Sufficiency or Excess: Analog and Digital Strategies for Film Heritage Sustainability[1]

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The contemporary media landscape is marked by a tendency to accept the market-driven practices of planned obsolescence, where questions of sufficiency and excess permeate the realms of media industry practices. While this is entering the broader discussion on media sustainability, inadequate attention has been given to these phenomena in the film heritage field.

As content libraries expand, the need for larger and more efficient data centres challenges the limits of storage, archiving, and accessibility. Many countries throughout Europe have witnessed the construction of cutting-edge film storage vaults and preservation centres, but the rising volume of digital content and the induced built-in redundancy of digital formats gradually replacing carrier-based collections have necessitated a heightened focus on digitization, such as digital preservation standards and access for both analog and digital-born film materials.

Our proposal aims to take a critical approach to the digital preservation infrastructure of film heritage. Is digital preservation a reliable answer, 'enough' sustainable in environmental and moral terms, closely linked to economic growth and resource exploitation principles? How can a democratic, inclusive approach to moving image preservation be reconciled with the current audio-visual production hypertrophy? Will economic dynamics face the risk of exposing the most fragile assets and heritage to disappearance?

> Are we ready to renounce part of our goals and ambitions as cultural agents in the interest of a safer, more equal treatment of the natural resources at our disposal?
> (Paolo Cherchi Usai, *"I Can't Breathe." Extinction Rebellion to Film Preservation*)

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INTRODUCTION: FILM HERITAGE PRESERVATION AND DIGITAL MEDIA GROWTH

The modern media environment is progressively dominated by market-oriented strategies, including the intentional design of products with a limited lifespan. Such a phenomenon reflects a broader trend where commercial interests shape content and technology, pushing consumers towards constant upgrades and replacements to maintain relevance and functionality. Consequently, media companies prioritize profit over longevity, driving a cycle of perpetual consumption. This trend reflects broader concerns regarding both sufficiency and excess within media industry practices; while these issues are beginning to enter mainstream discussions about media sustainability, they remain inadequately addressed within the specific context of film heritage. The film heritage sector, like other areas of the audio-visual media field, is grappling with the relentless drive for ever-increasing volumes of content. This situation is compounded by the broader symptoms of media overproduction in the digital age, where the emphasis on quantity often overshadows considerations of quality and sustainability, even in the GLAM field. This trend has been exacerbated by the exponential growth of digital media, which places unprecedented demands on the infrastructure supporting content creation and preservation. In particular, as content libraries expand, the need for larger and more efficient data centres becomes increasingly pressing (Antoniazzi 2020). These facilities are essential for storing and managing vast quantities of digital assets, yet their expansion poses significant challenges. The demands on storage capacity, archiving processes, and accessibility are reaching critical limits, and the environmental impact of maintaining and scaling these data centres is often overlooked (Cherchi Usai 2020). The energy consumption required to power and cool these data centres contributes to a substantial carbon footprint, raising urgent questions about the sustainability of current practices; this somehow reminds us of the materiality of the supposedly "immaterial" convergence related to the increasing presence of digital technologies.[3] Moreover, the film heritage sector faces additional complexities related to the preservation of historical media. Unlike contemporary digital content, which benefits from ongoing technological advancements, historical film materials require careful management to prevent degradation over time. The intersection of these challenges with the rapid pace of technological change means that film heritage institutions must navigate an increasingly complex landscape, and balance innovation against the duty to preserve assets for

3 "These fossils are then partial evidence of the materiality of electronics — a materiality that is often only apparent once electronics become waste. In fact, electronics involve an elaborate process of waste making, from the mining of metals and minerals to the production of microchips through toxic solvents, to the eventual recycling or disposal of equipment. These processes of pollution, remainder, and decay reveal other orders of materiality that have yet to enter the sense of the digital." (Gabrys 2013, vi).

the future. Experts now question which elements of our cultural past will survive escalating environmental threats, a concern that challenges everyone to reconsider the value of our legacy and the urgency of its protection. This involves rethinking conservation strategies, integrating sustainable practices, and fostering global cooperation to ensure that cultural artifacts withstand the challenges posed by climate change and other ecological pressures.

