FRAUD (AUDREY SAMSON & FRANCISCO GALLARDO)

Terra Analytica

The Automated Gaze of Corn and Soy

"History as we know it is a series of environmental assessments," anthropologist Elizabeth Dodd provocatively argues.[1] As *history-maker*, the analysis of environment has come to bear inscriptive properties. The stories told by contemporary analytical tools are written into the earth, and in turn, satellite imagery provides us with a dynamic rendering of these computational processes, materialized as areas of deforestation, low crop yield, contamination (i.e., unusable), or unproductive land, to name a few. The analytical apparatus creates a visualization of finance capital's random-access memory, constantly updating and rewriting itself.

The following traces a genealogy of the automated gaze of corn and soy leading to the conceptualization of our 2018 piece *Finis-terra*, which began with an interest in the broader cultural significance of the proliferation of analytics, and the methods and imaginaries employed to rationalize those lives *not* worth computing, *not* worth measuring, and *not* worth counting (or accounting for). The artistic research adds to the discussion concerned with the agency of predictive systems and archives to perform the future, as well as the operationality of technological assemblages.[2] The historical instances presented constitute an interpretive account of how representational abstraction materially reorganizes land and the species inhabiting it. Through this media genealogy,[3] we

1. Elizabeth Dodd, "Mitigations," *Places Journal*, June 2018.

2. Namely by Jacques Derrida, *Mal d'Archive: Une Impression Freudienne* (Archive Fever: A Freudian Impression) (Paris: Éditions Galilée, 1995), and more recently by institutions such as the Algorithmic Justice League founded by Joy Buolamwini and in several publications including Safiya Umoja Noble, *Algorithms of Oppression: How Search Engines Reinforce Racism* (New York: New York University Press, 2018); Wendy Hui Kyong Chun, "Queerying Homophily," in *Pattern Discrimination*, ed. Clemens Apprich, Wendy Hui Kyong Chun, and Florian Cramer (Minneapolis: University of Minnesota Press, 2019); Kate Crawford and Trevor Paglen, "Excavating AI: The Politics of Images in Machine Learning Training Sets," https://excavating.ai; Luciana Parisi, "Automated Thinking and the Limits of Reason," *Cultural Studies ↔ Critical Methodologies* 16, no. 5 (2016): 471–81; or Ruha Benjamin, *Race After Technology: Abolitionist Tools for the New Jim Code* (Cambridge, UK: Polity Books, 2019), which outline the racist, homophobic, sexist, ableist, and xenophobic properties that can be embedded in and deployed by machine learning. A forthcoming book by Jussi Parikka, *Operational Images: From the Visual to the Invisual* (Minneapolis: University of Minnesota Press, 2023), discusses the topic from a media archaeological perspective, and Linda Kronman delineates the notion of *indirect reverse operativity* in "Classifying Humans: The Indirect Reverse Operativity of Machine Vision," *Photographies* 16 (forthcoming).

3. Alexander Monea and Jeremy Packer, "Media Genealogy and the Politics of Archaeology," *International Journal of Communication* 10 (2016): 3141–59.

Afterimage, Vol. 50, Number 2, pps. 24–44. ISSN 2578-8531. DOI: https://doi.org/10.1525/aft.2023.50.2.24

Finis-terra (2018) by FRAUD; courtesy EIB institute permanent collection; photograph by Vincenzo Cardile.

outline the predictive propensity of views from above through various examples, considering how knowledge is organized and produced through these lenses.

The genealogy thus begins with an anecdote toward the politicized nature of labor mechanization that serves to contextualize the discourse of efficiency that shrouds the history of technological development, and to discuss how the aesthetics produced by industrial agriculture become machine readable and compatible with the cybernetic conception of systems. Simultaneous developments in early photogrammetry apparatuses served to interpret crop analysis, informing the legacy of early pattern recognition and interpretation in today's geospatial intelligence systems. From this curation of critical historiography, the text moves toward a consideration of the military actors driving the technological development of software such as René Descartes, sketching the stakes of space as a territory of preemption, and its concomitant ontological implications. The later part of the essay brings together figures that informed the making of *Finis-terra*: the Spring Carpet that introduces the expression of ordering nature as individuated elements from which greater generalizations can be inferred, and the hammock, which bridges colonial capture of space and peoples made possible through the Cartesian separation between observer and observed inherent in environmental analysis.

Finis-terra itself is a set of hammocks, each comprised of silk and wool woven patterns depicting crop yield prediction through the Descartes software, which couples satellite imagery and machine learning–based pattern recognition. The square shapes discernable in *Finis-terra*'s weave designate fields identified by crop segmentation, and the color denotes the forecasted crop yield, indicating "real time" value. These prognostications

inform live commodity trading and insurance valuation.[4] The assumed certainty upon which these exchanges are predicated exemplify the reorientation from data interpretation to data intelligence in the realm of geospatial information systems. The installation, which is mainly experienced by lying in it rather than looking at it, attempts to break with the subjectifying gaze of remote-sensing apparatuses. Following this, we conclude by threading possible decolonial epistemologies that explore alternative modes of understanding the world through the body, guided by the Andean philosophies of Silvia Rivera Cusicanqui, which call for an *embodied-earth-thinking*.

WHY CYBER ARMS: AN INTRODUCTORY ANECDOTE

One could posit that the automated gaze that environmental analytics afford is based in how machine vision is entangled with the abstraction of labor. Lewis Mumford famously wrote that new colonists lacked labor power and were therefore propelled to invent labor-abstracting agricultural devices.[5] Mumford overlooked the messiness of human laborers and their ability to organize in demand of basic requirements as a motivational factor to develop obedient mechanical replacements: cyber arms.

The politicized nature of labor mechanization is exemplified through the foundational marriage of agricultural engineering and plant breeding, which occurred between the cultivar VF-145 (a so-called square tomato) and the UC Blackwelder mechanical tomato harvester. Both are engineering marvels, a culinary tragedy and a testimony to the overlooked anti-unionist and xenophobic incentive to develop machinery and remote-controlled equipment for harvest.

In the mid-1950s plant breeder Gordie Hanna and agricultural engineer Coby Lorenzen, two scientists at the University of California, Davis, teamed up to invent a machine that could mechanically harvest tomatoes. Devices were optimized for monoculture production; however, more crucially, a tomato species was bred to withstand the rough touch and bulk handling of machine harvesting. It is often reported that Hanna literally threw tomatoes on the highway from a nearby bridge to test their resistance to impact.[6]

