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**Marek Jancovic**
(Vrije Universiteit Amsterdam, the Netherlands)

# Cinema's Atmospheric A Priori: How Weather and Environment Shaped Celluloid Film Manufacturing and Raw Material Supply at Fujifilm, Daicel, and Agfa

**Abstract**
Where was the cotton for Fujifilm's cine-film grown? Who supplied the animal parts that would end up coated on Agfa's film as gelatin? How did climate, environment, geology, and river hydrology shape the history of celluloid film manufacturing, and thus of cinema?

This article enlists several archival collections and a range of little-known, multi-language secondary sources in the broader task of understanding cinema's relationship with the material environment and climate, and its historical role in global trade, extractivist practices, and colonial politics. Drawing on primary source research in the archives of film stock and chemical manufacturers Agfa-Gevaert, IG Farben, and Schering, and on the corporate histories of Fujifilm and Dainippon Celluloid, I clarify how parts of the raw material supply chain for celluloid film were structured between roughly 1920 and 1945. Methodologically, this article integrates eco-media thought with spatial approaches to show how nonhuman elements (earth, wood, air, and water) are historically implicated in the global photochemical industry. It introduces the notion of the *atmospheric a priori* and shifts emphasis to East Asian sites — or rather: environments — often overlooked in English-language research.

By attending both to fine-grained microhistories of individual factories as well as global transnational trade networks, the article challenges prevailing Euro- and Americentric narratives of film technology and provides a situated account of the critical role of logistics and environment in cinema's material foundation.

**Keywords**
elemental film history, colonialism, cotton, gelatin, camphor

## Introduction

In this article, I enlist several archival collections and a range of little-known, multi-language secondary sources in the broader task of understanding cinema's relationship with the material environment and climate, and its historical role in global trade, extractivist practices, and colonial politics.

This contribution represents one of the interim results of CINEAGRI, an ongoing project mapping the global trade in raw materials needed to make photochemical cinema. Of special interest are the transnational supply chains of agricultural products used in nitrate film manufacturing that originate from plant and animal bodies: camphor, cotton, turpentine, and gelatin.

Via CINEAGRI, I was able to conduct research in the archives of film stock and chemical manufacturers Agfa-Gevaert in Belgium, as well as IG Farben and Schering in Germany, and also access the corporate histories of Fujifilm, its parent company Dainippon Celluloid (hereafter referred to as Daicel), and the Taiwan Governor-General Monopoly Bureau. Each of these archival collections and secondary sources is fascinating in its own right, but together they tell the history of an intensely global but also paradoxically place-bound industry whose geographic extent is quite at odds with the typical view of film stock's technological past. That view is dominated by Western inventors and businesses — Eastman Kodak, in particular. Clearly, I am not denying Kodak's outsized, pioneering role nor the great enrichment that studies of the company have contributed to economic history as well as to film and media studies.[1] Nevertheless, although dominant, Kodak, like all film stock makers, relied on a complex network of global suppliers and was but one company among many. That word — "many" — is the object of my research.

My contribution thus builds upon and advances existing eco-media research on the materiality and elementality of celluloid film and the workings of the international photochemical industry,[2] but also shifts attention to places (or, more saliently, *environments*) whose presence, especially in English-language research, remains thin. More specifically, this article clarifies how the supply of gelatin, cotton, camphor, and turpentine to Fujifilm and Agfa was organized in the period between roughly 1920 and 1945, and how the histories of these companies have been defined by weather and the natural environment. The choice of this time period is partly strategic, partly pragmatic: there are simply substantially more preserved archival records to study after World War I than before it. But this period also coincides with increasingly aggressive Japanese imperialist forays and the industrialization of the country's celluloid manufacturing, represented by Daicel's formation and meteoric global ascendance, as well as the founding and early period of its subsidiary, Fujifilm.

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1) Lutz Alt, "The Photochemical Industry: Historical Essays in Strategy and Internationalization" (PhD Dissertation, Massachusetts Institute of Technology, 1986); Emmet Winkle von Stackelberg, "Seeing Through Silver: A Chemical History of Moving Images 1880–1950" (PhD Dissertation, Rutgers, The State University of New Jersey, 2023); Alice Lovejoy, *Tales of Militant Chemistry: The Film Factory in a Century of War* (Oakland: University of California Press, 2025).

2) Elena Past, "The Ferrania Acquisition, the Cinematic Archive and the Anthropocene: Celluloid Materialities," *La Valle Dell'Eden*, no. 37 (2021), 147–158; Lovejoy, *Tales of Militant Chemistry*.

I conclude with the assertion that viewing cinema as a series of geographically situated, interlinked agricultural and chemical manufacturing sites operating within specific climatic environments allows us to recalibrate the received timeline and map of its technological history. Taking cues from recent environmental perspectives, the article is loosely structured around some of the elements that dictate where film can be made: earth, wood, air, and water.

## Integrating Spatial Precision and Eco-Materialism

Spatial approaches have been a thematic mainstay of film scholarship since the early days of new film history.[3] Nowadays often pursued in the context of digital humanities projects, the value of spatial approaches, as Vincent Baptist et al. explain, lies in their "ability to unearth patterns in different types of data [which] allows historians of cinema culture to identify relevant new connections that can then be studied more in-depth with traditional, qualitative methods."[4] To date, this utility has been applied predominantly to research on audiences and cinemagoing, film programming and film diffusion across cinemas, and the geographic distribution of production and exhibition venues.[5]

In their introduction to one of the influential volumes on the subject, Julia Hallam and Les Roberts argued that "spatial methodologies are reinvigorating film scholarship by charting new pathways […] through the multilayered landscapes of film production, distribution, exhibition, and consumption."[6] Conceptual developments within film and media studies in the intervening decade help us to recognize that this lifecycle had left out the first, quintessential step: film *manufacturing*. This lacuna, I posit, can be remedied through a dialog between spatial and eco-materialist methods.

Indeed, roughly coinciding with the publication of Hallam and Roberts's book, Eastman Kodak went bankrupt and entered suspended animation, and Fujifilm discontinued the production of motion picture film stock. Most commercial film processing laboratories have gone out of business, although new, artisanal ones have appeared in their place, and photochemical cinema is experiencing a small revival in both screening practice

3) Thomas Elsaesser, "The 'New' Film History," *Sight and Sound* 55, no. 4 (1986), 246–251; Robert Allen and Douglas Gomery, *Film History: Theory and Practice* (New York: McGraw-Hill, 1994).

4) Vincent Baptist et al., "A Digital Toolkit to Detect Cinema Audiences of the Silent Era: Scalable Perspectives on Film Exhibition and Consumption in Amsterdam Neighbourhoods (1907–1928)," *Studies in European Cinema* 18, no. 3 (2021), 252–273.

