

FORMAT		
1. Name of resource	Toward Environmentally Sustainable Digital Preservation	
2. Location	https://dash.harvard.edu/bitstream/handle/1/40741399/360-9081-82.1.165.pdf?sequence=1&isAllowed=y	
3. Alternative location	https://doi.org/10.17723/0360-9081-82.1.165	
4. Author[s]	Keith L. Pendergrass, Walker Sampson, Tim Walsh, and Laura Alagna	
5. Publisher/producer/host	The American Archivist	
6. Year	2019	
7. Suggested citation	Pendergrass, K. L., Sampson, W., Walsh, T. and L. Alagna (2019). Toward Environmentally Sustainable Digital Preservation. The American Archivist 82 (1): 165–206	
8. Languages in which available	English	
9. Geographic area resource relates to	Worldwide	
10. Does the resource relate to a specific time frame?	No	
11. Type	Report	
	Toolkit/Framework/Roadmap	Yes
	Sign-post to other resource (database)	
	Case studies	
	Other	Article
12. If this is part of an initiative, what is the initiative?		
COLLECTIONS AND COLLECTIONS-BASED INSTITUTIONS		
13. Explicit links to collections	Yes	
14. Explicit links to museums/libraries/archives	Yes	
15. Types of institutions the resource covers	Museums	X
	Archives	X
	Libraries	X
	Other	
16. Types of collections/disciplines the resource covers	Arts, humanities and social sciences: philosophy, psychology, religion, social sciences, law, politics, language, arts and recreation, architecture, literature, history,	X

	geography and ethnology, anthropology, archaeology	
	Science, natural history, technology, medicine, engineering, manufacturing	X
17. If no explicit links to collections, justification for inclusion		
HOW IT CONTRIBUTES TO SUSTAINABLE DEVELOPMENT		
18. Collections-related activities the resource relates to (mark all that apply)		
Develop collections to protect and safeguard wider cultural and natural heritage more effectively, for example by targeting collecting to threatened forms of heritage in strategic ways	X	
Use collections to promote learning and educational opportunities that contribute to sustainable development more effectively, for example education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture’s contribution to sustainable development and/or skills development relating to collections		
Use collections to promote cultural participation/social inclusion more effectively, for example by reducing barriers to participation, to ensure no-one is ‘left behind’		
Use collections to promote sustainable tourism more effectively, for example by developing new products based on local cultural heritage, and/or considering the rights of stakeholder groups in relation to collections		
Use collections to support research that contributes to sustainable development (including all forms of personal and self-directed research at all levels that make use of stored collections) more effectively, for example by providing effective facilities, collections and information to meet researchers’ needs	X	
Make decisions around collections that contribute to sustainable development more effectively		
i. employment (recruiting, staff training, staff safety)		
ii. energy consumption, greenhouse gas emissions, reduction, monitoring and reporting	X	
iii. waste management and reduction of waste	X	
iv. transport (forms of transport, energy use)		
v. commercial activities including copyright and IP		
vi. governance and management		
vii. security, disaster preparedness and risk reduction	X	
Direct external leadership, partnerships and collaborations towards sustainable development more effectively, for example		

by developing impactful partnerships	
19. Does the resource relate clearly to any international conventions (mark all that apply)?	
Culture conventions:	
1952, 71 Protection of Copyright and Neighbouring Rights	
1954 Protection of Cultural Property in the Event of Armed Conflict	X
1970 Fighting Against the Illicit Trafficking of Cultural Property	X
1972 Protection of the World Cultural and Natural Heritage	
2001 Protection of the Underwater Cultural Heritage	
2003 Safeguarding of the Intangible Cultural Heritage	X
2005 Protection and Promotion of the Diversity of Cultural Expressions	
Rio Conventions:	
Convention on Biological Diversity (CBD), Convention to Combat Desertification (UNCCD), Framework Convention on Climate Change (UNFCCC)	X
AIMS AND CONTENT	
20. What issues does the resource aim to address?	<p>“Digital preservation relies on technological infrastructure (information and communication technology, ICT) that has considerable negative environmental impacts, which in turn threaten the very organizations tasked with preserving digital content. While altering technology use can reduce the impact of digital preservation practices, this alone is not a strategy for sustainable practice. Moving toward environmentally sustainable digital preservation requires critically examining the motivations and assumptions that shape current practice. Building on Goldman’s challenge to current practices for digital authenticity and using Ehrenfeld’s sustainability framework, we propose explicitly integrating environmental sustainability into digital preservation practice by shifting cultural heritage professionals’ paradigm of appraisal, permanence, and availability of digital content.”</p> <p>The authors “call for a paradigm shift in digital preservation practice in the areas of appraisal, permanence, and availability.”</p>
21. Intended audience of resource	Cultural heritage professionals and organizations, notably those involved in digital preservation and ICT.
22. Process of development	“Building on [Benjamin] Goldman’s challenge to current practices for digital authenticity and using [John] Ehrenfeld’s sustainability framework, (this paper) propose(s) explicitly integrating environmental sustainability into digital preservation practice by shifting cultural heritage professionals’ paradigm of appraisal, permanence, and availability of digital content.”