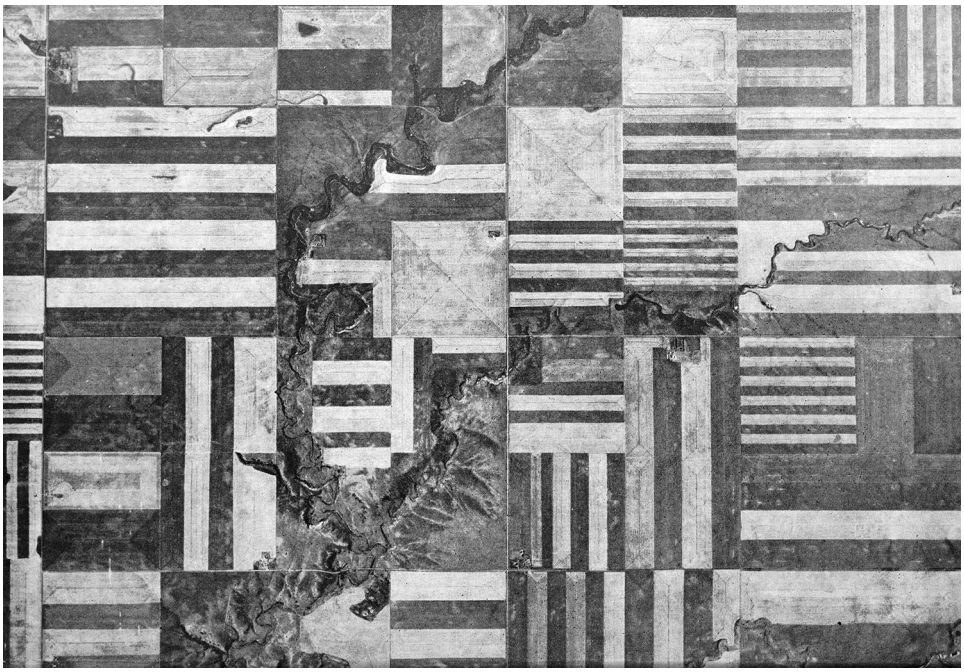
By 1962, the machine and the plant were market ready. Two years later, the United States Government refused to extend the provision of Public Law 78 allowing foreign nationals, who are often referred to as "otherwise inadmissible aliens,"[7] into the US to

4. The field of precision agriculture is projected to reach a market value of $12.9 billion by 2027, according to specialized media. This has instigated research investment on a wide range of issues like artificial intelligence applied to grain yield prediction, remote sensing, agricultural robotics, etc. Most notorious is the 2022 Special Issue of *Agronomy*: "Crop Yield Prediction in Precision Agriculture," or the research undertaken at the Center for Digital Agriculture, based at the University of Illinois. See "Precision Farming Market Size Worth $24.09 Billion By 2030," Press Room, Grand View Research, March 2022, www.grandviewresearch.com/press-release/global-precision-farming-market.

5. Lewis Mumford, *Technics and Civilization* (Chicago: The University of Chicago Press, 2010 [1934]), 113.

6. David Stuart, "Tomatoes in the Delta, Part 2 of 2," *Soundings Journal*: *Northern California People, Places & Things*, August 21, 2019, https://soundingsmag.net/2019/08/21/tomatoes-in-the-delta-part-2-of-2.

7. Philip Martin, "Mexican Braceros and US Farm Workers," Wilson Center: Farm Labor & Rural Migration News Blog, July 10, 2020, www.wilsoncenter.org/article/mexican-braceros-and-us-farm-workers.



Dry belt near Champion, Alberta; cover of *A New Geography of Canada* (1963) by Neville V. Scarfe, Doreen Margaret Tomkins, and George S. Tomkins.

help with crop production and harvesting.[8] This is cleverly alluded to in Alex Rivera's mock-marketing film *Why Cybraceros?* (2012) in which the ultimate American Dream is one where immigrants can labor in the US remotely, never having to live in, or become the responsibility of, American society.[9] A short animated demonstration within the video depicts stereotyped Mexican workers controlling robotic harvesters in the US from across the border in Mexico. Rivera's video sarcastically posits these caricatures as trouble-free, low-cost laborers for which the state is not accountable: the perfect immigrant.

LABOR MECHANIZATION

The mechanization of labor ushered by monoculture engineering developments, such as the UC Blackwelder mechanical tomato harvester, also brought about carefully delineated fields that unintentionally catered to the eye in the sky. Fields serving mechanical harvesters were characteristically geometrical, for example in the shape of long rectangles

8. For further discussion on the entanglements of labor, immigration, and mechanization, see Carolyn de la Peña, "Good to Think with: Another Look at the Mechanized Tomato," *Food, Culture & Society* 16 (2013): 603–31; Philip L. Martin and Alan L. Olmstead, "The Agricultural Mechanization Controversy," *Science* 227, no. 4687 (1985): 601–06; Raymond E. Webb and William M. Bruce, "Redesigning the tomato for mechanized production," *Science for Better Living: Yearbook of Agriculture* (Washington, DC: US Government Printing Office, 1968): 103–07.

9. Alex Rivera, *Why Cybraceros?* (2012), YouTube video, 4:51, www.youtube.com/watch?v=Xr1eqKcDZq4&ab_channel=Freewaves.

to accommodate the machine's preference for straight lines, and a width a minimum of twice that of the machine, allowing for the necessary 180-degree turn at the end of each lap. Checkered lines such as those pictured in the dry belt near Champion, Alberta, would inspire a mathematical reading of space through calculable parameters. Such neatly isolated variables could then inform narratives of economic growth and facilitate the application of the circular causality and regulatory logics of cybernetics to industrial agriculture. The prairie township fields reminiscent of Hanna's square tomato became surfaces, which are easier to capture, measure, and valuate.

The "input" and "output" paradigms that dominate computational and financial operations could now easily be measured in land allocations such as the following:

INPUT

Petroleum

Fuel Oil

Raw Sugar

Motor Vehicles

OUTPUT

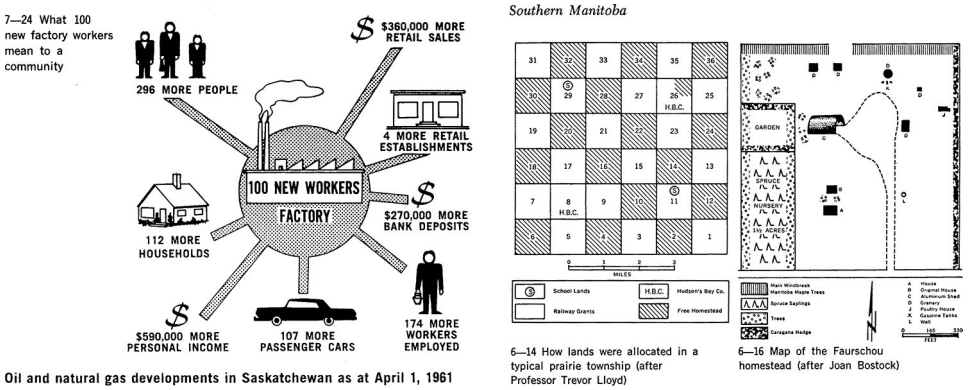
Grain

Newsprint

Flour

Lumber

Thus, the tools mechanical harvesting produced ushered in an aesthetics of machine-readability that also facilitated narratives of circular causality.



Left: Oil and natural gas developments in Saskatchewan, sampled on April 1, 1961. Right: Land allocation in prairie townships (Canada). Both from *A New Geography of Canada* (1963) by Neville V. Scarfe, Doreen Margaret Tomkins, and George S. Tomkins.

PHOTOGRAMMETRY AND INTERPRETATION

These aesthetics also facilitated crop analysis using photogrammetry based on views from above. Contemporaneous modes of capture, measure, and valuation, along with forecasting based on machine learning, are rooted in a tradition of methods earlier developed for interpreting aerial photography. Before these photographs were bulk processed like Californian tomatoes by trained algorithms, pattern recognition and analysis were termed "photographic interpretation."[10] In 1960, the preface of the American Society of Photogrammetry and Remote Sensing's volume *Photographic Interpretation* described the practice as akin to "detectives who are involved in the extraction of valuable information from aerial photographs . . . obscured by nature's camouflage."[11] Massive fields dedicated to monoculture were one of the areas where such extraction was pioneered.

