Environmental Considerations of Digital Preservation

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Digital preservation plays a critical role in ensuring that knowledge, research data, and cultural heritage remain accessible to future generations in an increasingly digital world. From safeguarding scholarly datasets to protecting digitized historical materials from physical degradation and loss, digital preservation has become an essential component of modern information stewardship. However, the infrastructure required to sustain these digital assets (such as data centers, cloud storage systems, server maintenance, and technological migration) comes with significant environmental costs, including energy consumption, carbon emissions, and electronic waste ("e-waste"). While digital preservation is both necessary and valuable, it must be pursued through mindful and sustainable practices that balance long-term access to information with environmental responsibility. To support this claim, the paper examines the role of digital preservation in research and cultural heritage, analyzes the environmental impact of long-term digital storage, and explores mitigation strategies such as data lifecycle management and selective preservation frameworks. Rather than positioning digital preservation as an environmental liability, this discussion highlights opportunities for innovation in sustainable information management.

As mentioned by Myntti and Zoom in their book's introduction, Libraries, archives, and museums (LAMS) have intentionally preserved physical materials for many, many years (pp ix). There are what they called "tried and true" methods of preservation that have been used in various parts of the world; digital content, however, remains a rapidly evolving field. In the next chapter, Baucom mentions that archivists are constantly trying to prevent obsolescence by moving digital materials to new materials (Myntti & Zoom, 2019, pp. 3).

One solution that I may suggest is brought to me by Rosy Jan in the same book, and that is technology preservation. Technology preservation focuses not only on the digital object itself, but the tech environment that enables access. Rather than recreating an environment through simulation, this approach preserves the digital object alongside their original hardware or system. When used selectively, technology preservation can support sustainability efforts in digital preservation by extending the functional lifespan of existing equipment, reducing the immediate need for disposal. This delays their inevitable demotion to e-waste, while also allowing institutions to maximize the value of what they already have (Myntti & Zoom, 2019, pp. 49).

While technology is one of the most environmentally consequential parts of digital preservation, as it directly impacts energy consumption and material use. As Corrado and Sandy outline in the Digital Preservation Triad, preservation heavily depends on the coordinated management of repositories and integrated systems. When digital preservation systems are treated with expected standards and documentation, institutions are better positioned to minimize inefficient workflows, redundant storage, and unnecessary system replaces that contribute to hardware disposal. In addition, trust also is key to committing to stable, well-planned systems rather than repeatedly adopting new technologies with uncertainty. Ongoing audits of objects' lifecycles support environmentally sustainable digital preservation by preventing resources from being misused (Corrado & Sandy, 2017).

Trevor Owens draws a comparison between traditional art conservation and digital preservation, arguing that just as a painting conservator must understand the chemistry of physical materials, a digital preservationist must understand the "sciences of the artificial," including computers and artificial intelligence (AI) (Owens, 2018, pp. 56). Owens goes on to explain that this field can be difficult as the "refresh cycle" is too fast to keep up with the demand of digital preservation, so choosing a media that will not need to migrate in ten years is essentially impossible (pp. 57), so the "future of digital preservation" relies on the ability to copy and move that copy to a new system (pp. 58).

Owens' discussion of rapid refresh cycles suggests that media, hardware, and storage systems become obsolete very quickly, and therefore older objects are routinely discarded, contributing directly to the accumulation of e-waste. As preservationists migrate data to new systems, outdated servers, drives, and devices lose functional value, continuing the cycle of replacement and disposal rather than long-term material stability. E-waste is not the result of poor planning or misuse, but from the logic of the systems themselves, where technological turnover is intentional by the manufactures.

As described by Dr. Lischer-Katz, the archive is no longer a facility bound to it's one location, it requires "fiber cables, network switches, and servers." While this article was written nearly ten years ago, his point concerning the digital archive has only solidified: "it uncoils over a landscape, serpentine and flickering; it does not restrict itself to one epistemological position but generates and multiplies many that may twist and claw for dominance" (Lischer-Katz, 2016). With data centers increasing concern amongst the public (just this last week the City of Chandler rejected the proposal for an AI data center, lobbied by former senator Kyrsten Sinema [Klepp, 2025]).

Since the onset of the digital age, the relationship between cultural heritage organizations (CHOs) and information technologies has deepened. While digitization was initially perceived as a pathway to sustainability, it has led to unexpected environmental costs. The reliance on server farms and cloud storage has resulted in significant greenhouse gas emissions. Although the carbon footprint of libraries and archives is relatively minor compared to larger industries, their role in the cycle of consumption must be acknowledged. Server farms and cloud storage are energy intensive. The infrastructure required to operate these technologies consumes huge amounts of electricity, contributing to global carbon emissions. Estimates indicate that a significant portion of carbon dioxide emissions comes from electricity used in data storage facilities. As data centers continue to grow, their environmental impact is expected to rise despite improvements in efficiency. (Zastrow, 2022, pp. 14)

The exponential growth of AI has been driven by increases in training data, model parameters, and infrastructure capacity. Notably, the amount of data for AI applications has surged by 2.4 times, resulting in 3.2 times increase in data ingestion bandwidth. This growth is accompanied by a substantial carbon footprint, which encompasses both operational and embodied carbon emissions. Using the framework being developed by researchers in the AI field may be helpful to digital preservationists. Adopting a sustainability mindset is crucial for future advancements. Practitioners must prioritize environmental impact by evaluating the eco consequences of AI innovations should be standard practice. Striving for high model accuracy should not come at the expense of significant energy use. Finding a balance between performance and environmental responsibility is essential. (Chauhan, 2024).