As discussions on media sustainability evolve, it is crucial to include the film heritage field in these conversations. The sector must address the implications of planned obsolescence and overproduction to mitigate the broader environmental impact associated with the digital transformation of media. This approach will require a re-evaluation of industry practices, greater investment in sustainable technologies, and a renewed focus on preserving the cultural heritage embedded within film (Keilbach and Pabiś-Orzeszyna 2021).

This article employs a hybrid methodological approach, combining a critical review of literature on media sustainability and infrastructure, with original empirical findings from the SAFE (Sustainability of Italian Film Heritage) research project. This dual strategy allows us to situate our analysis within existing scholarly debates while introducing new, concrete evidence from the Italian field, challenging the assumption that digital transition is inherently sustainable. Our empirical data is drawn from three coordinated actions:

- Infrastructural Diagnostics: A twelve-month microclimatic monitoring campaign was conducted in the film vaults of five partner archives to collect concrete data on energy profiles and conservation environments. This selection covers diverse climatic zones (North, Centre, South, Islands) and institutional scales.
- The SAFE Survey: A comprehensive quantitative and qualitative questionnaire distributed to over 20 Italian film heritage institutions focusing on the non-theatrical sector (industrial, amateur, and scientific film). The sample was selected to ensure typological (from state-funded national bodies to small community archives) and geographical diversity, allowing us to observe how sustainability policies impact institutions, providing a realistic snapshot of the Italian ecosystem rather than an idealized one.
- Ethnographic Fieldwork: In-depth interviews and participatory observation were conducted with archivists, technicians, and policymakers across a subset of these institutions. This qualitative data reveals the 'lived experience' of sustainability, capturing the affective, symbolic, and practical challenges that quantitative surveys might miss.

By cross-referencing findings from these methods with the theoretical frameworks of Critical Infrastructure Studies and the degrowth theories, we move beyond a purely exploratory probe to an empirically grounded critical analysis that operationalizes the concept of 'sufficiency' and 'excess', presenting the Italian ecosystem as a symptomatic case for broader European challenges.

METHODOLOGICAL FRAMEWORK: CRITICAL INFRASTRUCTURE STUDIES

By critically engaging with these complex and interrelated issues, we aim to reflect on a more sustainable, inclusive, and ethically grounded approach to preserving film heritage in the digital age. With such general issues at stake, our main research methodology concerns Critical Infrastructure Studies, which delve into the intricate connections between society and its frameworks, addressing media, technology and society (Larkin 2013; Hesmondhalgh 2021; Parks and Starosielski 2015; Thylstrup 2019; Thylstrup et al. 2021; Flensburg and Lai 2020; Pasek, Vaughan, and Starosielski 2023). In fact, over the past twenty years, the concept of infrastructure has evolved to encompass not only physical networks like railroads and highways but also essential systems and services such as mass media. Media infrastructures encompass both physical forms and discursive constructions, shaped by public ownership, private enterprise, design strategies, regulatory frameworks, collective imaginations, and habits. These infrastructures are deeply intertwined with political and economic agendas. Their reliance on land, raw materials, and energy connects them to broader issues such as finance, urban planning, and natural resource management. This perspective shifts the focus towards the processes of distribution, which have often been overshadowed by the emphasis on production, consumption, encoding, decoding, and textual interpretation in humanities-based research. In traditional humanities media studies, there is a notable disparity between the extensive scholarly focus on screened entertainment and the limited attention given to the infrastructures that enable the distribution, whether they traverse undersea cables, terrestrial networks, or cloud-based systems (Parks and Starosielski 2015, 5). Media infrastructures encompass a vast array of elements, including hardware and software, prominent installations and subtle processes, synthetic objects, human personnel, as well as rural and urban environments. While Infrastructure Studies examine the role of technology within our society, Critical Infrastructure Studies delve deeper into the intricate relationships between society, culture and these structures, by critically analyzing the interactions between materials, artifacts, systems, individuals, institutions, considering the dynamics of power, while also highlighting the unequal distribution of infrastructural resources on national, institutional, and cultural levels.

This theoretical framework is particularly relevant to this research on film heritage institutions, since they vary significantly in size, institutional role, and methodological approaches, reflecting a broad spectrum of practices and perspectives within the field, shedding light on the resource disparities that influence the preservation and dissemination of film heritage, enabling a more comprehensive exploration of the infrastructural dynamics.