5) Julia Hallam and Les Roberts, eds., *Locating the Moving Image: New Approaches to Film and Place* (Bloomington: Indiana University Press, 2014); Charles R. Acland and Eric Hoyt, eds., *The Arclight Guidebook to Media History and the Digital Humanities* (Sussex: Reframe Books in association with Project Arclight, 2016); Clara Pafort-Overduin et al., "Moving Films: Visualising Film Flow in Three European Cities in 1952," *TMG Journal for Media History* 23, no. 1–2 (2020), 1–49; Julia Noordegraaf et al., "Discovering Cinema Typologies in Urban Cinema Cultures: Comparing Programming Strategies in Antwerp and Amsterdam, 1952–1972," in *The Palgrave Handbook of Comparative New Cinema Histories*, ed. Daniela Treveri Gennari et al. (Cham: Palgrave Macmillan, 2024). Jeffrey Klenotic showcases more examples of concrete projects and their histories: Jeffrey Klenotic, "Mapping Flat, Deep, and Slow: On the 'Spirit of Place' in New Cinema History," *TMG Journal for Media History* 23, no. 1–2 (2020), 1–34.

6) Hallam and Roberts, *Locating the Moving Image*, 3.

(through film clubs and festivals) and academic research,[7] undergirded by a societal interest in and nostalgia for analog cinema's materiality. The closely related and increasingly necessary emphasis on environmental themes in film and media scholarship raises an interesting prospect: Do spatial approaches have anything to offer to the eco-materialist study of film, specifically? In the face of *global* environmental crises, does geographic specificity even matter? (Yes, it does.)

Eco-materialist studies of media sometimes paint with broad brushstrokes, foregoing local discussions of space in favor of emphasizing planetary entanglements. The methodological heuristics of media studies are capacious enough to generate insight at this macro-scale, too, but as Priya Jaikumar and Lee Grieveson argue in their recent introduction to an issue of *Media+Environment* on "extractive film,"

> bird's-eye narratives of imperialism, colonialism, and globalization are, upon close examination, composed of a patchwork of fragmented, differential, and dispersed events and conditions around the world. One part of our work is to demonstrate how these pieces fit together by exposing the long arc capitalist extractivism. The other part is to refute the inevitability and universalizing logic of extractivism by staying alive to particularities.[8]

As our field has now developed a good *general* sense that 1) both analog and digital media production is shockingly resource-hungry, polluting, and toxic to living beings, and that 2) media technology is "deeply entangled [with] logics of extractive racial-imperial capitalism,"[9] then whither do we continue onward?

Put differently, how does the cartographic approach taken by CINEAGRI contribute anything not already addressed by previous inquiries? What does it matter that Fujifilm's cellulose acetate factory was in Arai, and not any other township in Japan or elsewhere? Are there benefits — in terms of method or theory-building — in increasing the resolution of our inquiries beyond the regional or national?

That question echoes much older (but still ongoing) debates about the merits of micro-historical and transnational approaches to both History *lato sensu* and *media* history more narrowly,[10] and about emerging conceptual tools like "commodity frontiers."[11] I draw on both commodity history and what Nicole Starosielski and others call "elemental analysis."[12]

7) Grazia Ingravalle, "Allegories of the Past: Nitrate Film's Aura in Postindustrial Rochester, NY," *Screen* 60, no. 3 (2019), 371–387; Kim Knowles, *Experimental Film and Photochemical Practices* (Cham: Palgrave Macmillan, 2020).

8) Priya Jaikumar and Lee Grieveson, "Introduction to Media and Extraction: On the Extractive Film," *Media+Environment* 6, no. 1 (2024), accessed September 30, 2025, https://doi.org/10.1525/001c.123925.

9) Ibid.

10) Bernhard Struck et al., "Introduction: Space and Scale in Transnational History," *The International History Review* 33, no. 4 (2011), 573–584; Marie Cronqvist and Christoph and Hilgert, "Entangled Media Histories: The Value of Transnational and Transmedial Approaches in Media Historiography," *Media History* 23, no. 1 (2017), 130–141.

11) Sven Beckert et al., "Commodity Frontiers and Global Histories: The Tasks Ahead," *Journal of Global History* 16, no. 3 (2021), 466–469.

12) Nicole Starosielski, "The Elements of Media Studies," *Media+Environment* 1, no. 1 (2019), accessed September 30, 2025, https://doi.org/10.1525/001c.10780.

However, I am not just aiming to describe the circulation of physical goods from which celluloid was made, but also to critically disassemble abstract business entities like "Agfa" or "Fujifilm" into their elemental components: their sites of extraction, routes of trade and supply, and places of manufacturing and processing.

The purpose of this "elemental" film history — which Elodie A. Roy recently powerfully performed for the sonic and visual culture of shellac, Siobhan Angus for photography, and Alice Lovejoy for Kodak and Agfa's film products[13] — is twofold. Firstly, it enables the formulation of new answers to Malte Hagener's enduringly relevant question "Where is film?",[14] dispersing "film" as a research object into unexpected locales like Eilenburg in Germany, Keelung in Taiwan, or Ashigara in Japan.

Secondly, as Bhaskar Sarkar, Raka Shome, Yuriko Furuhata, and many others remind us, the persistent trope of the West as the normative heart of media history and media technology still lingers in our discourse and research.[15] Mapping the spaces of photochemical cinema and the movements of its raw materials reveals a rich "celluloid geopolitics" (as Lovejoy calls it),[16] through which we can partially enact a decentering of the North Atlantic region.

Hunter Vaughan has observed that "the ecomaterialist approach struggles with access and record, attempting to wrest indirect observation and theoretical conclusion from a black hole of information scarcity."[17] The spatial lens alone will not alleviate these methodological impediments, but it is an unexpectedly productive way of organizing and interpreting what historical information is available. Where Vaughan is interested in piecing together an environmental history of cinema from the fragmented production histories of various films, I turn to the manufacturing history of *film*, the material, as such.

## Partial and Fragmented: The Archival Collections of Celluloid Film Makers

Due to the structure of the European and Japanese photochemical industry, archival collections related to celluloid film manufacturing are highly fractured. Historically, this industry was characterized by a minuscule number of successful manufacturers and a similarly limited group of raw material suppliers — a consequence of the industry's proclivity toward secrecy, exclusive contracts, and vertical integration. The businesses, however, fre-

13) Elodie A. Roy, *Shellac in Visual and Sonic Culture: Unsettled Matter* (Amsterdam: Amsterdam University Press, 2023); Siobhan Angus, *Camera Geologica: An Elemental History of Photography* (Durham: Duke University Press Books, 2024); Lovejoy, *Tales of Militant Chemistry*.

14) Malte Hagener, "Where Is Cinema (Today)?: The Cinema in the Age of Media Immanence," *Cinema & Cie* 8, no. 11 (2008), 15–22.

15) Bhaskar Sarkar, "Tracking 'Global Media' in the Outposts of Globalization," in *World Cinemas, Transnational Perspectives*, eds. Nataša Ďurovičová and Kathleen E. Newman (London: Routledge, 2010); Raka Shome, "When Postcolonial Studies Interrupts Media Studies†," *Communication, Culture and Critique* 12, no. 3 (2019), 305–322; Yuriko Furuhata, "Of Dragons and Geoengineering: Rethinking Elemental Media," *Media+Environment* 1, no. 1 (2019), accessed September 30, 2025, https://doi.org/10.1525/001c.10797.

