incidence of revolts or the collapse of kingdoms/dynasties occurring across a range of years after a climatic shock have, for example, already been examined in this manner (Manning et al. 2017; Gao et al. 2021). The project employs this approach to assess whether associations exist between the timing of four climate-altering explosive volcanic eruptions dated 750, 723, 703, and 676 BCE: (Cole-Dai et al. 2021) and counts of documented violence, conflict, and other societal stresses between 750 and 650 BCE. Initial results illustrate a clear increase in the average of these counts in the first decade following these eruptions (Figure 1.8). While this increase may have occurred simply by chance, the advantage of a quantitative approach is the ability to calculate the likelihood that the observed counts occurred randomly or not. Statistical analysis suggested that there was less than a 10% chance that elevated counts in the years immediately following the eruptions were random. Forthcoming ice core volcanic reconstructions will provide more event dates to examine. These, combined with an examination of violence, conflict and stressors by individual type, as well as the application of the previously described scale of intensity, will provide a more nuanced analysis. This will help determine whether the manner of sociopolitical conflict responses observed in Figure 1.8 are maintained, say, for all 50-year sub-periods across a broader time range or are notably absent or reduced for particular periods and/or types of violence. This will, in turn, provide clues as to potential changes in underlying socio-economic and political contexts that might promote greater environmental resilience and offer new questions to be pursued by scrutinising documentary and archaeological evidence.

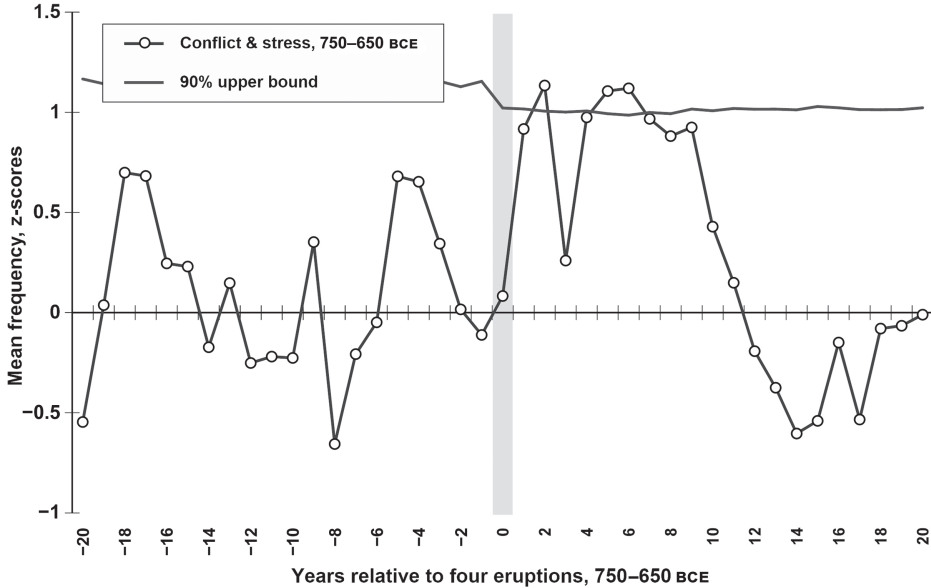


Figure 1.8 Superposed epoch analysis, showing the mean frequency of documented conflict and societal stress counts for each of the 20 years before four major volcanic eruptions seen in polar (Antarctic) ice cores (i.e. years -20 to -1 on the horizontal axis), the years of these eruptions (i.e. year 0 , horizontal axis), and each of the 20 years following (i.e. years 1 to 20 , horizontal axis). The average frequencies are notably elevated in the first decade following these eruptions, with the probability of observing such high values at random being less than 10%. Figure redrawn after Ludlow, Kostick, and Morris (2022).