Moreover, the intersection of archival studies with alternative economic models, such as degrowth (Hesmondhalgh 2021), can become a focal point for other theoretical frameworks: questioning the sustainability of film pres-

ervation infrastructures means mapping not just the environmental costs, but the cultural and ethical sustainability of visual ecologies. Our approach aims to interrogate the power structures and institutional frameworks that shape these institutions' practices, as well as consider how technological advancements and shifts in media consumption patterns influence the curation of film heritage.

The concept of sustainability is widely discussed today, covering environmental, social, economic, and cultural dimensions to promote balanced resource use and growth. In film preservation, sustainability means maintaining film heritage in an ecologically, economically, and culturally viable way. It involves the physical care of celluloid in stable conditions and a metaphorical investment in these materials' cultural and economic value. In turn, this includes reducing degradation and finding financial support for costly preservation efforts. However, sustainability in this field addresses ethical questions about commodifying public memory, balancing public interest with market imperatives, and ensuring that economic needs do not eclipse the cultural mission of preservation.

Digital Humanities, Critical Infrastructure Studies, and sustainability intersect in a growing area of inquiry that reflects the evolving relationship between cultural heritage, technological mediation, and ecological responsibility. The digitization and computational analysis of cultural artefacts have opened new avenues for access and interpretation, yet they also reveal the material and infrastructural underpinnings of seemingly immaterial digital practices (Gold 2012; Drucker 2014; Meschini 2019). Critical Infrastructure Studies provides a lens to examine these very systems—servers, databases, metadata standards, energy-intensive data centers—as sociotechnical assemblages shaped by power relations, economic imperatives, and historical legacies. When brought into dialogue with questions of sustainability, this perspective urges a reconsideration of digital projects through their environmental footprint, labor conditions, and long-term viability.

FILM ARCHIVES AND THEIR INFRASTRUCTURAL STRATEGIES

Institutions dedicated to film heritage systematically engage in the processes of collecting, cataloging, preserving, restoring, and making films available for educational, cultural, research, and other non-commercial purposes. In recent years, there has been a notable shift from traditional photochemical materials and methods to digital technologies, alongside an increase in digital objects and platforms. This shift has brought a focus on digitization, digital preservation standards, and frameworks. The advent of digital moving image technologies and the declining use of film-based systems have sparked a broader debate about the role of technology, extending its impact beyond film production to influence film scholarship and critical practice as well.

The revival and preservation of archival materials, that might otherwise have been left to deteriorate, have been significantly impacted by commercial interests, especially in the US due to the prominent role of Hollywood studios and digital OTT platforms. Despite these economic motivations, Barbara Klinger notes that film preservation has an 'ecological dimension' since "Like many preservation movements, it is motivated by the double concerns of conservation and commerce — that is, by both the commitment to safeguard a resource and the desire to find a profitable use for it" (Klinger 2006, 117). Klinger's use of ecological rhetoric serves a dual purpose. Literally, it describes the carefully controlled conditions needed to protect celluloid from decay. Figuratively, it positions the film as a valuable commodity worth preserving, also for its potential to generate revenue.[4] Parallel to the methodological consolidation of deontology for film heritage preservation, over the past decade these entities have been acknowledged as memory gatekeepers by governmental and educational institutions. Many archives, holding firm to their mission of patrimonial preservation, raise the controversial issue of selling images. Lindeperg and Szczepanska raise the question:

> L'Ina, établissement public à caractère industriel et commercial, est ainsi contraint de se financer en partie par la vente de ses documents. Cette autre différence avec les sources écrites et le fonctionnement des Archives nationales donne la mesure du traitement singulier réservé aux images filmées (Lindeperg and Szczepanska 2017, 41).

It seems that for Ina, whose heritage mission has never been denied, this revenue issue has also been a driver of activity and development.

Considering the global warming conditions, and the general need for analog film conservation related to the need for temperature- and humidity-controlled storage centres, film archives are facing prominent infrastructural challenges regarding sustainability, pollution, and consumption.

> Film archives require a great amount of energy to run properly. To have a complete understanding of their needs, we must take into consideration all aspects of the activities that are necessary to ensure a correct working environment: the transportation of staff; that of the films themselves (physically or by air transfer); the energy required to run the offices; and so on (Lafite 2024, 161).