16) Alice Lovejoy, "Celluloid Geopolitics: Film Stock and the War Economy, 1939–47," *Screen* 60, no. 2 (2019), 224–241.

17) Hunter Vaughan, *Hollywood's Dirtiest Secret: The Hidden Environmental Costs of the Movies* (New York: Columbia University Press, 2019), 76.

quently subsidiarize, merge, branch off, and form holding companies, patent pools, syndicates, and cartels. Such institutional perturbances, along with historical events like World War II or the German Partition, have resulted in patchy, multi-sited collections. The business structures are arcane; understanding them is difficult.

Take Agfa as an example. Much of what survives of Agfa's records is at the German Federal Archives in Berlin, as part of the massive IG Farben collection. But materials can also be found in Wolfen, where its old film factory was located, and Leverkusen, where it was re-established as a Bayer subsidiary in West Germany. The 1964 Agfa-Gevaert merger sent some records to Belgium, in the care of the Fotomuseum Antwerp since 2017.

The Agfa-Gevaert archive is therefore enormous in scope, but also intensely fragmented and, as of yet, practically undescribed. There is a modicum of English-language publications,[18] as well as a respectable stream of German-language research dealing with the history of Agfa and its Wolfen film factory (especially the dedicated series of academic brochures published by the Industry and Film Museum Wolfen),[19] and yet it is still difficult to interface individual companies and archival collections with a broader, global story. The few studies that have taken an international perspective gravitate toward the subject primarily from the vantage point of business strategy.[20] Lovejoy's recent monograph has brought some redress, showing the global scale of Kodak's and Agfa's chemical empires, as well as their toxic and radioactive legacies. Aside from Hidenori Okada's now more than twenty-five-year-old article on the early history of Fujifilm and Konica,[21] what we are still largely missing, however, is an eco-materialist account of film manufacturing in East Asia.

As for other manufacturers, records related to Schering — a major producer of synthetic camphor and key supplier to celluloid makers like DuPont and Fiberloid — are held at the Bayer AG corporate archive in Berlin and are accessible by request. Fujifilm's documentation center with historical materials in Ashigara, Japan, is closed to external scholars, although inquiries are possible. Nevertheless, the official corporate histories of Fujifilm, the Fujifilm Labor Union, and Daicel can be consulted at libraries. They span several thousand pages and are very informative. A small handful of historical materials from Konica is scattered among multiple university and museum libraries across Tokyo. Impor-

18) Carlos Bustamante, "AGFA, Kullmann, Singer & Co. and Early Cine-Film Stock," *Film History* 20, no. 1 (2008), 59–76; Miriam De Rosa and Andrea Mariani, "Experimenting in Circles: Agfa, Amateur Cinema, and the Art of R&D," *NECSUS: European Journal of Media Studies* 12, no. 2 (2023), 176–195.

19) Rainer Karlsch, "Zwischen Partnerschaft Und Konkurrenz: Das Spannungsfeld in Den Beziehungen Zwischen Den VEB Filmfabrik Wolfen Und Der Agfa AG Leverkusen," *Zeitschrift Für Unternehmensgeschichte / Journal of Business History* 36, no. 4 (1991), 245–281; Herbert Bode, "Geschichte der Filmfabrik Wolfen 1909 bis 1994," *Mitteilungen der Gesellschaft Deutscher Chemiker, Fachgruppe Geschichte der Chemie*, no. 13 (1997), 157–162; Silke Fengler, "Den Markt klar im Sucher!? Krise und Niedergang des Amateurkamerageschäfts der Agfa-Gevaert AG in den 1960er und 1970er Jahren," *Jahrbuch für Wirtschaftsgeschichte / Economic History Yearbook* 47, no. 2 (2006), 95–114.

20) Alt, "The Photochemical Industry;" Patricia A. Nelson, "Competition and the Politics of War: The Global Photography Industry, c. 1910–60," *Journal of War & Culture Studies* 9, no. 2 (2016), 115–132.

21) Appeared in English translation as Hidenori Okada, "Nitrate Film Production in Japan: A Historical Background of the Early Days," in *The Oxford Handbook of Japanese Cinema*, ed. Daisuke Miyao, trans. Ayako Saito and Daisuke Miyao (New York: Oxford University Press, 2014).

tantly, not a single one of the collections mentioned here is presently digitized.[22] All are very place-bound.

A *comprehensive* view of the film stock industry is impossible because many archival records from the early period simply no longer exist. But even a modestly *accurate* portrayal will thus impel the historian to a sensitivity to place, if for no other reason than the prosaic circumstance of having to pay for a lot of trans- and intercontinental travel to study the records of even just one business entity. CINEAGRI circumnavigates these difficulties. By logistically enabling archival research at different, scattered collections, it seeks to combine "monocentric" — or as Paul S. Moore describes them: "often incredibly localized and particular"[23] — microhistories with the connective analysis of geographically wider transnational trade and knowledge networks. Both, as Jeffrey Klenotic argues, drawing on Selina Springett, remain in a generative tension, but work best when epistemologically flattened into each other.[24]

## Film Stock and the Elements

The elements provide a helpful way of mapping and understanding why film stock was produced in specific locations around the world. Next to the contemporary understanding of elements as basal chemical substances, readers are likely familiar with the Hellenic idea of the four elements: earth, water, air, and fire. In her discussion of elemental media, however, Yuriko Furuhata points out that Chinese cosmology inflects elementality somewhat differently, recognizing five elemental phases instead: fire, water, wood, metal, earth.[25] This constellation is woven into folk practices and into the fabric of daily life in East Asia; it appears in calendars, *feng shui*, horoscopes, and Chinese medicine. Heeding Furuhata's proviso about the importance of *global* elemental media genealogies, I borrow from both the Western and Eastern framework and use earth, wood, air, and water as a hybrid scaffolding for the remainder of this article.

### *Earth*

Photochemical cinema has always been a medium that forced those involved in its manufacturing to be very, very geographically precise. In an anecdote now firmly embedded in Eastman Kodak's corporate mythology, cattle raised in specific regions with specific diets were to blame for the initial photographic gelatin failures that nearly ruined George Eastman's budding business in 1882. As Emmet von Stackelberg documents in his recent doctoral dissertation, gelatin had to be rendered from cattle that ate mustard plants, because they contain trace amounts of sulfur. Without sulfur, bovine gelatin — for instance, from

22) A few folders from the IG Farben collection have been scanned on an ad-hoc basis and are freely available online. Published corporate histories held at Japanese libraries are also excellently digitized, allowing full--text search, but access is only possible on site.

23) Paul S. Moore, "Space, Place, and Case: Surveying the Grounds of Cinema History," *Early Popular Visual Culture* 13, no. 4 (2015), 336.

24) Klenotic, "Mapping Flat, Deep, and Slow."