One suggestion Zastrow offers is “save less, forget more.” This seems, on the surface, the antithesis to digital preservation but the future of the field may require a shift in perspective. As the sustainability of ongoing digital archiving practices comes into question, it may be necessary to reconsider the balance between preservation and access. The concept of "Save Less, Forget More" could become a guiding principle, encouraging an approach to data management that prioritizes environmental sustainability (Zastrow, 2022, pp. 17).

Preservationists should feel encouraged to adopt an ethical consumption policy. Ethical consumption refers to the practice of making decisions that consider the broader impact on society and the environment. The environmental considerations include evaluating how the production and disposal of electronic devices contribute to e-waste and pollution (Poggiali, 2016).

Another solution that is somewhat controversial is the “more product, less process” proposed by Mark Greene and Dennis Meissner. Pendergrass, et al. describe this model as providing research access as soon as possible, “reducing the amount of arrangement, preservation, and description” that is needed. While this point is made regarding reducing the need for more staff time, I would argue that is also reduces the need for immediate storage space (Pendergrass, et al. 2019, p. 168). However, they do go on to focus specifically on environmental impact, including the negative impact of the “built environment" (pp. 171). The writers also mention Poggiali's research, highlighting the point that considering the "proper end-of-life recycling" is crucial, along with the chain of production and labor involved in these practices (pp. 171). It is also suggested that a shift in appraisal, permanence, and availability needs to occur by reevaluating the digital content to be preserved. CHOs should focus on content that has enduring value, reducing the need for unnecessary duplication and storage. Organizations need to consider the necessity of maintaining multiple copies of digital content, or keeping it to a strict three copies only, as suggested by Owens. On demand access can "greatly reduce" the impact of digital content on the environment by slowing the growth of storage (pp. 192).

While Baucom outlines the framework for developing a sustainable digital preservation program, there are opportunities to build in considerations for the environmental impact. For example, in chapter one, Baucom frames digital preservation as an exercise in acceptable risk. Environmental sustainability can be introduced as operational costs such as energy costs, cooling failures, and climate related disasters. In the chapter on policies, sustainability policies that could be included are a preference for energy-efficient vendors and defined data retention and appraisal schedules. When it comes to administration and staff, it could be a standard to train staff on environmentally sustainable digital practices, including coordinating with the IT department on these initiatives (Baucom, 2019).

Beyond these points, environmental sustainability can be more full integrated into Baucom's framework by embedding the technical and financial aspects of a digital preservation program. In discussions of infrastructure, for example, repositories could evaluate storage architectures through this lens. Decisions about redundancy, geographic locations, and storage should all consider the use of energy. Tiered storage models can reduce both operation costs and carbon emissions by storing less accessed materials to a lower-energy storage while more popular content can take priority. The choice between on-site infrastructure and cloud services should also be considered. Risk management, which Baucom emphasizes throughout the text, can further incorporate environmental considerations. Climate-related threats such as flooding, heatwaves, and power outages pose real risks to digital infrastructure. Preservation planning can address these risks through system design, storage, and disaster preparedness strategies that explicitly account for environmental change. This approach reframes sustainability not as an optional ethical add-on, but as a component of preservation risk mitigation (pp. 8).

Digital preservation is no longer solely a technical or social concern; it is increasingly an environmental concern. As I have mentioned, the systems that enable long term access to digital materials are deeply entangled with energy consumption, carbon emissions, and electronic waste. While the mission of preserving knowledge for future generations remains vital, traditional assumptions about unlimited storage, constant migration, and perpetual technological growth are no longer environmentally neutral. Libraries, archives, and museums have long relied on methods to preserve physical materials, but digital preservation introduces challenges that demand new ethical frameworks. Rapid technological obsolescence ensures that hardware and storage media will continue to cycle quickly toward irrelevance, making e-waste a feature of digital preservation rather than a failure of planning. At the same time, expanding the footprint of data centers and AI-driven infrastructures really highlights the urgency of reevaluating how much we preserve, how often we migrate, and at what cost to the environment. This paper highlighted several strategies that offer a more sustainable path forward. While these ideas are not my own, they are sourced from professionals established in the field who have observed a need for change. These have included selective technology preservation as this can extend the useful life of existing equipment, standards-based systems to promote trust and efficiency, and lifecycle audits to help avoid resource intervention. Preservationists are also being challenged to rethink permanence, calling for a shift in values. It's critical that one prioritizes the enduring significance of the objects, minimizing duplication and understanding that not all digital content requires perpetual storage.

The key takeaway is that environmental sustainability must become a core principle of digital preservation rather than an afterthought. Understanding the "sciences of the artificial" requires not only technical expertise, but an awareness of the environmental consequences. As digital preservation continues to evolve over the next decade, its success will depend on the field's ability to balance not only the needs of their institutions but also that of the environment. Sustainable strategies help ensure that efforts to preserve the past for future generations do not come at the environmental expense of the future itself.

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