Given the ongoing uncertainty regarding the environmental impact of large-scale policies, archives are increasingly called upon to integrate eco-friendly practices into their operations (Figueroa Fuentes 2024); this involves a careful assessment of every aspect of their workflow, from the materials and methods used in preservation to the energy consumption associated with digital storage and the day-to-day functioning of archival facilities. This means not

4 "These business models, in many cases, are still based on the commercialization of goods and services with short lifespans, incompatible with long-term preservation planning." (Antoniazzi 2020, 2).

only implementing green practices but also actively seeking innovative solutions to reduce their ecological footprint. The commitment to reducing waste and environmental impact extends beyond technical adjustments to encompass a broader cultural shift within archival institutions.

What once was valid mostly for film archives in Global South countries, is now becoming relevant also for many other institutions in the Northern Hemisphere. Since the primary challenge in prolonging the lifespan of films lies in mitigating their accelerated degradation due to high temperature and humidity levels, effective management of storage conditions is therefore essential, achieved through a combination of passive (construction-based) and active (service-based) strategies (Nikolaidou, King, and Coley 2021, 43). Passive control can be enhanced by leveraging thermal mass to create a buffer between external and internal temperatures, with systems such as phase change materials, underground construction, and similar methods that aid in maintaining consistent internal temperatures and reducing energy use. Furthermore, vaults should be fireproof, thermally insulated, and protected against water influx, which may happen for a number of reasons.[5] However, due to the global increase in temperatures, more than passive measures are needed. Active systems, including ground source heat pumps and variable air volume systems, become crucial for achieving the low temperatures necessary for film preservation. Despite these advances, the importance of renewable energy cannot be understated in the quest for net-zero carbon operations: on-site renewable energy sources, like photovoltaics, are critical to reducing reliance on the grid, especially during periods of high carbon intensity. The relationship between lower cooling and dehumidification setpoints and the extended usability of films is well established; however, this also correlates with higher energy consumption for film storage facilities, therefore, balancing these factors is key to achieving both preservation goals and energy efficiency (Nikolaidou, King, and Coley 2021, 46).

THE DIGITAL PRESERVATION PARADOX

The advent of digital technology has significantly captivated film and media scholars, prompting a thorough examination of its epistemological, historical, and technological ramifications. This shift has broadened the scope of André Bazin's foundational ontological query: researchers are now investigating the historical identity of cinema and contemplating the future trajectory of digital cinema. While historians like Paolo Cherchi Usai have interpreted the departure from analog film technologies as a monumental historical shift, and advocates

5 "Ideally, a storage area should be in the centre of a building, slightly elevated from the ground floor [...] Any location at the fringe of a building would make such control more difficult, and possibly less effective. Any location lower than ground level makes air conditioning more expensive, and effective prevention of water influx difficult." (IASA Technical Committee 2014).

of medium specificity argue that these transformations have influenced the medium's relation to realism and materiality, scholars such as Thomas Elsaesser and Tom Gunning have challenged the rigid dichotomy between old and new media. However, beyond these ontological debates, the current discourse necessitates an "infrastructural turn". About cinema, a larger metahistorical issue arises—how to conceptualize and periodize the medium's evolution throughout history. We must shift focus from what digital cinema *is* to how it *is sustained*, revealing the complex, interwoven dependencies between media and their material support system.

Besides these theoretical frameworks, the adoption of digital technologies is often heralded as a 'green' sustainable alternative to traditional methods. Within the realm of archival institutions, digitalization is promoted as a key strategy for reducing carbon footprints, with the promise of minimizing the environmental impact associated with physical records. However, this optimistic view often overlooks the "materiality of the immaterial". As noted by Hunter Vaughan and Pietari Kääpä, the digital ecosystem is underpinned by a heavy reliance on energy-intensive infrastructures, from server farms to cooling systems (Vaughan 2019; Kääpä 2018). At first glance, the shift from physical to digital archives appears to be a logical step towards environmental sustainability: the vision of a "paperless office" eliminating the need for paper, ink, and physical transport (York 2006). This transition has triggered what Jevons' Paradox describes (Wolfe 2012, 36): increased efficiency leads to increased consumption. As archival institutions become more efficient at managing records digitally, there is a corresponding increase in the volume of data generated, stored, and accessed, leading to greater demand for storage capacity, energy consumption, and technological infrastructure, rather than decreasing resource use. A more complete approach is required, one that integrates digital tools with thoughtful archival practices designed to mitigate environmental impact. This includes strategies such as careful appraisal and selection of records for digitization, minimizing data redundancy, and adopting energy-efficient technologies and practices (Pendergrass et al. 2019).