25) Furuhata, "Of Dragons and Geoengineering."

cows that were fed cottonseed meal — is not photographically useful.[26] Sulfur from the earth, traversing the plants and the animals that eat them, is thus one of the first elements that govern how and where cinema is made.

Sulfur and gelatin are what we might classify as the *chthonic elements* of cinema: filmic substances bound to the earth either through their origin in the underworld (much like silver or saltpeter), or by their association with death and the afterlife, like the animal carcasses from whose bones and hides gelatin is made.[27] In chemical manufacturing, this earthly attachment is a problem. Studying Eastman Kodak's raw material supply, von Stackelberg observes that gelatin — a beastly, fleshy, difficult-to-purify substance of non-human metabolic origin — was the most frustrating material for photochemical engineers to work with.[28] Agfa's historical trail is consistent with this finding. Photoemulsion research at Agfa is well-documented between 1919 and 1928, permitting identification not only of Agfa's gelatin suppliers, but, unusually, also of the specific tanneries that delivered animal parts to them, such as Carl Freudenberg and Lederwerke Cornelius Heyl.[29]

Even after signing an exclusive supply contract in 1922 with Deutsche Gelatine-Fabriken AG (DGF), Agfa continued experimenting with formulas from different companies. And the exasperation in its archive is palpable: batches made in separate factories using the same recipes behaved inconsistently. Letters from 1921 indicate that the Göppingen DGF factory was apparently terrible at making photographic gelatin. Kalbe's product had been excellent, then worsened quickly and the company was unable to deliver anything good for a year. Only DGF's headquarters in Schweinfurt satisfied Agfa's demands.[30] But a later report dated November 13, 1925 complains about the poor stability of Schweinfurt gelatin, praising instead products made in Ziegelhausen by Stoess, the principal supplier to Kodak.[31]

These manufacturing failures alert us to the fact that the film supply chain is a fibrous, branching structure. The movement of materials does not follow a straight line; rather, chemically similar materials originate from multiple places, move around different destinations, sometimes bouncing back-and-forth for various parts of the processing. A single company will own multiple factories and production sites, which have their own manufacturing microcultures. For example, Fujifilm first bought materials from Germany in the 1930s, but very quickly shifted to domestic production and its own vertically integrated factories (which I discuss later in this article) before World War II, then returned to international suppliers after the war. Among so many tributaries, "[m]aterials were defined by their provenance," von Stackelberg observes.[32] The drive toward chemical standardization notwithstanding, gelatin sites in both Europe and Japan were bedeviled by inexplicable behaviors for decades.

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26) von Stackelberg, "Seeing Through Silver," 98.
27) For an extended discussion of the close parallels between cinema and animal disassembly, see Nicole Shukin, *Animal Capital: Rendering Life in Biopolitical Times* (Minneapolis: University of Minnesota Press, 2009).
28) von Stackelberg, "Seeing Through Silver," 15.
29) Multiple reports from 1921 and 1922 in *Bundesarchiv* (henceforth abbreviated to BA) folder R8128/16907.
30) Various letters in BA R8128/16908.
31) Technical report "Haltbarkeit von Emulsionen," BA R8128/16907.
32) von Stackelberg, "Seeing Through Silver," 31.

In matters of celluloid, a chain of metabolic events links the element of earth to cinema's photochemistry. It is not entirely far-fetched to speculate that, like at Kodak, some of the frustrating inconsistencies in gelatin quality at Agfa and Fujifilm may similarly be attributable to the land — the earth where the cattle had grazed. In the archive, gelatin is always already situated, earthbound. Not a fungible, uniform commodity identified by its manufacturer, but by the specific production site.

### *Wood*

By weight, however, cinema is of largely vegetal origin. Celluloid is made from cellulose fibers, usually derived from cotton. But in a narrower sense, *wood* is also a quintessential element of cinema. Alice Lovejoy posits that it was primarily the forests that attracted Eastman Kodak to a wood alcohol plant in Kingsport, Tennessee, and motivated it to transfer all of its acetate manufacturing there in 1930. Lovejoy concludes that "trees were at the core of nearly all of Tennessee Eastman's photographic supplies and goods."[33)]

Wood figures in the Agfa archives in interesting ways, too. After World War I, multiple companies supplied Agfa with cellulose "dope,"[34)] including the German explosives manufacturers Deutsche Sprengstoff-AG and Wasag. Nevertheless, by the mid-1920s, cellulose nitrate and acetate dope were mostly sold to Agfa and Gevaert by the Deutsche Celluloid-Fabrik AG in Eilenburg. In 1924, Agfa signed a contract stipulating that the Celluloid-Fabrik would satisfy two thirds of Agfa's cellulose needs. Several draft versions of the nitrocellulose contract survive, along with modification requests from Agfa.[35)] The initial contract postulated that dope pricing would be contingent on raw material costs. Agfa insisted on removing such a blanket clause and separating fibers by origin, because the company feared that Eilenburg might raise dope prices when cotton linters were expensive, even though it might be delivering cheaper wood-based cellulose.[36)] Although I have not seen evidence that Agfa made any market-ready wood-based photographic or cine-film products in this period, it did test wood pulp nitrocellulose specifically for this purpose, and the excellent performance of wood cellulose from Eilenburg was ultimately one of the reasons that tipped the contract in favor of the Celluloid-Fabrik and against its competitor, Agfa's long-standing partner, Wasag.[37)]

Wood's vegetal specificities were therefore so important to the manufacturing that they had to be spelled out in detail in business negotiations, and they also led to the decades-long procurement relationship between Agfa — later IG Farben — and the Cellu-

33) Lovejoy, "Celluloid Geopolitics," 153.

34) "Dope" is the liquid precursor to celluloid film — a syrupy form of nitrated cotton which can be poured and dried into a film after being mixed with camphor and solvents.

35) "Vertragsentwurf Nitrozellulose-Fabriken" and related correspondence from August-September 1924, BA R8128/17127.

36) Cellulose fibers derived from wood pulp have several disadvantages over cotton. For example, they require much higher amounts of acid for nitration or acetylation because of attached lignin and resins. For more detail, see also Jonathan Haid, "The Raw Materials of Celluloid Film: Wartime Economy, Educational Animation, and Film's Plasticity," *Research in Film and History*, no. 5 (2023), accessed September 30, 2025, https://film-history.org/issues/text/raw-materials-celluloid-film.

37) Letter from Oppenheim to Agfa directorate, July 9, 1924; and "Aktennotiz über die Besprechung mit Herrn Professor Berl," July 12, 1924, in BA R8128/17127.

loid-Fabrik Eilenburg. As Lovejoy argues, the scientific possibility of wood-based cellulose was hailed as a way of severing the reliance on U.S. cotton, and therefore as a matter of national political and economic autarky and imperial expansionism in the German Reich.[38)]

The cotton linters used in celluloid film in the West, indeed, largely originated from the United States. Agfa's suppliers bought them on the Bremen cotton market from companies such as O'Neill Brothers (East Point), P. F. Cornwell (Atlanta), Mississippi Cottonseed Products Co. (Memphis), and others, and brought them to Germany via Rotterdam or Hamburg. Given the U.S.'s dominant position as a global cotton exporter, one might plausibly assume that Japan imported cotton for its film products from there, too. However, this does not seem to be the case.