Photogrammetry was largely used to survey geologic structures, drainage patterns, and agricultural areas, which could indicate lithology and soil structure as well as crop yield forecasting. Various types of film and filters were employed to capture oblique and vertical views, such as Camouflage Detection and Ektachrome film, or Panchromatic 25 A and Infrared 89 A filters. Depending on the film or filter, certain wavelengths are largely absorbed while others are reflected, and these properties vary by crop type, or for example when a plant is diseased. In a diseased leaf, the spongy mesophyll tissue, which is usually highly reflective of infrared light, collapses while for a time retaining its green color. Thus, the infrared film can detect crop disease before it is observable to panchromatic photography.[12] As such, as a means of cross-referencing with a more complete spectrum, several images of an area were aggregated and compared for analysis, in combination with the use of vertical stereograms to understand topography. Stereograms were created by using two images of an area taken from the same height at different angles and collated with the help of a mirror or scanning stereoscope with a binocular attachment used to plot boundaries or terrain features on the aerial photographs. Photographs were aligned precisely with match lines and annotated with colored pencils according to land use.[13] The analysis of these images was determined with pattern detection, usually a combination of geologic, drainage, or crop pattern features.

PATTERNS

Crop patterns in aerial photography were largely determined through tone and texture. The tone had an array of values from nearly white to light gray, and the texture spanned such values as reticular, cordlike, striate, and linear. From these texture and pattern values, we can infer the future algorithms' pseudocode.[14] As an example, based on land use

10. Robert N. Colwell, ed., *Manual of Photographic Interpretation* (Washington, DC: American Society of Photogrammetry and Remote Sensing, 1960).

11. G. Carper Tewinkel, preface to *Manual of Photographic Interpretation*, v.

12. Elon H. Bombergek and Henry W. Dill, "Photo Interpretation in Agriculture," in *Manual of Photographic Interpretation*, 614.

13. Lawrence Chalmers, Eugene Manley, and Jack Pickup, "Fundamentals of Photo Interpretation," edited by Ellis L. Rabben, in *Manual of Photographic Interpretation*, 140.

14. Pseudocode is a plain language description of an algorithm's function. It is often used in the initial stages of software development.

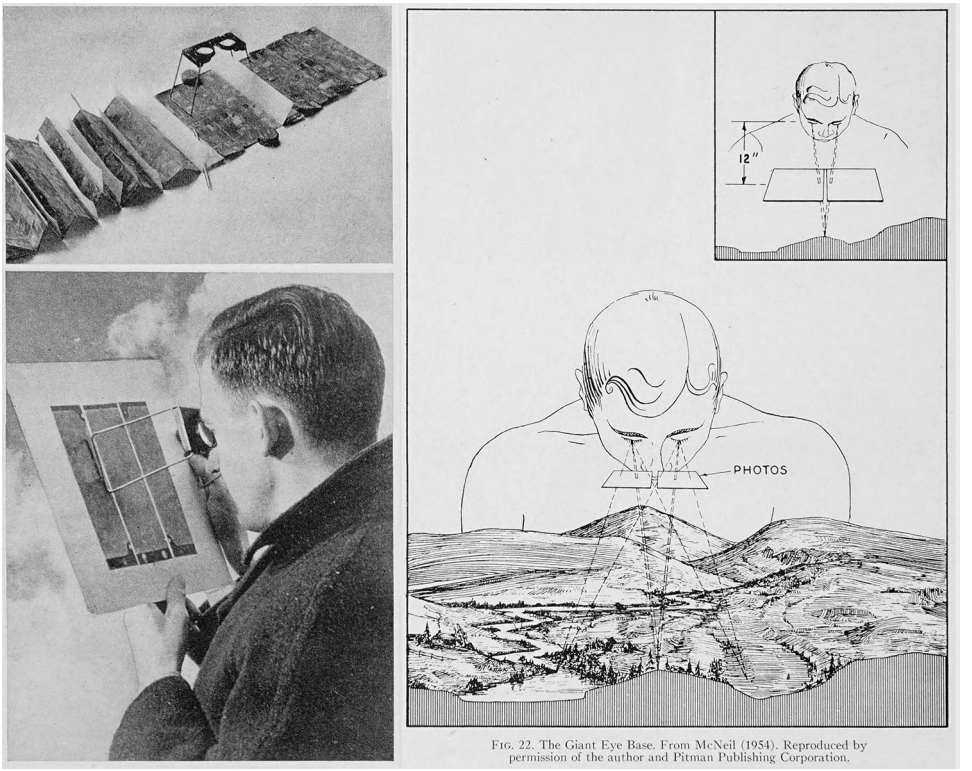


Fig. 22. The Giant Eye Base. From McNeil (1954). Reproduced by permission of the author and Pitman Publishing Corporation.

Left bottom: Stereotriplet for use as a working map in the field. Left top: Stereomultiplet consisting of strips of aerial photographs. The upper strips form a mosaic, and the underlying ones can be used for stereoscopic viewing. Both from Elon H. Bombergek and Henry W. Dill, "Photo Interpretation in Agriculture," in *Manual of Photographic Interpretation* (1960), ed. Robert N. Colwell, 637. Right: The interpreter and landscape idealized from L. Rabben Ellis, "Fundamentals of photo interpretation," in *Manual of Photographic Interpretation*, 140.

categories employed in Switzerland circa 1960,[15] we can imagine the following instruction set:

If tone is nearly white and texture is speckled, type of land use is **Field**.

If tone is very dark and texture is cloudy, type of land use is **Improved meadows.**

If tone is light and texture is partly dotted, type of land use is **Pasture**.

If land use is field and tone is light gray, field is **Small Grain**.

If land use is field and tone is nearly white, field is **Potatoes**.

If land use is field and tone is light, field is **Barley or Wheat**.

Else land use is **Unimproved Meadows**.

15. Bombergek and Dill, "Photo Interpretation," 599.

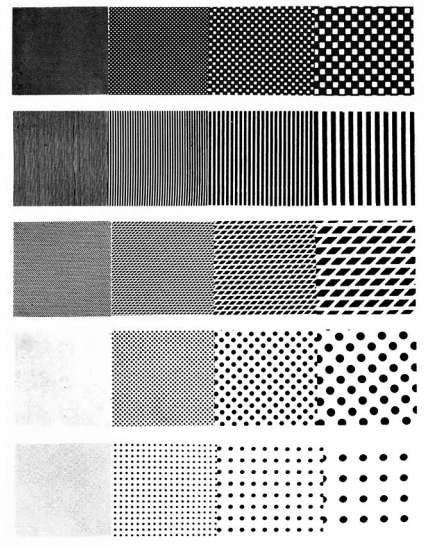


PHOTO INTERPRETATION IN AGRICULTURE

PHOTOGRAPHIC TONE AND TEXTURE CHARACTERISTICS FOR LAND-USE CATEGORIES EMPLOYED IN SWITZERLAND
(Compare with Figures 39A, B, and C)

Type of land-use	*Figure Number*	*Tone*	*Texture*
Fields	39A	nearly white	without t.
	B	nearly white (p) light grey (s)	without t. (p) linear, striped (s)
	C	dark (o) medium grey (p) light (b, w)	speckled (s) grainy (p)
Improved meadows	A	very dark (region 2) medium grey to dark (region 1)	without t. (region 2) cloudy, fluffy (region 1)
	B	dark	without t.
	C	medium grey	id.
Unimproved meadows	A	light	reticular, cordlike
	B	medium grey to dark	id.
	C	light to medium grey (cut) dark (uncut)	id., partly striate
Pasture	A	light	partly like the unimproved meadows, partly dotted
	B	id.	id.
	C	medium grey	id.