There is, therefore, a paradox inherent in digital preservation. While digitization is touted as a solution to the preservation of film heritage, digital formats themselves are not inherently stable: digital files require constant, active maintenance, to prevent obsolescence. Unlike analog carriers that decay slowly, digital assets face binary risks of total loss. This demands continuous collaboration within and across industries, such as data migration to new formats and storage media: "Migration is designed to avoid having to preserve old devices to read the old storage media, old application software to interpret the old data, and old hardware to run the old software to use the old data" (AMPAS 2007). Migration is not merely a technical necessity but a systemic vulnerability. In the best scenario, newly transferred data successfully replaces the old. However, a significant challenge associated with migration is the potential loss of information, involving the primary data and the associated metadata. Standard protocols now advocate for a "continuous migration" approach, treating data

transfer as an ongoing background activity, complete with quality controls and auditing measures to ensure integrity and obviate the risks of distinct, traumatic format shifts. Yet, this idealized workflow clashes with the material reality of most film heritage institutions, which often lack the financial and human resources to sustain such relentless schedules. Moreover, each migration cycle is an environmentally costly event, necessitating data replication and accelerating hardware turnover. This contributes to the accumulation of e-waste and energy consumption, forcing archives into a difficult trade-off between digital safety and ecological responsibility.

To mitigate these risks, institutions explore energy-efficient storage solutions and prioritize minimizing the data footprint, archiving only essential assets. Furthermore, the 3-2-1 rule (maintaining three copies on two different media, with one off-site) can help reduce the risk of data loss. While this strategy enhances redundancy and safety against disasters, it also triples the infrastructural footprint of every single digital object.

Moreover, the infrastructure needed to store and manage these files is expensive. High-quality digital storage solutions, backup systems, and Digital Asset Management (DAM) platforms require continuous investment in hardware and software licensing. This economic reality creates a disparity: funding often focuses on the visible act of digitizing archival heritage, neglecting the "invisible" costs of long-term storage and staff training. Ultimately, the digital shift profoundly impacts the entire archival workflow It necessitates a broader consideration of methodologies and skills, requiring archivists to manage not just content, but complex metadata and verification processes to identify deep fakes or corruption (Arrighetti 2019).

Furthermore, the digitization process must be seen as an opportunity to rethink how film heritage is preserved, studied, and made accessible to the public, to enhance the richness and accessibility of audiovisual heritage for future generations (Jones and Jancovic 2025). Moreover, archival institutions must engage in ongoing evaluations of their sustainability practices, recognizing that digitalization is not a one-size-fits-all solution.

POLICIES

The current emphasis on digitization in funding allocations for European film heritage institutions, while beneficial in many respects, fails to fully address the comprehensive needs of film archives. In Europe, the financial landscape is predominantly shaped by the allocation of funds toward extensive digitization campaigns rather than long-term structural preservation. This trend reflects a broader neoliberal trend in heritage management, as noted by Antoniazzi and Edmondson, where "capacity" is often confused with technological accumulation (Antoniazzi 2019; Edmondson 2011). While the primary appeal of digitization lies in its potential to democratize access and enhance visibility, this focus often misaligns with archival realities. Film archives require a balanced approach that

includes not only digital access but also the physical maintenance of analogue elements. As digitization "has complicated film archives' work of historical mediation, significant problems remain unresolved, particularly concerning the environmental and economic sustainability of digital storage" (Ingravalle 2024, 21).

Many countries throughout Europe have witnessed the construction of cutting-edge film storage vaults and preservation centres (Venturini 2022), but the rising volume of digital content and the induced built-in redundancy of digital formats gradually replacing the carrier-based collections have necessitated a heightened focus on digitization, such as digital preservation standards and access for both analog and digital-born film materials (Edmondson 2016; Prentice and Gaustad 2017; Catanese, Heftberger, and Olesen 2021). This endeavour prompts digital preservation's sustainability, both environmentally and ethically, as it remains intertwined with the principles of economic growth and resource exploitation.