Third and Fourth Aims: Pathways from Climate to Conflict and Importance of Historical Context

CLICAB's third and fourth aims are to delineate pathways by which climatic changes may have catalysed violence and conflict and assess if and how ancient Near Eastern societies developed mitigation strategies depending on their changing historical contexts. The project's contribution to *The Cambridge World History of Genocide* (Ludlow, Kostick, and Morris 2022) illustrates the latter's importance in mediating and or amplifying climatic influences by providing new insights into the fall of the Kingdom of Israel in 722 BCE. In that year, a revolution occurred in Assyria, possibly leading to the death of King Shalmaneser V and a likely opportunistic attempt by Israel to escape Assyrian domination (put simply). But a quick internal consolidation of power by the new Assyrian king Sargon II crushed the rebellion, and the population of Israel was dispersed by mass transportation (Frahm 2019; Hasegawa 2019). Until now, discussions of the pathways by which such violence and conflict erupted have largely excluded climate. Indeed, historian Bob Becking (2019, 23) states that

climate in the Iron Age II–III period remained stable in ancient Israel. We can therefore assume that no specific impulses from a (sudden) change in climate would have influenced the course of events leading to the end of the kingdom.

However, recent ice core data from Antarctica identifies a massive, possibly tropical volcanic eruption in approximately 723 BCE (Cole–Dai et al. 2021).⁷ The severe drop in temperature and disruption of seasonal precipitation patterns that likely followed, alongside the introduction of new, onerous taxes, plausibly acted as catalysts for internal revolt in Assyria. This, it may be posited, raised existential questions for the ruling elite of the Kingdom of Israel – was the time right to take advantage of the Assyrian crisis and risk challenging their subordinate position? Ultimately, their decision to do so can therefore be hypothesized as an indirect and partial outcome of the eruption but also a fatal misjudgment leading to the destruction of Israel. This case study is only one example of previously unobserved coincidences between major historical events in the ancient Fertile Crescent region and the incidence of extreme weather and abrupt climate changes documented in natural archives such as ice cores and cave speleothems. The detailed reconstruction of the historical Near Eastern climate (which now stands to be considerably advanced by the DEH-informed study of the astronomical diaries) is likely to reveal further such coincidences, as well as prove to be relevant for present climate change concerns. For example, explosive volcanic eruptions are known to impact river flow in many regions, but the size and number of eruptions in the modern period are limited by historical standards (Iles and Hegeral 2015). Examining responses to eruptions in the ancient Near East may thus prove salient to water supply issues following the next large contemporary eruption in an already acutely hydro-sensitive region. We hope that the CLICAB project showcases how a self-reflective and self-critical “digital” environmental humanities can co-produce new insights with colleagues (and methods and sources) from the natural sciences into societal vulnerabilities and resiliencies to environmental change.

Conclusion

As a liminal field, the DEH is an adaption to 21st-century cybernetic, climactic, and sociopolitical transformations. Featuring innovative approaches, research, and pedagogical questions, the DEH promotes the study of past and present human–environmental relations in order to cultivate better understanding of future potential and sustainable paths. The case studies featured in this chapter showcase how theory, techniques, and scholarship in literary geography, open-source geospatial hermeneutics, maritime environmental history, data taxonomies, historical climatology, automated digital reading, and statistical analysis find confluence and coherence in this emerging field. Collectively, the projects provide evidence that by no means are the arts and humanities in “intellectual crisis” but rather are becoming increasingly relevant to understanding how to address social, environmental, and digital threats and opportunities of our “new human condition” (Holm and Travis 2017). Our generation has been gifted with enormous computing power, including the means to inform and misinform itself about the state of the world, not least on the causes and mitigatory practices concerning human-induced climate change. The DEH may – and should – face up to the challenges that humanity faces as we discover the true positive potential of our environmental-social-political agency.

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Notes

- 1 *Larry McMurtry's Literary Geography* (<https://blog.uta.edu/travisc/research/larry-mcmurtrys-literary-geography>) project features 3D Google Earth tours of the four novels that comprise the *Lonesome Dove Chronicles* and *Portal to Texas History* (<https://texashistory.unt.edu>).
- 2 *NorFish Platform: Databases & Cartography Hub* (<http://cehresearch.org/norfishplatform>).
- 3 *UNESCO OBIS* (<https://ioc.unesco.org/our-work/ocean-biodiversity-information-system>).
- 4 *4-OCEANS project* (www.tcd.ie/tceh/4-oceans).
- 5 *State Archives of Assyria Online* (<http://oracc.museum.upenn.edu/saao>).
- 6 In addition to exploiting text search and encoding software like MaxQDA and open-source alternatives, CLICAB focuses on the complete “close reading” of texts to appreciate the context in which project-relevant references to drought or other phenomena are recorded.
- 7 Personal communication: Michael Sigl, University of Bern, 2020. Eruption location is important in determining climatic impacts.

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