Explanation: s=small grain w=wheat
o=oats p=potatoes
b=barley

Key visual ontologies in graphic and quantitative representation from *Semiology of Graphics, Diagrams, Networks, Maps* (2011 [1983]) by Jacques Bertin). Right: Table mapping how tone and texture were used to determined type of land-use from Elon H. Bombergek and Henry W. Dill, "Photo Interpretation in Agriculture," in *Manual of Photographic Interpretation*, 599.

INTERPRETATION

In the 1960s, while automation was being researched, the analysis central to photogrammetry was being accomplished by an interpreter, invariably a human, and usually female-identified.[16] It was also understood that the properties that the interpreter was trained to detect—texture, pattern, tone, or shape—were qualitative and therefore appraised subjectively.[17] The complexity of this appraisal also lay in the necessary knowledge of the multifarious interrelations between soil, plants, and weathering processes, together with experience in recognizing their combined agencies. A number of questions were provided to interpreters during training to aid the assessment process, such as: "Is the pattern location related to: (a) land, (b) water, (c) continent, (d) subcontinent, (e) regional, (f) local?"; "Is the pattern[:] a) random or (b) systematic?"; "Is the tone of the pattern[:] (a) Consistent, (b) Lighter, or (c) Darker?"; "Is the pattern a unit in itself or subject to breakdown of identity?"; or "Is the pattern near or related to similar patterns?"[18] However, the conclusion was ultimately understood to be a subjective process achieved through the interpreter's deduction. As the task of interpreting has been largely delegated to computational assemblages, such as Descartes Lab, it has come to be considered an

16. Shane Hamilton, "Crop insurance and the New Deal Roots of Agricultural Financialization in the United States," *Enterprise and Society* 21, no. 3 (2019): 663.

17. John Carow et al., "Photo Interpretation in Forestry," ed. Richard C. Wilson, in *Manual of Photographic Interpretation,* 457.

18. Thomas Seymour, "Procedures of Interpretation of Unidentified Information," ed. John Roscoe, in *Manual of Photographic Interpretation,* 775.

Left: Vertical stereogram of an area taken just before crops have matured, using Camouflage Detection Film from Elon H. Bombergek and Henry W. Dill, "Photo Interpretation in Agriculture," in *Manual of Photographic Interpretation*, 606. Center: Stereogram of an area in Waukesha County, Wisconsin, on which annotations relative to crop distribution and to the analysis of agricultural patterns have been made; from Elon H. Bombergek and Henry W. Dill, "Photo Interpretation in Agriculture," in *Manual of Photographic Interpretation*, 590. Right: Aerial Ektachrome photos, oblique (top) and vertical (bottom) views. The vertical view shows how the filter identifies discolouration in the fields, which denote plant disease: oat stem rust (yellow) and reddish stem rust (red); from Elon H. Bombergek and Henry W. Dill, "Photo Interpretation in Agriculture," in *Manual of Photographic Interpretation*, 607.

objective form of intelligence. Thus, the methods and conclusions inferred from the female-identified human, which were deemed subjective interpretation, became understood as objective when performed by the machinic.

STAKEHOLDERS

Photo interpretation was also key in agricultural economics.[19] In the US, yield was forecasted for commercially important crops by the Department of Agriculture. Thus, wartime photography analysis became integrated into Rural Sociology, a then-new field dedicated to the economics of farm production.[20] Perhaps unsurprisingly, software based on pattern recognition, which is used to predict crop yield contemporaneously, is an area of significant interest to military organizations, namely the US Defense Advanced

19. Steven Charter et al., "Photo Interpretation in Agriculture," ed. Elon H. Bombergek and Henry W. Dill, in *Manual of Photographic Interpretation*, 601.

20. An instance of World War II military aerial photography was namely used in Harun Farocki's *Bilder der Welt und Inschrift des Krieges* (Images of the World and the Inscription of War) (Duisburg: Duisburger Filmwoche, 1088), 16 mm film, 75:00. Farocki's use of the images that captured Auschwitz on film taken by the British military in 1944, made public only in 1977, problematized how Britain and the Allies ignored the Holocaust. See discussion in Hans Carlsson, "A Visual Sceptic: Thoughts on Harun Farocki's Descriptive Criticism," Harun Farocki Institute, July 19, 2022, www.harun-farocki-institut.org/en/2022/07/19/a-visual-sceptic-thoughts-on-harun-farockis-descriptive-criticism.

Research Projects Agency (DARPA).[21] In 2017, DARPA solicited proposals for its Geospatial Cloud Analytics (GCA) program to develop technology for accessing and analyzing geospatial data.[22] The defense research agency has been making significant investment into machine learning–enhanced, pattern recognition–based software that processes satellite imagery to estimate the likelihood of social unrest resulting from low crop yield.[23] Inflation driven by rising agricultural commodity prices, or "agflation," is now widely acknowledged as a key stressor for uprisings such as what is referred to by some as the Arab Spring.[24] According to these reports, in 2010 and 2011, a winter drought in China, a heat wave in Russia, and an outbreak of stem rust in East Africa all contributed to dramatically reduce grain production for export.[25] The climactic stress, leading to droughts and global wheat shortages, exacerbated the subsequent upheavals in the Middle East/North Africa region (MENA).[26] To this effect, Joseph Evans, the program manager in DARPA's strategic technology office, states: "One of the things we've seen is that regional unrest has been linked to circumstances that seem detached from national security—like the price of bread."[27] This introduces a new twist to Joachim Radkau's statement: "When it comes to implementing ecological concerns, it is especially advantageous if they converge with military interests."[28]

One of the companies that has received a significant amount of funding through DARPA's GCA program is the New Mexico–based Descartes Lab, a software development corporation focused on the provision of geospatial intelligence through the automation of analysis of satellite imagery and data. It is named after French mathematician René Descartes, to whom we owe the Cartesian system, which describes the position of an object through coordinates. He also cemented the separation of mind and body in his dualism theory, a division that still haunts us today. Descartes Lab was founded in 2014 as a spin-off from the Los Alamos National Laboratory (host of the Manhattan Project,

21. DARPA is an agency of the US Department of Defense responsible for the development of emerging technologies for use by the military.

22. "Geospatial Cloud Analytics (GCA)," *Defense Advanced Research Projects Agency (DARPA), Strategic Technology Office*, October 11, 2017, https://research-authority.tau.ac.il/sites/resauth.tau.ac.il/files/DARPA_Geospatial%20Cloud%20Analytics_HR001118S0004.pdf.

23. "Harnessing Commercially Available Geospatial Imagery for Defense Analysis," *DARPA News and Events*, October 11, 2017, www.darpa.mil/news-events/2017-10-11.

24. See Rami Zurayk, *Food, Farming, and Freedom: Sowing the Arab Spring* (Washington, DC: Just World Books, 2011); Caitlin E. Werrell and Francesco Femia, eds., *The Arab Spring and Climate Change* (Washington, DC: The Center for American Progress, 2013).

25. Troy Sternberg, "Chinese Drought, Wheat, and the Egyptian Uprising: How a Localized Hazard Became Globalized" in *The Arab Spring and Climate Change*), 7–14; Mohamed Abdallah Youness, "How climate change contributed to the conflicts in the Middle East and North Africa," *World Bank Blog*, December 10, 2015, https://blogs.worldbank.org/arabvoices/climate-change-conflict-mena.