However, the 'green' promise of digital preservation is increasingly questioned. The environmental costs of maintaining vast digital archives, particularly the energy consumption and carbon emissions of data centres, pose significant ethical concerns (Currò 2024, 169). Cloud storage, often touted as a good solution, presents limitations: according to Antoniazzi, it 'might be useful [...] only for small institutions, or to store relatively small amounts of data [since] the initiatives seem characterised by a high level of fragmentation' (Antoniazzi 2017, 182). Consequently, the sustainability of these practices must be evaluated not only by their ecological footprint but also by their adherence to principles of equity and justice (Currò 2024, 169; Holt and Vonderau 2015; FIAT/IFTA 2019). A critical, often overlooked aspect of this funding model is the neglect of human capital. Investments frequently involve significant capital for infrastructure but fail to foster staff integration.

Resources are allocated primarily into infrastructure or hardware, while training remains underfunded, or worse, trained personnel are not retained due to precarious contracts. This not only diminishes the return on investment but also undermines the long-term sustainability and success of the organization by failing to secure a well-integrated and skilled workforce. For instance, under the NRP (National Recovery and Resilience Plan) several ambitious digitization projects have started. Yet, these investments have not been matched by a corresponding increase in the stabilization of staff trained to be capable of managing these technologies. This gap undermines the return on investment, as the success of digital initiatives depends on the human capacity to harness them. This systematic vulnerability is evident in Europe, as demonstrated by the crisis of the German *Fonds zur Förderung der Digitalisierung des Filmerbes* (FFE). Launched in 2019 to counter the disappearance of analog heritage, the FFE was designed as a ten-year agreement providing million euros annually (Trumpler 2020). Despite its robust 'three-pillar model' based on conservation and curatorial perspectives, recent budget cuts have endangered the programme, calling its initial goal into question (FFA 2024).

Both the Italian and German cases illustrate that without long-term political commitment to both human and financial resources, digital strategies remain fragile.

SYSTEMIC VULNERABILITIES

Another case of inefficiency in the vision and management of large-scale digitization projects is the disappearance of the European Film Treasures website from the Internet, which marks a significant loss for the field. This publicly funded project, launched in 2008, was a unique digital archive that provided free access to a vast collection of restored films from across Europe. The platform was celebrated for its ability to bring together a diverse range of cinematic works, many of which were rare and previously inaccessible to the public. These included early silent films, documentaries, and avant-garde pieces, offering a glimpse into the rich history of European cinema. The platform was supported by many film archives and institutions across Europe, which contributed to its extensive catalog of over 1,500 films. The website also served as an educational tool, providing information about the films, their creators, and the historical time in which they were made. The website's sudden disappearance is a stark reminder of the fragility of digital cultural heritage projects. Despite its huge public funding and cultural significance, European Film Treasures fell victim to the shifting priorities and financial challenges that often plague such initiatives. The loss of this platform underscores how the sustainability of online cultural repositories is frequently compromised by a lack of long-term support and funding (Giannetti 2022). In fact, these types of investments involve significant amounts of capital up until the final stages of reporting. However, they frequently fail to adequately foster the integration of staff into the organization. A considerable portion of these resources tends to be allocated primarily to infrastructure or other physical assets, while much less attention and funding are directed toward ensuring that staff members are effectively integrated into the institution. Furthermore, often investments are made in training personnel who, after receiving the training, cannot be retained within the institution, leading to a considerable loss of both financial and human resources. This not only diminishes the return on investment but also undermines the long-term sustainability and success of the organization by failing to secure a well-integrated and skilled workforce. For instance, the Italian Ministry for Cultural Heritage, under the NRP Investment for Digital Strategies and Platforms for Cultural Heritage, has initiated several projects aimed at establishing a comprehensive hardware and software infrastructure to support the entire digital ecosystem across the nation, but the investments made in the digital infrastructure have not been matched by an increase in training of staff capable of operating, managing, and systematizing these new technologies. This gap poses a challenge, as the success of these digital initiatives depends not only on the technology itself but also on the human capacity to harness and optimize its potential. This situation

calls for a more balanced approach where investments in technology are paralleled by efforts to upskill and retain staff who are essential to the effective implementation of these digital strategies (ICDP 2022).