In its early years in the 1930s, Fujifilm received all of its cellulose nitrate and acetate from Daicel, which made them out of rag tissue paper and textile scraps. A former Daicel employee recalls that no U.S. linters were imported in the early period.[39)] Linters only replaced rag paper in 1937, when research at Fujifilm and investments into new bleaching and refining machinery shifted the manufacturing process.[40)] Prior to that, Daicel and its precursors were buying cellulose fibers from domestic companies like Tōyō Paper and Mitsubishi Paper. While it is unclear to me where exactly the cotton for rag paper came from, based on Chisako Tsuji's analysis, during the period at stake here (1920s–1940s), most cotton in Japan would have originated from India and China.[41)]

Indeed, Northern China's abundant cottonseed production, along with the pressures of growing celluloid demand, prompted Daicel to aggressively pursue self-sufficiency. It opened several of its own cotton linter factories on the occupied Asian continent: in 1938 in Tianjin, China, and Mokpo, Korea, expanding to Manchuria the following year (either in Mukden, according to Daicel's 1952 corporate history, or Liaoyang, per the newer book from 1981). Linters from the continent were sent to Aboshi for refining into cellulose nitrate, and some to Arai for acetate. As far as I am aware, Daicel's — and thus, by extension, Fujifilm's — investment in Japanese colonial cotton has never been addressed in English-language literature previously.

But celluloid stock manufacturing revolves around wood not only as a source of methanol, acetone, acetic acid, or potentially cellulose, but also of camphor, the only economically viable plasticizer for nitrate film, and of turpentine, the raw material for making synthetic camphor.

Camphor is a crystalline substance distilled from certain species of trees native to Taiwan, Southern China, and Southern Japan. A specialty product of Japan and Taiwan, camphor was a primary source of revenue for the Government-General of Taiwan during the Japanese era (1895–1945), as well as a critical natural resource at the center of violent global conflicts between Indigenous Taiwanese, Hakka settlers, and practically every imperial empire throughout the 19th and 20th centuries. The history of camphor extraction in

38) Lovejoy, *Tales of Militant Chemistry*, 53–58.
39) Dainippon Celluloid, *History of Dainippon Celluloid Co.* [大日本セルロイド株式会社社史] (Amagasaki: Dainippon Celluloid, 1952), 408.
40) Dainippon Celluloid, *History of Dainippon Celluloid Co.* [大日本セルロイド株式会社社史], 153.
41) Chisako Tsuji, "Cotton Improvement Projects in Japan and Korea," in *Intra-Asian Trade and Industrialization*, eds. A.J.H. Latham and Heita Kawakatsu (London: Routledge, 2006).

Taiwan is a microcosm of planetary colonial extractivism. It is a fecund area of research among historians of East Asia that enjoys continued popularity as a subject of doctoral dissertations.[42] The gamut of research spans all of cultural, economic, and environmental history, but the consensus among scholars is that the celluloid industry's hunger for camphor fueled the deforestation of Taiwan's mountainous regions and an increasingly violent displacement of their native inhabitants, both by settlers from the Chinese mainland during the Qing era, as well as under Japanese rule. It is only recently that media scholars such as WZ Hill, Jonathan Haid, Emmet von Stackelberg, and others have begun lobbying for more awareness of cinema's part in this dark camphor history.[43]

Celluloid film is fundamentally intertwined with the Japanese monopoly on camphor wood and Japan's colonial forestry.[44] The precious wood-derived crystals are not only chemically indispensable to cinema; they also point us to a trade infrastructure woefully invisible in scholarship on film technology and chemistry: that of East Asian shipping and trading firms. Samuel Samuel, Suzuki Shōten, and Mitsui Bussan controlled the international trade in camphor. These businesses did not operate simply as transparent "media" of goods circulation. They actively intervened in the early celluloid film industry.

The Yokohama-based Samuel Samuel, for instance, held the Japanese Monopoly Bureau's exclusive camphor sale license early on, at the start of the 20th century, and puppeteered European industry by prioritizing supplies to camphor refineries over celluloid producers.[45] Hirokazu Hirai has argued that, aside from the Russo-Japanese War, it was Samuel Samuel's throttling of sales to celluloid makers that led to the dramatic global price fluctuations and the sudden emergence of Chinese natural and German synthetic camphors on the market in 1907.[46] Displeased, the otherwise hands-off Monopoly Bureau first forced Samuel Samuel to allocate 80% of its camphor to celluloid companies, then terminated its contract entirely in December 1906 and shifted its consignment to Mitsui Bussan, causing a minor diplomatic row. Mitsui itself was later instrumental in repeatedly in-

42) Daigaku Tei, "Research on the History of Taiwan-Japan Camphor Policy [臺日樟腦政策史の研究]" (PhD Dissertation, Osaka Metropolitan University, 1995); Antonio C. Tavares, "Crystals from the Savage Forest: Imperialism and Capitalism in the Taiwan Camphor Industry, 1800–1945" (PhD Dissertation, Princeton University, 2004); Ken Riebensahm, "Der steigende Kampferbedarf infolge der Erfindung des Celluloids und die Unterwerfung der indigenen Bevölkerung Taiwans während der japanischen Kolonialherrschaft" (PhD Dissertation, University of Hamburg, 2011); Matthew Tyler Combs, "Camphor, a Plastic History: China, Taiwan, and Celluloid, 1868–1937" (PhD Dissertation, UC Irvine, 2018); Toulouse-Antonin Roy, "'The Camphor Question Is in Reality the Savage Question:' The Japanese Empire, Indigenous Peoples, and the Making of Capitalist Taiwan, 1895–1915" (PhD Dissertation, UCLA, 2020); Faizah Zakaria, *The Camphor Tree and the Elephant: Religion and Ecological Change in Maritime Southeast Asia* (Seattle: University of Washington Press, 2023).

43) W. Z. Hill, "The Life of a Film: Medianatures, Camphor, and the Ideology of Technological Modernity," *JCMS: Journal of Cinema and Media Studies* 61, no. 4 (2022), 85–105; Haid, "The Raw Materials of Celluloid Film;" von Stackelberg, "Seeing Through Silver."

44) Marek Jancovic, "'Please Reseed:' Camphor, Turpentine, and the Agrogeographies of Celluloid Cinema," in *Cinematic Ecosystems: Screen Encounters with More-than-Humans in the Era of Environmental Crisis*, eds. Mary Hegedus and Jessica Mulvogue (Wilmington: Vernon Press, 2026).

45) Japan Monopoly Corporation [日本専売公社], *History of the Camphor Monopoly* [樟脳専売史] (Tokyo: Japan Monopoly Corporation, 1956), 455.