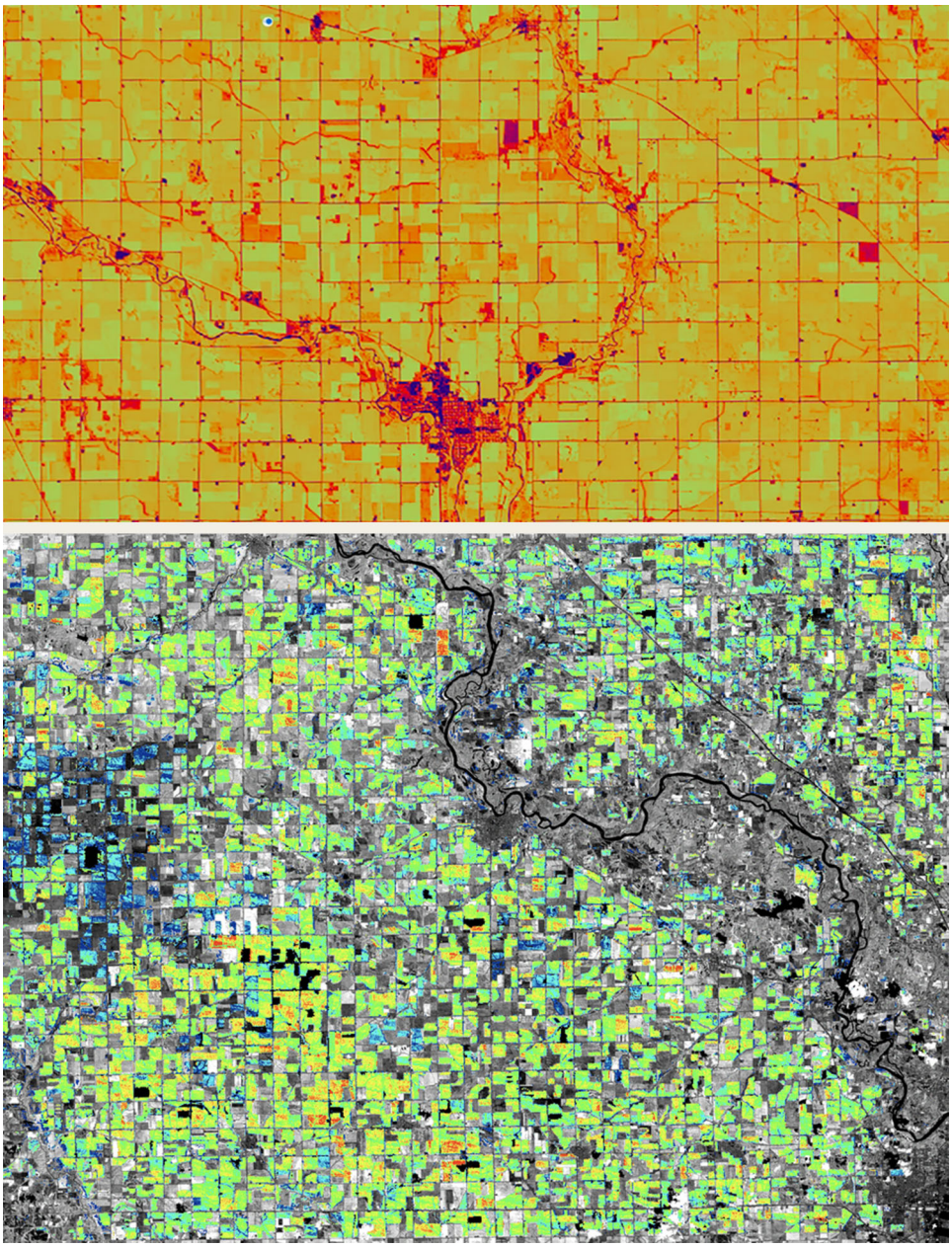
26. Including Tunisia, Morocco, Syria, Libya, Egypt, and Bahrain.

27. Michal Lev–Ram, "Why DARPA Funded a Farm Tech Startup," *Fortune*, March 17, 2017, https://fortune.com/2017/03/23/new-mexico-descartes-labs-darpa-grant.

28. Joachim Radkau, *Nature and Power: A Global History of the Environment* (Cambridge, UK: Cambridge University Press, 2008), 119.

The infamous "Bread Helmet Guy" meme is in fact a Yemeni protester who was spotted at a street demonstration wearing loaves of bread around his head; from "Bread Helmet Man—Image #97, 640," Know Your Meme.

the World War II nuclear bomb program and a former private ranch school for boys). In addition to providing so-called "business solutions," Descartes Lab offers a platform that is publicly accessible through a Python client. A limited amount of imagery is available to experiment with and understand how the parameters work. Full access to the platform and data catalog requires a registered account and, more importantly, that one be granted access. *Finis-terra* was created with openly available data. At the time, 2018, this consisted of an array of approximately twenty images upon which certain functions could be applied, such as segmentation through measurement of infrared light reflected from the earth's surface together with synthetic aperture radar (SAR). The accessibility of this data and these functions is obtained through the terminal (via the Python client) and requires some understanding of the command-line interface (CLI) as well as the Python programming language. This, together with the very limited satellite imagery made available to the general user, creates ambiguity around its open-access policy. Who is granted full access to this data, and at what cost, is relevant in considering the power dynamics at play in geospatial intelligence services.



Top: The health of cornfields around Humboldt, Iowa, as measured by the infrared reflectiveness by Descartes Labs. Bottom: The health of cornfields, as measured by the infrared reflectiveness by Descartes Labs from Robinson Meyer, "The Start-up That Watches Corn Grow, From Orbit," *Atlantic*, August 10, 2016.

THE FUTURE AS SEEN FROM ABOVE

> "Because machine learning has no fixed idea of pattern . . . it claims that machine learners uncovering hidden patterns in data might be better grounded in the operational practices of working with differences."
>
> —Adrian Mackenzie[29]

The geological gaze of the Anthropocene has trained us to understand deep time as earthward vision through the succession of strata. In other words, to look from below is to look from the past. From this modernist epistemology, it follows that to look from above is to look *from the future*. As prediction modeling based on geospatial intelligence has implications reaching agriculture, insurance valuation, commodity market value, and military operations, guiding not only decision making and policy, but also value fluctuation in real time, the eye in the sky becomes an all-seeing oracle, performing the future through its predictions made truth. Similar to the bird's-eye perspective stemming from ballooning, which had a profound epistemological effect on viewing the world,[30] the computational perspective of machine learning coupled with GIS data provides the contemporary material ordering of the globe, embodying what Adrian Mackenzie has referred to as a new "enunciative modality."[31] The latter generates operational statements by connecting various elements in the production of classifications and predictions. However, machine learning does not understand pattern *per se*. Pattern recognition, or data analysis, is rather based in the perception of difference. And while this may relate to earlier stereoscopic practices in which the difference between two images is used to infer topography, machine learning deduction is more akin to "approximation through variation."[32] How might these recursive and dynamic processes modify modes of knowledge production and of knowing? Is the future presenting itself from the vantage point of unsupervised learners creating new realities by iterative model generation?