In addition to training in digital technologies, the current global context — marked by accelerating climate change and frequent emergencies— demands attention to a broader range of challenges. Beyond the virtual realm, physical infrastructures face significant risks that can impact their sustainability and resilience. Instances such as floods, wildfires, and other natural disasters pose serious threats to archival collections, emphasizing the need for comprehensive strategies that prioritize disaster preparedness and infrastructure strengthening. For instance, on 8 June 2024, at Cineteca Nazionale - Centro Sperimentale di Cinematografia, the Italian national film archive in Rome, a fire broke out, burning 500 boxes of nitrate reels, a total of 220 titles destroyed (Editoriale Domani 2024). Unfortunately, similar episodes can happen and occurred several times in some Italian film archives, always in summer, when temperatures rise sharply; the nitrate film is a highly flammable material and short-circuits can happen in the systems that are supposed to monitor the temperature and humidity conditions at which those reels are stored. However, the Italian Ministry decided to hide the incident, which was only spoken about publicly when a parliamentary interrogation occurred, a month later, as a political debate. In the same days, on 4 June 2024, a rise in groundwater caused flooding in the nitrate vault of the Dutch national cinematheque, Eye Filmmuseum, with water affecting the lowest-shelf cans. The Eye Collections Center staff called the fire brigade to pump out the water and restore power, after which new pumps and an emergency dryer were installed. The flood impacted only about 80 out of 7,000 cans, as the old metal can lids kept water out of most. Affected films were frozen to stabilize them, and further conservation is planned. Both incidents have added urgency to the longstanding plans for new nitrate vaults both in Rome and Amsterdam, but in the second case an account of the event was immediately shared in the cinematheque's official website and social media pages (Eye Filmmuseum 2024). This testifies a different sense of responsibility for community engagement, but also a different relationship with governmental institutions and their policies.

Moreover, the democratization and inclusivity of moving image preservation must be reconciled with the current hypertrophy of audio-visual production. The overwhelming influx of digital content necessitates the establishment of selective criteria to determine what is preserved. These criteria inevitably involve political and ideological considerations, as decisions about what constitutes culturally significant heritage often reflect power dynamics and societal values. The process of selection thus opens up various scenarios, each with distinct political and ideological implications. It appears evident that the validation provided by digital technologies to the methods involved in safeguarding, archiving, and enriching audiovisual materials does not primarily stem from their technological application, but rather from a fundamental reconsideration of the

underlying epistemology of the archival process. In essence, while digital tools play a significant role in these practices, their true significance lies in prompting a deeper reflection on how archival work is conceptualized and performed. This shift involves not only adopting new technologies but also reevaluating the theoretical frameworks and methodologies that govern how we preserve and interpret audiovisual heritage. Thus, the evolution towards digital methods represents more than just a technical adaptation; it signifies a paradigmatic shift toward a more comprehensive understanding and application of archival principles in the digital age.

CURATORIAL STRATEGIES: STEWARDSHIP INTO FILM COLLECTIONS

Defining limits in terms of stewardship and growth is another critical aspect of this discourse. The question of who will set these limits and on what basis is central to the future of film heritage preservation. The actors and agents involved in this process, ranging from governmental bodies to cultural institutions and private entities, will play crucial roles in shaping the preservation landscape. The potential for a transformative, and possibly traumatic, shift in this landscape looms large, driven by economic dynamics and crises that could expose fragile assets and heritage to the risk of disappearance.

Furthermore, the discourse must address the concept of degrowth in heritage preservation. Echoing the concerns raised by Vaughan regarding the environmental toll of the "digital cloud", and the need for "sustainable media" advocated by Starosielski and Jancovic, a paradigm shift is necessary. As the unsustainable nature of perpetual growth becomes increasingly apparent, a paradigm shift towards degrowth may be necessary. This shift could involve a rebalancing towards the Global South, where moving images are paradoxically at the greatest risk of loss. Embracing degrowth would necessitate a rethinking of preservation priorities, focusing on the equitable distribution of resources and attention to often marginalized or minor heritages. Rather than relying on directives from higher authorities, we must take proactive steps toward adopting more energy-efficient models through practices that should not be delayed by waiting for centralized mandates. There are already effective solutions being put into practice at local levels, demonstrating that meaningful change is possible without top-down intervention: these grassroots initiatives showcase that we have the tools and knowledge to reduce energy consumption in audiovisual archiving today, and the momentum for this transition can and should be driven by local actions and community-led efforts: "We should offer a common answer to this challenge as a community, as we did when digital technologies first shuffled the cards within the profession" (Lafite 2024, 162).