46) Hirokazu Hirai, "A Study of Historical Japanese Colonial Finances [日本植民地財政史研究]" (PhD Dissertation, Hokkaido University, 1996).

viting George Eastman and his engineers to Japan as part of its (ultimately unsuccessful) efforts to seduce Kodak into building a film factory there.[47)]

These brief historical vignettes demonstrate that there are still major blind spots in English-language celluloid film research, which can be successfully identified by heightening our sensitivity to places, materials, and environments.

Even Japanese camphor's nemesis — German and U.S. synthetic camphor — is a forest product. Turpentine oil, made by distilling pine tree resin, can be chemically synthesized into camphor through successive transformations into pinene hydrochloride, camphene, and isoborneol. Figuring out the nuances of this process was a major driver of Schering's success as one of the world's most important pharmaceutical manufacturers. Schering was the first to commercially make synthetic camphor on a large scale and ultimately broke the Japanese Monopoly Bureau's grip on the world market in the 1920s. Synthetic camphor alone accounted for 37% of Schering's turnover in 1924.[48)]

As I have described in more detail elsewhere, turpentine suitable for camphor synthesis could only be won commercially from specific pine species growing in specific regions that produced correctly polarized resin.[49)] Locational specificity matters here, too: graphs in the archives of Schering and Agfa's parent company IG Farben show that U.S. turpentine, shipped overseas from Savannah, New York City, or New Orleans, was considered most suitable for camphor production due to its high pinene content. This was followed (in quickly descending order) by Portuguese, French, Russian, Nordic, and German turpentine.[50)]

Correspondence and waybills in the Schering archive depict in crisp geographic detail the vicissitudes of a transnational industry hampered by unreliable logistical infrastructure and the smelly, pesky corporeality of its commodities. On occasion, camphor shipments were so fetid that shippers refused to load them on passenger steamboats traveling down the Rhine. Because of this, in 1928, one such delivery missed a transatlantic freight ship leaving from Rotterdam to Wilmington, where DuPont was waiting to process it into celluloid. DuPont's London office was furious![51)]

Later, as World War II raged on the continent, Schering frantically scrambled to source substitutes for U.S. turpentine oil. Its Hamburg-based import partner Willers, Engel & Co. sent weekly updates with prices for French, Spanish, and Portuguese products. In 1944, a typical supply route might have looked like this: Schering would buy a trainload of Portuguese and Spanish turpentine from Willers, to be delivered from Hendaye at the Spanish–French border to Schering's factory in Eberswalde by rail via Strasbourg and Frankfurt. Sometimes, French turpentine came from Willers's stocks in Mühlhausen. Occasionally, trains arrived completely empty and the importer had to divert replacement cargo from other clients in Wiesbaden.[52)]

47) Fuji Photo Film Co., *25 Years in Business* [創業25年の歩み] (Tokyo: Fuji Photo Film Co., 1960), 20.

48) According to the unpublished corporate history by Karl Otto Mittelstenscheid, "Kampfer: Ein wichtiges Kapitel der Schering-Geschichte," 1996, SchA-B3-788, Schering Archiv, Bayer AG, Berlin, henceforth abbreviated as SchA.

49) Jancovic, "'Please Reseed.'"

50) I.e., "Pinen u. Kampfer Ausbeuten," January 15, 1941, in BA R8-VIII/356.

51) Letter and telegram correspondence in SchA, folder B2-973.

52) Letter correspondence in SchA folder B2-460.

In these examples, the materiality of wood-derived substances not only clearly exerts a great deal of influence over the supply chain. It is also the condition of possibility for tracing the supply chain to begin with. There is a paper trail because things went *wrong*. Had the camphor not been so smelly as to interrupt the trade route, there likely would not have been many confused letters and telegrams — the kinds of sources that tend to survive in historical collections better than, for example, invoices. Wood and its manifold forms — including the very paper of archival documents — therefore must be considered a fundamental element of celluloid cinema and its history.

***Air***

Air has always been a silent antagonist to film manufacturers. Berlin's turbid airs were what drove Agfa to the countryside in Wolfen in 1909.[53] When Agfa was looking to establish its own film factory in the United States, its executives initially considered building it in New York City, then rejected the idea chiefly because of the unfavorable climate. High temperatures and humidity in the summer and too much cold in the winter would have made the maintenance of consistently tempered air conditioned to 8°C prohibitively expensive.[54] Eastman Kodak's own plans to open a film stock plant in Japan also fell through because its engineers found the Japanese climate too warm and humid to make celluloid.[55] Indeed, finding a suitable site was not easy for the locals, either. The company histories of both Fujifilm and its parent Daicel describe the quest in some detail.

By 1930, the celluloid company Daicel had been experimenting with making nitrate film base for a decade and finally resolved to build a dedicated film plant.[56] After scouring the entire wider Kantō area, Shūichi Asano (Fujifilm's future first president), Sakae Haruki (its second president), and Seisuke Sakuma (the engineer responsible for celluloid dope pouring) initially decided on the town of Gotemba, in a generally dry area with few salt aerosols and plentiful clean water. But they later realized that Gotemba's location at the base of Mount Fuji created a microclimate that raised the humidity above the regional average and caused a weather phenomenon known as "watashiame" — frequent rains around the town even when it was sunny in the larger Numazu urban area just 30 kilometers away.[57] Air was thus also central to the siting of celluloid factories — so much so that we might even speak of an *atmospheric a priori* of cinema.

It was the clean mountain air that convinced the later Fuji Photo Film Company to invest in (and later purchase) a gelatin factory in the village of Kawakami in May 1939. Fuji purchased Nikka Kōgyō's bovine gelatin facility both because World War II escalations suddenly threatened the supply, but also because the cold climate and pure air at an elevation of 1060 meters were thought to be ideally conducive to gelatin production and curing.[58]

53) Bustamante, "AGFA, Kullmann, Singer & Co. and Early Cine-Film Stock."
54) „Bericht über die Möglichkeit der Fabrikation photog. Produkte in Amerika," n.d. [1928?], BA R8128/20784
55) Fuji Photo Film Co., *25 Years in Business* [創業25年の歩み], 5.
56) Daicel Chemical Industries, *A 60-year history of Daicel Chemical Industries* [ダイセル化学工業６０年史] (Osaka: Daicel Chemical [ダイセル化学工業株式会社], 1981), 29.
57) Fuji Photo Film Co., *25 Years in Business* [創業25年の歩み], 28.
58) Ibid., 103; Jun Arakawa, "Industrial History of the Photographic Materials - 'How Dainippon Celluloid Esta-