In *The Future of Futures: The Time of Money in Financing and Society* (2011), Elena Esposito refers to the change in direction engendered by monetarization. As opposed to the industrial, capitalistic, or modern society that looked backward, as evidenced by their post formulations—post-industrial, post-capitalistic, and post-modern—"the risk society defines itself by looking forward."[33] Technologies of capture such as geospatial intelligence produce forms of abstraction that facilitate the risk society, fueled by derivatives trading. Like derivatives, which abstract "from the specificity of the capital, making every

29. Adrian Mackenzie, *Machine Learners: Archaeology of a Data Practice* (Cambridge, MA: MIT Press, 2017), 126.

30. See Lily Ford, "'For the Sake of the Prospect': Experiencing the World from Above in the Late 18th Century," *Public Domain Review*, July 20, 2016, https://publicdomainreview.org/essay/for-the-sake-of-the-prospect-experiencing-the-world-from-above-in-the-late-18th-century; Stephan Oettermann, trans. Deborah Lucas Schneider, *The Panorama: History of a Mass Medium* (New York: Zone Books, 1997).

31. Mackenzie, *Machine Learners*, 220.

32. Mackenzie, *Machine Learners*, 101.

33. Elena Esposito, *The Future of Futures: The Time of Money in Financing and Society* (Northampton, MA: Edward Elgar Publishing, 2011), 4.

form of capital convertible into any other,"[34] prediction modeling abstracts from the specificity of the crop, making the risk associated with lower or higher predicted yield a value that can be traded, irrespective of the property, thus facilitating the circulation of investments. If prediction is resolutely predicated upon a future looking toward the earth from above, *Finis-terra* allows one to *contemplate* the view from the future, to lie in its silk and woolen abstraction, creating a space to conjure subversive threads. At the same time, the woven textile grids and patterns point to the reification of this epistemology shaped by the *futureabove*, and consider the implications of algorithmic subjectivation. Rebecca Uliasz outlines how taxonomy is central to the training of algorithms to recognize patterns in digital images.[35] Taxonomies mobilize and calcify knowledge systems, in this case based on a set of parameters readable from the perspective, angle, and distance of a satellite lens and rooted in the predictive potential of the view from above. How might we then understand the specific co-individuation of crops being captured with the technologies they are being captured by? And the implications for the more-than-human being captured?

SPACE AS TERRITORY OF PREEMPTION

In reference to earlier conceptions of photogrammetry, pattern recognition software is the new "detective" extracting valuable information from aerial photographs. Software such as Descartes Lab, which described itself in 2022 as "global-scale predictive intelligence,"[36] presents an ontological shift from interpretation audited by female-identified computers to machinic intelligence. This realignment promises the exploitation of crops with unparalleled efficiency, where the earth's surface is rendered a digital field that affords agricultural mapping, inspection, and surveillance (for crop pests as well as so-called illegal migrants)—a conception in which the digitally cultivated field has the ability to combine and navigate a seemingly endless variety of elements while simultaneously promising perfectly tailored specificity.

Based on methods developed in photogrammetry, satellite imagery is analyzed with algorithms trained to recognize several kinds of patterns, an iterative process of difference recognition. These readings are then used to price crop insurance, to estimate crop yield and to predict social unrest. Much like Kathryn Yusoff's conception of the geological strata gaze as a worlding agent of meta-ontologies,[37] technologies of capture from above are in turn *inscribing* the earth, in a recursive iteration of READ-WRITE.

34. Elena Esposito, "The Mysteries of Money," *Inaesthetics* 3 (2012): 7.

35. Rebecca Uliasz, "Seeing like an algorithm: operative images and emergent subjects," *AI & Society* 36, no. 4 (2021): 1233–41.

36. "Descartes Lab," https://descarteslabs.com.

37. Kathryn Yusoff, "Epochal Aesthetics: Affectual Infrastructures of the Anthropocene," *e-flux Architecture* (March 2017), www.e-flux.com/architecture/accumulation/121847/epochal-aesthetics-affectual-infrastructures-of-the-anthropocene.

SPRING HETEROTOPIAS: DESCARTES IN THE HAMMOCK

> "Here in this carpet lives an ever-lovely spring."
>
> —Sixteenth-century Sufi poem[38]

> "[T]he garden is a rug onto which the whole world comes to enact its symbolic perfection, and the rug is a sort of garden that can move across space."
>
> —Michel Foucault[39]

Such orderings of space and nature as that prescribed by photogrammetry and geospatial intelligence software are also manifest in Spring Carpets, often referring to ancient Persian carpets depicting pleasure gardens seen from above. They were used as floor coverings during wintertime, alluding to a symbolic control of the ruling elites over the succession and return of seasons.[40] As intimations of larger pleasure gardens, their design was organized around a central watercourse from which four streams flowed at geometrical angles. These then forked into a myriad of tributary canals, islands, and ponds populated by fish, flower plots, and trees.[41] The rug produced a specific representation of nature, a human-organized space with differentiated entities. Furthermore, as a microcosm, the carpet had the startling ability to represent both the smallest part of the garden and its totality.[42] These are stand-in qualities foundational to prediction modeling techniques, that is, the capacity to individuate elements and to generalize and make large-scale inferences based on those individuations.

WEAVING WORLDS AND HAMMOCKS

> "From ancient times through the present, it has been the weavers and astrologer-poets of the communities and villages who have revealed to us this alternative and subversive thread of knowledges and practices capable of restoring the world and setting it on its rightful course."
>
> —Silvia Rivera Cusicanqui[43]

Thinking with the Earth-as-body might help us to understand the processes at play in geospatial intelligence, whose changeable inscription of history can not only be read or

38. Robert Pogue Harrison, *Gardens: An Essay on the Human Condition* (Chicago: University of Chicago Press, 2008), 270.

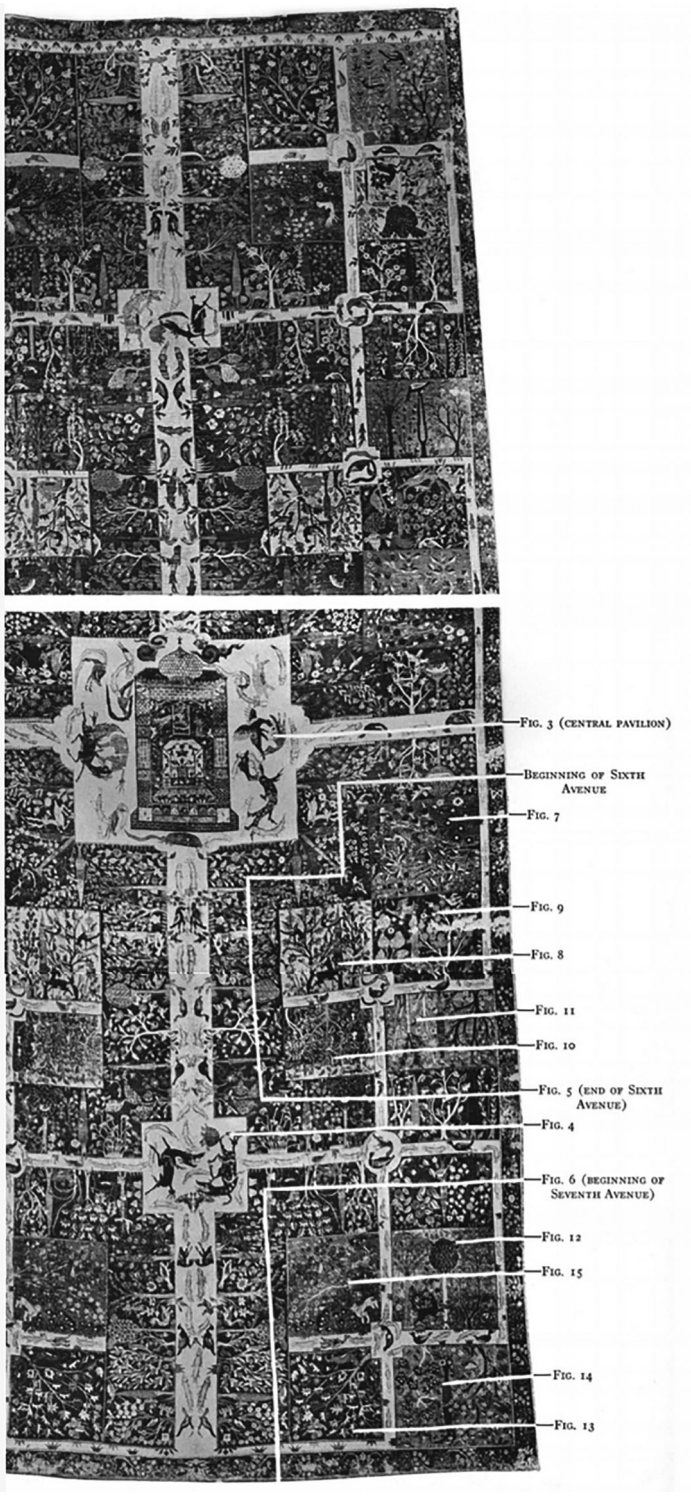
39. Michel Foucault, "Nietzsche, Genealogy, History," in *Aesthetics, Method, and Epistemology: Essential Works of Foucault 1954–1984*, ed. James Faubion (New York: The New Press, 1998), 375.