While the field of film and cinema history and the global film archiving community increasingly turn their focus to the less examined aspects of archives, a notable shift is occurring (Ráduly 2022). The advent of new documentary phenomenologies

has highlighted the growth of intriguing niches, even within Italy (Cavallotti, Lotti, and Mariani 2021). These niches encompass a diverse array of film types, including industrial, amateur, family, military, scientific, and local cinema. This expansion has prompted the development of new archival practices and perspectives, which are fundamentally reshaping the landscape of Italian film archives. By uncovering and valuing these previously overlooked areas, the archival community is broadening its scope and redefining the conceptual maps that guide the preservation and study of film heritage in Italy, ensuring a more inclusive representation of the diverse cinematic expressions found within the countries' cultural history. Archivists from both prominent national and smaller local collections have highlighted how the priorities of commercial studios have eclipsed a wide array of culturally significant film material, such as amateur films, home movies, experimental, industrial, educational, scientific films, and other non-theatrical film materials, indicating a substantial gap in the historical documentation (Simoni 2015). Representatives from these non-commercial archives advocated for the importance of the valorization of these genres, which often capture regional histories and marginalized voices, expanding the parameters of what is preserved as cinema, which is crucial for a more comprehensive understanding of our cultural and historical landscape (Bozak 2012, 184). Some institutions are looking for solutions on how to preserve and disseminate audiovisual materials using web-based platforms or databases specifically designed to deal with amateur films, family films, institutional films, regional productions, or "filmic memory of territories", such as the Diazinteregio project. This example is particularly interesting because they build up a network to connect organizations from local to regional scale in France (Ange 2024, 36). By advocating for the preservation of these diverse forms of film, heritage institutions are pushing for a reassessment of cultural value that not only enriches the historical record, but also ensures that future generations have access to a more representative and multifaceted view of the past: "in their work, archivists prefer not to speak about selection, but rather about creating an order of priority" (Brunow 2017, 102). Our examination of how archives narrate their own histories, manage scarcity, and articulate their fundamental raison d'être expresses the deeply ingrained values that underpin daily archival practice, clarifying that the long-term viability of cultural heritage is fundamentally rooted in a human-centric dedication that animates and transcends the associated technical and structural difficulties.

CONCLUSIONS

This reflection is part of ongoing research that investigates the film heritage institutions on the Italian territory regarding photochemical, digital, and curatorial preservation aspects. While the challenges of digital preservation and the environmental impact of media are increasingly documented in broader media studies, this literature often remains siloed from the on-the-ground infrastructural and policy realities of FHIs. Our article argues that the Italian context, with its rich yet fragmented archival landscape, can serve as a critical case study

that exposes the central paradox of contemporary film preservation: the pursuit of digital sufficiency, driven by EU and national policies, in fact generates new forms of excess, in energy consumption, data management, and often, inefficient capital allocation.

By integrating critical infrastructure studies with degrowth principles and grounding our analysis in empirical data from the SAFE project, including a nationwide survey, microclimatic monitoring, and ethnographic fieldwork, we inquire not just the "state of the art," but the structural misalignments between policy, technology, and sustainable stewardship. Our contribution offers a granular, evidence-based critique of how these tensions manifest in a major European patrimony state. Ultimately, the fragility of these infrastructures undermines their ability to operate effectively, leaving them vulnerable to economic instability and climate risks.

Therefore, rethinking the digitization process requires moving beyond. As our findings suggest, precise guidelines on data and metadata are useful tools, but they are insufficient if not accompanied by a paradigm shift. The challenge for the future is not simply to manage the transition to new carriers, but to question the logic of accumulation itself. A truly sustainable strategy must prioritize "human infrastructure" over the endless acquisition of hardware. Only by embracing a perspective of sufficiency can film heritage institutions resist the pressures of market-driven excess, ensuring that the preservation of the past does not compromise the livability of the future.

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