But this drive toward ideal atmospheric conditions — Furuhata calls it "thermostatic desire"[59] — would also lead to the factory's demise. Clean air clashed with logistical reality. Tucked away in the mountains of Nagano (Fig. 1), the site was inconvenient and difficult to communicate with, and had no direct connection to tanneries. It somehow managed to keep alive the supply to Fujifilm's celluloid plant in Ashigara throughout the war, in part by resorting to making gelatin from whales, even as Fuji's other bone gelatin factory in Karino was shut down. Representatives were sent far north to Hokkaidō to buy whale blubber. Whatever was too fatty to be used for cinema, was then canned and sent to employees as food. In normal times too smelly to eat, it was greeted as a blessing during wartime shortages, the corporate history recalls.[60] The Kawakami site ceased operations on July 21, 1954. But it had an essential role in teaching Fujifilm's later suppliers — Nihon Hikaku (now Nippi) and Nitta Kōshitsu (now Nitta Gelatin) — how to make photographic gelatin.[61]

Fig. 1: The site of Fujifilm's former gelatin factory in the village of Kawakami. The original buildings were dismantled in the 1950s; the current structures are a produce collection facility. Photo by the author

Air, the most tenuous of elements. In the film factory, it acquires a thickness, a tenacity, a mind of its own. We know from existing literature that it is constantly treated with suspicion, monitored as a disturber of purity, subjected to thermal control and heavy-duty filtering.[62] A carrier of dust, dirt, moisture. And later, as Lovejoy recounts, of radioactive fallout.[63] But air steers the supply network even *before* the factory is there. It marks certain sites as atmospherically (and therefore financially) suited to pouring and handling celluloid or gelatin. It precludes others as too humid, too warm, or too polluted. Tales of

blished Fuji Photo Film' [感光材料の産業史-「大日本セルロイドから富士写真フイルム 設立の経緯」]," *Journal of The Society of Photographic Science and Technology of Japan* [日本写真学会誌] 87, no. 2 (2024), 79–86.

59) Yuriko Furuhata, *Climatic Media: Transpacific Experiments in Atmospheric Control* (Durham: Duke University Press, 2022).

60) Fuji Photo Film Co., *25 Years in Business* [創業25年の歩み], 221.

61) Fujifilm Labor Union, *History of the Fujifilm Labor Union* [富士フイルム労仂組合の歴史： 前史・1945年-1957年・追補] (Tokyo: Rōdō Keizaisha [労働経済社], 1960).

62) von Stackelberg, "Seeing Through Silver," 56–57.

63) Lovejoy, *Tales of Militant Chemistry*.

air tend to be anecdotal in corporate histories, but by stitching them together across multiple archives, we begin to see how heavily the atmospheric preconditions of a place are implicated in the choice for a particular manufacturing site. And given how much film factories tend to orient the culture and economy of a city around themselves,[64] this atmospheric a priori must be understood and accounted for as more than just a passive "environment" or "weather."

### *Water*

The atmospheric a priori of cinema has a parallel in water. Let us return to the search for a location for Fujifilm's first factory. Not far from both Gotemba and Numazu, on the northwestern side of Mount Myōjingatake, Asano, Haruki, and Sakuma found what they had been looking for. The town of Ashigara offered an agreeable climate and clean air. The water of the Kari river had chemically ideal properties, a stable temperature, and contained almost no metals, salts, or organic inclusions. It flowed through a V-shaped valley, so that Daicel's usage of one branch would not upset farmers who relied on it for irrigation.[65] The elements — earth, air, and water — perfectly converged at this site, and became the reason Daicel decided to construct its first film stock plant here, spinning it off into a separate corporation, Fuji Photo Film, just before construction was completed at the end of 1933. Fujifilm's factory remains in Ashigara to this day.

Water prolifically permeates the voluminous corporate archives of film stock makers. Across the decades, numerous reports document how floods and water shortages regularly disrupted production. Agfa's 1905 annual report informed shareholders that shipment prices for nitrate and pyrite skyrocketed because the Elbe and Oder rivers had dried up, forcing a shift to rail transport.[66] The drought of 1911 was, again, a shock large enough that it had to be explained to investors.[67] Floods contaminated the groundwater with bacteria in 1913, causing quickly degrading, faulty emulsions.[68] Droughts on these major waterways periodically appear in IG Farben's records well into the 1940s. When global cotton and linter prices spiked in 1936 due to a drought in Mississippi and Tennessee, IG Farben tested alternative Greek, Romanian, Turkish, and Syrian cotton linters that had appeared on the markets but found them unusable for cine-film.[69]

Several scholars have pointed to the damage that Eastman Kodak and its partners and subsidiaries have caused to people and creatures living in close proximity to the Genesee and Holston rivers.[70] Much less is known of such toxic celluloid pasts in other parts of the

64) Ibid.
65) Fuji Photo Film Co., *25 Years in Business* [創業25年の歩み], 28–29.
66) 32nd shareholder report in BA R8128/20667.
67) Report of May 2, 1912 in BA R8128/20667.
68) Peter Löhnert and Heinz Mustroph, *Von der Trockenplatte zum Schwarz/Weiss Kinefilm*, Aus der Geschichte der Filmfabrik Wolfen 61 (Betriebsarchiv d. VEB Filmfabrik Wolfen, 1987), 40.
69) BA R8128/20367.
70) Richard Maxwell and Toby Miller, "Film and the Environment: Risk Offscreen," in *Film and Risk*, ed. Mette Hjort (Detroit: Wayne State University Press, 2012); Past, "The Ferrania Acquisition, the Cinematic Archive and the Anthropocene"; Heather Davis, *Plastic Matter* (Durham: Duke University Press, 2022); von Stackelberg, "Seeing Through Silver"; Lovejoy, *Tales of Militant Chemistry*.

world, although even official corporate histories offer glimpses of water-related environmental damage.

Both Sakai Celluloid in Ōsaka and Nippon Celluloid Artificial Silk in Hyōgo, the precursors to Daicel, built their factories near renowned rivers.[71] The Yamato in Ōsaka was considered an "illustrious water" so pure that it was shipped to *sake* makers all the way in Nada.[72] The Ibo, flowing through the town of Aboshi in Hyōgo (Fig. 2), was equally famous already beginning in the Nara period.[73] But by the time the Camphor Monopoly Bureau ordered Sakai and Nippon Celluloid to merge and form Daicel in 1919, these acclaimed streams were at their limits. The rivers had developed a habit of drying up in the summer, causing expensive production interruptions and forcing the factories to repeatedly rebuild water collection facilities.[74] Gravel extraction sank both riverbeds and caused saltwater intrusions from the sea. By 1932, Daicel had to petition the Ōsaka prefectural government to build a weir, half of which it financed itself. Even that was not enough to secure sufficient water, as the company was gearing up to start supplying its soon-to-be new subsidiary, Fujifilm, with paper and raw celluloid. Production had to move from Sakai to Aboshi completely, where an expanded cellulose factory on the Ibo began operations in 1936.[75]

Fig. 2: The Ibo river in 2025, within walking distance from the Daicel compound. Photo by the author

Daicel's later acetate factory in Arai was also positioned there because of fluvial conditions deemed well-suited for manufacturing. After surveying the entire country, Daicel decided to set up shop in Niigata prefecture. The town of Arai offered land, financing, and access to enticingly cheap hydropower, thanks to the Ikejiri and Seki rivers. The Seki, Ya-