40. Marie Luise Schroeter Gothein, *A History of Garden Art: From the Earliest Times to the Present Day*, vol. 1 (Cambridge, UK: Cambridge University Press, 2014), 143–4.

41. Martin Conway, "A Persian Garden Carpet," *Burlington Magazine for Connoisseurs* 23, no. 122 (1913): 95–96.

42. Peter Johnson, "The Geographies of Heterotopia," *Geography Compass* 7, no. 11 (2013): 798, https://doi.org/10.1111/gec3.12079.

43. Silvia Rivera Cusicanqui, *Ch'ixinakax utxiwa: On Practices and Discourses of Decolonization* (Cambridge, UK: Polity Books, 2020), 28.



The Jaipur Garden Carpet mapped out from Maurice Sven Dimand, "A Persian Garden Carpet in the Jaipur Museum," *Ars Islamica* 7, no. 1, (1940): 95–8.

Allegory of America, from *New Inventions of Modern Times (Nova Reperta)*, plate 1 of 19, Theodoor Galle (c. 1600, Antwerp), Metropolitan Museum of Art, New York; from Ilja M Veldman, Ger Luijten, and Friedrich W. Hollstein, *Dutch & Flemish Etchings, Engravings, and Woodcuts* (1450) from Elon H. Bombergek and Henry W. Dill, "Photo Interpretation in Agriculture," in *Manual of Photographic Interpretation*, 6.

traced, but also allegedly predicted. As space and its capture is now emerging as a lucrative domain for technical and financial systems, the figure of the hammock and the Spring Carpet are introduced as apparatuses of *embodied-earth-thinking*, as they bridge notions of the technological-capture frontier economy through remote sensing or viewing from above, with earlier notions of the colonial frontier of exploration.

An early European depiction of the hammock by Stradanus is famously used in postcolonial studies to critique the so called "Awakening" of America by Amerigo Vespucci.[44] In this image, an often-overlooked detail is that "America" was disturbed from History's slumber from the comfort of a hammock's net. Christopher Columbus, as well as other chroniclers such as Bartolomé de Las Casas, noticed the hammocks with great interest.[45] After crossing the westernmost regions of the Atlantic ocean, unknown to

44. Ania Loomba, *Colonialism/Postcolonialism*, 2nd ed. (1998; repr., Abingdon, UK and New York: Routledge, 2004), 151; Helen Carr, "Women/Indian, The 'American' and his Others," in *Europe and its Others: Proceedings of the Essex Conference on the Sociology of Literature*, vol. 2, ed. Francis Barker et al. (Colchester, UK: University of Essex Press, 1985), 46–60.

45. Christopher Columbus, *The Journal of Christopher Columbus,* trans. Cecil Jane (London: Anthony Blond & The Orion Press, 1960), 52; Gonzalo Fernández de Oviedo y Valdes, *La Historia General y Natural de las Indias*, vol. 1, *Isla y Tierra Firme del Mar Oceano* (Madrid: Real Academia de la Historia Press, 1851), 132; Gonzalo Fernández

Europe and therefore dubbed *finis terrae*, Columbus noticed the low-hanging beds in the Bahamas in 1492 and stated in his diary that "people were sleeping in nets between the trees."[46] "They lye on a coarse Rug or Matt, and those that have the most plentiful Estate or Fortunes, the better sort, use Net–work, knotted at the four corners in lieu of Beds, which the Inhabitants of the Island of Hispaniola, in their own proper Idiom, term Hammacks,"[47] wrote de las Casas in 1552.

The hammock was one of the many curiosities brought to Europe. Gonzalo Fernández de Oviedo y Valdes, one of the first chroniclers of "New World" goods, introduced Spanish, English, and French audiences to an enormous variety of previously unheard-of *exotica* including the pineapple, the canoe, smoking tobacco, the manatee, and hammocks.[48] To produce the textile-based exotica, the Spanish empire placed Indigenous women under forced labor as weavers.[49] Undoubtedly, the hammock wove a story of pain, loss of dignity, and loss of way of life. These tensions between the possibility to hold subversive threads of knowledge as well as world-restoring practices together with the knotted histories of colonial degradation, provide a critical antagonism.

According to archaeological records, hammock culture dates back to 400 BCE, from the Taíno and Arawak peoples who settled in South and Central regions of the South American continent from the Caribbean islands. The first hammocks were made using hammock tree bark, from which the term *hamaca* is derived.[50] "Amaca" is the Taíno word for fish nets, which also described the appearance of their cotton hammocks.[51] The Wayuú of La Guajira argue that a spider named Waleker taught them how to weave hanging beds.[52] Hammocks were also used for birth and during funerary rites to wrap the embalmed dead before burials.[53] *Hamacas* were fundamentally world-restoring threads.

Like Columbus, who marveled at the people of the new world in their hammocks, *Finis-terra* offers a glimpse of the entanglement of finance, imperialism, and colonialism afforded by the automatic gaze. *Finis terrae,* in addition to literally signifying the land's

de Oviedo y Valdes, *Misfortunes and Shipwrecks in the Seas of the Indies, Islands, and Mainland of the Ocean Sea (1513–1548): Book Fifty of the General and Natural History of the Indies*, trans. and ed. Glen F. Dille (Gainesville: University Press of Florida, 2011), 132.

46. Christopher Columbus, *Personal Narrative of the First Voyage of Columbus to America: From a Manuscript Recently Discovered In Spain*, trans. Samuel Kettell (Boston: T.B. Wait and Son Press, 1827), 50–73; Samuel Eliot Morison, *Christopher Columbus Mariner: The Epic Story of the Great Seafarer Told by America's Foremost Naval Historian* (New York: New American Library, 1942), 44.

47. Bartolomé de las Casas, *A Short Account of the Destruction of the Indies*, trans. and ed. Nigel Griffin (London: Penguin Books, 1992), 89.