71) Regarding Daicel's prehistory, see Okada, "Nitrate Film Production in Japan."
72) By the 1970s, the Yamato was one of the most polluted rivers in Japan.
73) Koyama Hisashi, *History of the Japanese Plastic Industry* [日本プラスチック工業史] (Tokyo: Kōgyō Chōsakai [工業調査会], 1967), 20.
74) Dainippon Celluloid, *History of Dainippon Celluloid Co.* [大日本セルロイド株式会社社史], 93.
75) Dainippon Celluloid, *History of Dainippon Celluloid Co.* [大日本セルロイド株式会社社史], 126–127; Daicel Chemical Industries, *A 60-year history of Daicel Chemical Industries* [ダイセル化学工業６０年史], 26–27.

shiro, and Shibue should have provided the factory with more than enough process water, yet extreme droughts plagued it as early as 1937, a mere year after it began operations.[76]

As with air, one would be hard-pressed to find a manufacturing site involved in photochemical cinema whose existence is not in some profound manner intertwined with rivers. Rivers and water supply are constantly a point of discussion in the archival record, and also prominently remembered in corporate historiographies, where water appears as a processing chemical, as an energy source, as logistical infrastructure, and as waste.

Already a decade ago, in his now seminal book, Jussi Parikka had established that media technology is of the environment and returns to the environment.[77] Cinema, too, is a thing of the living world. Aside from the raw materials themselves, making film is contingent on an atmospheric and fluvial a priori, and on specific geographic, hydrological, and meteorological features found in some places and not others. If we interrogate the archival records to ask *why* Fujifilm's or Agfa's factories were situated exactly where they were, they generously disclose a cast of nonhuman characters who direct the construction and operation of buildings and the movement of goods, trains, trucks, and ships. Throughout the history of cinema, chemical discoveries and technological inventions matter, yes, but so do droughts and microclimates, floods and aerosols, mustard plants and camphor trees, and whale blubber.

## Three Takeaways

What analytical value do all these site-specific anecdotes really carry, beyond satisfying some primal encyclopedic obsession with film-related geographic trivia? By way of conclusion, allow me to format my answer as a list.

**1. A geographically situated approach to cinema as a material object indicates new historical focal points and unexpected industrial, environmental, and colonial entanglements.**

Recent celluloid film history has already established that cinema must be theorized as a close relative of explosives and fertilizers, and that a theory of cinema aesthetics also requires an understanding of the chemistry of the film base and emulsion.[78] A situated approach to global cine-film manufacturing and its environments further reveals new regional foci and unexpected nonhuman entanglements — such as that between Fujifilm and the Japanese whaling industry, or the importance of the water systems around Ōsaka Bay and Myōkō in Niigata. It also directs us toward previously undertheorized logistical actors, such as shipping and trading companies.

76) Dainippon Celluloid, *History of Dainippon Celluloid Co.* [大日本セルロイド株式会社社史], 142–43; Daicel Chemical Industries, *A 60-year history of Daicel Chemical Industries* [ダイセル化学工業６０年史], 33–34.

77) Jussi Parikka, *A Geology of Media* (Minneapolis: University of Minnesota Press, 2015).

78) Lovejoy, *Tales of Militant Chemistry*; Pansy Duncan, "CelluloidTM: Cecil M. Hepworth, Trick Film, and the Material Prehistory of the Plastic Image," *Film History* 31, no. 4 (2019), 92–111; Pansy Duncan, "Towards a Natural History of Film Form: Silver Salts and the Aesthetics of Early Studio-Era Hollywood Cinema," *Screen* 63, no. 4 (2022), 411–426; Past, "The Ferrania Acquisition, the Cinematic Archive and the Anthropocene."

This geographical realignment from Euro-American manufacturing sites to a more global map goes hand in hand with the emergence of new temporal foci. The two World Wars often serve as narrative anchors in the story of celluloid film due to both new chemical discoveries spurred by material shortages, and also because relatively many archival records survive, so the period is amenable to research. However, other armed conflicts have also distinctly shaped raw material availability. Camphor is a case in point: its price fluctuations (which impacted celluloid film manufacturers heavily and either stimulated or stymied the development of German synthetic manufacturing and the later success of Schering) can be tied directly to the First Sino-Japanese and the Russo-Japanese Wars. As I have shown, the Mukden Incident and the Japanese occupation of Korea were also instrumental to the celluloid base that Fujifilm was making until Japan lost its colonies.

**2. Locational and material specificity can inform the study of film aesthetics and preservation.**

Cheap electricity and labor in a given region, as well as the road, railway, and port infrastructure, weigh heavily into celluloid manufacturers' managerial decisions, but the natural environment — *the elements* — dictates a fair proportion of where celluloid film is made, its price, as well as its aesthetic and material properties. Gelatin must not be cloudy. Camphor must resist yellowing — in fact, Schering's synthetic camphor, used to make both cine-film and laminated car windshields, was subjected to intense aesthetic scrutiny from its U.S. clients. Reports show that the so-called "DuPont-grade" camphor had to withstand special testing because the celluloid interlayer in windshields made with synthetic camphor sometimes began discoloring after two years, while U.S. car warranties lasted for five.[79] For obvious reasons, color stability was equally important to photographic and cine-products.

In a roundabout way, the environmental history of cinema is therefore also tied up in its archival present. Hypothetically, a batch of films in the archive that deteriorate faster than others could, on occasion, be traced back to environmental disruptions — such as a past drought that toppled the cotton supply chain and forced celluloid companies to resort to other markets. This avenue of research has tremendous potential for collaboration between historians, film archivists, and archival chemists.

**3. The relevant unit of analysis is not the company, but the factory.**

This article has shown that the environmental conditions underpinning celluloid film manufacturing — soil chemistry, river hydrology, forest access, and atmospheric stability — are not an abstract backdrop in cinema's industrial history, but agentive forces. In order to account for them historically, we must shift our analytical lens from the company to the factory: the site where climate meets chemistry, and where logistical decisions are shaped by nonhuman constraints. By foregrounding the factory as the nexus of environmental, colonial, and technological entanglements, we gain a more precise understanding of cinema's material infrastructure.

79) Various materials in SchA B2-0167.

In conjunction with this approach that asks about the local specificities of celluloid manufacturing sites, organizing the history of film stock elementally can be a productive way of reassessing historical documents and existing corporate historiographies, and expanding cinema's global geography eastward and toward the Pacific.

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**Biography**

Dr. **Marek Jancovic** is Assistant Professor of Media Studies at the Vrije Universiteit Amsterdam. His research is centered around the materialities of the moving image, film preservation practices, media and the environment, and format studies. Marek is the author of *A Media Epigraphy of Video Compression: Reading Traces of Decay* (2023); together with Jimi Jones, the author of *The Future of Memory: A History of Lossless Format Standards in the Moving Image Archive* (2025) and, with Axel Volmar and Alexandra Schneider, the editor of *Format Matters: Standards, Practices, and Politics in Media Cultures* (2020).
Email: m.jancovic@vu.nl