48. Kathleen Ann Myers, *Fernández de Oviedo's Chronicle of America: A New History for a New World* (Austin: University of Texas Press), 36.

49. Cusicanqui, *Ch'ixinakax utxiwa*, 42.

50. Francisco Moscoso, *Caciques, aldeas y población Taína de Boriquén (Puerto Rico), 1492–1582* (San Juan: Academia Puertorriqueña de la Historia, 2008), 22–23.

51. Antonio M. Stevens-Arroyo, *Cave of the Jagua: The Mythological World of the Taínos* (Albuquerque: University of New Mexico Press, 1988), 4–5.

52. Enza García and Belén López, *La cosmovisión Wayuú a través de los textiles* (Caracas, Venezuela: Fundación Carlos Eduardo Frías, 1996), 53–54.

53. Guillermo López Acevedo, "La cultura como tejido y espacio de la sacralidad de los wayuu," in *Tü Natüjalakat Wayuu—Lo que saben los Wayuu*, ed. Leonardo Otálora Cotrino et al. (Bogotá: Universidad de Bogotá Jorge Tadeo Lozano, 2016), 184.

end, is also a Latin term that designates a payment, settlement, fine, or tax—thus a coupling with the historic material process of the frontier thesis and its financial contemporary. The unresolved contradictions of uneven "patterns of accumulation"[54] woven from wool and silk begin to address the task of undertaking a "political economy of knowledge."[55] For Cusicanqui, this process of decolonial thought requires the examination of economic and material mechanisms obfuscated by discourses that maintain colonial domination. Here, we can think of the discourse of efficiency put forward by geospatial intelligence companies such as Descartes Labs: "We create new sources of operational advantage for our customers and partners by combining multimodal data with machine intelligence to deliver solutions quicker, more efficiently and at planetary scale."[56] According to Descartes Lab, their service enables "a better understanding of the physical world through the scalable analysis of geospatial data."[57] Hannah Arendt warned of the seductive potential of abstracted tools of analysis in *The Human Condition* (1958). She explains that the disembodiment of eye and body, or eye and mind, creates a distance that is powerful because of its inherently reductionistic capacity.[58] This begs the question: what onto-epistemologies are modes of geospatial analytics mobilizing?[59]

CONCLUDING NOTES: THREADS OF KNOWLEDGE

> "We do not obtain knowledge by standing outside of the world; we know because 'we' are *of* the world."
>
> —Karen Barad[60]

In some respects, *Finis-terra* also refers to the end of the earth as a habitable planet, not as an inevitable scenario, but rather a cautionary tale. Fatalism poisons the nourishment of practices capable of restoring the world and as such, this contribution refutes the inevitability of planetary crisis.

The financial sphere, "ever in search of new fields [and surfaces] to securitize,"[61] has been apprehended as a pattern of accumulation. In considering how automated pattern recognition turns the Earth into a permanent yet uneven surface of accumulation, it is useful to remember that machine learning operates as an accumulation—of settings, data,

54. Greta R. Krippner, "The financialization of the American eEconomy," *Socio-Economic Review* 3, no. 2 (2005): 173–208, https://doi.org/10.1093/SER/mwi008.

55. Cusicanqui, *Ch'ixinakax Utxiwa*, 60.

56. "Descartes Lab," https://descarteslabs.com.

57. "Descartes Lab," https://descarteslabs.com.

58. Hannah Arendt, *The Human Condition*, 2nd ed. (Chicago and London: University of Chicago Press, 1998 [1958]), 264–6.

59. Karen Barad, "Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter," *Signs: Journal of Women in Culture and Society*, Special Issue: Gender and Science: New Issues 28, no. 3 (Spring 2003): 829.

60. Barad, "Posthumanist Performativity," 829.

61. Philip Mirowski, *Never Let a Serious Crisis Go to Waste: How Neoliberalism Survived the Financial Meltdown* (New York: Verso Books, 2013), 215.

and devices—rather than a knowledge shift.[62] Embroidering databases into recognizable shapes, such as in the work *Finis-terra*, renders the subjection of terrestrial sense data and movements into mathematical formulae *material*. These patterns are rooted in the practice of photogrammetry and the interpretation of photographs, from which "regularities . . . appear through a series of related differences and similarities."[63] The capacity to infer and draw conclusions from these generalizations are principles embedded in the field of geospatial intelligence. One of its main protagonists, the largely DARPA-funded Descartes Lab in partnership with several agribusinesses, thus compares weather patterns with grain-growing patterns, resulting in the emergence of potential sites for investment, or divestment, according to valuation in the calculations of finance capital. This could be thought of as the reduction of "nature" to patterns of accumulation that terraform the earth through analytical systems; the satellite camera lens and the algorithm, slowly scanning the earth, as a tool that both captures and erases. Similar to the condemning apparatus in Kafka's Penal Colony,[64] the surveying apparatus is rewriting the earth into zones of lower or higher risk, which may warrant rising insurance premiums or the deployment of counter-revolutionary military forces.

Space conceived as areas of preemptive potential is alluring, like discourses of continued growth made possible with ever more efficient systems. This, however, is based in an ontological ordering of the world, namely the Cartesian reduction and translation of the world into algebraic formulae, which Arendt foresightedly disqualified as a possible indication of truth or objectivity. She also noted that Descartes's mathematical analysis could not surpass sensorial perception.[65] The earth is, after all, the site of many *incomputables*, which can be confounded or erased by incompatibility with mathematical analysis or geospatial intelligence taxonomies, such as migrants, traditional and Indigenous knowledges, or complex species such as lichen.[66] What is not captured is potentially not simply excluded from the archival database, but being slowly overwritten. Reminiscent of the colonial frontiers of so-called discovery, claiming *terra nullius* and erasing people to the order of genocide, Cusicanqui's words resonate. We must uncover subversive threads of knowledge and, with them, decolonial epistemologies.

A thought of counterintelligence on which to linger from Karen Barad: "[T]he 'knower' does not stand in a relation of absolute externality to the natural world being investigated—there is no such exterior observational point."[67] They also expound Niels Bohr's quantum theory, which insisted that human epistemology must consider its indivisibility with the environment that it seeks to observe and understand. On the one hand, *Finis-terra* invites us to stay with the trouble of the onto-epistemologies mobilized

62. Mackenzie, *Machine Learners*, 22.

63. N. Katherine Hayles, *How We Think: Digital Media and Contemporary Technogenesis* (Chicago: The University of Chicago Press, 2012), 74.

64. Franz Kafka, *In the Penal Colony*, trans. Michael Hofmann (London: Penguin Books, 2011).

65. Arendt, *The Human Condition*, 264–6.

66. For a greater discussion on the categorization and modeling systems that terraform the Northern European forests, see FRAUD (Audrey Samson and Francisco Gallardo), "Carboniferous Capitalism[1]," *Helsinki International Artist Programme*, November 5, 2020, https://www.hiap.fi/carboniferous-capitalism1.

67. Barad, "Posthumanist Performativity," 828.

by geospatial intelligence,[68] and on the other, to move beyond modes of subjectivation these technologies formulate by inviting an *embodied-earth-thinking*. As such, by decentering the perspective of the gaze, it gestures toward a possible decolonial critical epistemology in media practice. As narratives of capture permeate environmental analysis, it becomes urgent to develop modes of sensing and knowing that stem from embodied cosmologies, ones in which humans are "of" the world and not external observers. ■

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68. We borrow this phrase from Donna Haraway's book by the same title. See Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, NC: Duke University Press, 2016).