23. Organisation/structure/contents	<p>“The article is organized in four parts. First, we review the literature for differing uses of the term “sustainability” in the cultural heritage field: financial, staffing, and environmental. Second, we examine the negative environmental effects of ICT throughout the full life cycle of its components to fill a gap in the cultural heritage literature, which primarily focuses on the electricity use of ICT. Next, we offer suggestions for reducing digital preservation’s negative environmental impacts through altered technology use as a stopgap measure. Finally, we call for a paradigm shift in digital preservation practice in the areas of appraisal, permanence, and availability. For each area, we propose a model for sustainable practice, providing a framework for sustainable choices moving forward.”</p>
FRAMEWORKS	
24. Framework structure	<p>The article makes recommendations for a paradigm shift in the areas of Appraisal, Permanence and Availability. These recommendations can be considered as a framework.</p> <ol style="list-style-type: none"> 1) Recommendations for reducing digital preservation’s environmental impact through technology including: Efficiency (energy usage, multi-tier systems, system selection, etc.), Scheduling (moving activities to off-peak hours), Energy-Sourcing (clean energy, on-site energy, etc.). 2) Paradigm Shift in the following areas of focus: <p>Appraisal: Recommendations on increasing selectivity over what to preserve, and how to preserve it (potentially using a tiered approach to preservation). A table is provided to guide considerations regarding: storage size, capture and analysis, and reappraisal.</p> <p>Permanence: A discussion is provided on the environmental impact of maintaining the current practices related to permanence of stored assets. A table is provided asking questions focusing on: determination of acceptable loss, fixity check methods and frequency, storage technologies used, file format migration policies, and number of redundant copies necessary.</p> <p>Availability: Arguments are given for a paradigm shift away from current assumptions and practices</p>

	related to availability. A table is provided to guide considerations related to: (on demand) digitization, access storage, and delivery of content.
25. Relevant policy considerations	Yes
26. Resources for implementation identified	Yes
27. Specific assessment points/indicators/milestones/action plan for monitoring	Yes
28. ASPECTS OF SUSTAINABILITY COVERED BY RESOURCE (mark all that apply)	
People (social sustainability)	
Planet (environmental sustainability)	X
Prosperity (economic sustainability)	X
Peace	
Partnerships	
29. CROSS-CUTTING CONSIDERATIONS COVERED BY RESOURCE (mark all that apply)	
Gender perspectives	
North and South perspectives	X
HOW THE RESOURCE CONTRIBUTES TO AGENDA 2030 AND THE SDGs	
HOW AGENDA 2030 AND THE SDGs FEATURE IN THE RESOURCE	
30. SDGs and Agenda 2030 specifically mentioned?	No
31. SDGs specifically mentioned?	No
32. SDG targets specifically mentioned?	No
33. SDG indicators specifically mentioned?	No
SDGs AND SDG TARGETS AND LINKAGES	
34. Comments on SDG linkages	<p>The resource is directed to transforming digital preservation, beyond improving efficiency to produce more effective, sustainable preservation approaches.</p> <p>Supporting reliable, sustainable infrastructure supports SDG 9.1.</p>

	<p>Recommendations for reducing digital preservation's environmental impact support a number of SDG targets, including through reducing energy usage and increasing energy efficiency, upgrading to sustainable systems, scheduling of energy use, and using renewable and on-site energy (all supporting SDG 9.4, and SDGs 7.2 and 7.3, and 8.4). Reducing water use for cooling supports SDG 6.4. The resource supports a number of targets in SDG 12 (responsible production and consumption), around use of natural resources (SDG 12.2), use and recycling of chemicals (SDG 12.4), reducing waste (SDG 12.5), adopting sustainable practices (SDG 12.6), and sustainable procurement practices (SDG 12.7). Sustainable infrastructure development in the Global South supports SDGs 9.A and 9.C. Reducing e-waste, much of which is shipped to be dealt with in dangerous conditions in the Global South, supports SDG 8.8 (labour rights, safe and secure working environments) and pollution (e.g. SDG 6.3 and 11.6).</p> <p>Implementing the resource supports institutional capacity to mitigate and adapt to climate change (SDGs 13.1 and 13.3).</p> <p>Strengthening efforts to protect and preserve heritage supports SDG 11.4, and ensuring the right of access to information (SDG 16.10). Providing more effective services to researchers supports SDG 9.5.</p> <p>Notably, the resource is about transforming digital preservation practices and staff's commitments to sustainable practices, supporting SDG 4.4 (staff skills), 4.7 (Education for Sustainable Development), 12.8 (lifestyles in harmony with nature) and 13.3 (climate change education and awareness).</p> <p>Overall, the resource supports effective policies for sustainable development (SDG 17.14), and transparent and effective institutions (SDG 16.6).</p>
35. SDGs and SDG targets the resource helps advance	
SDG 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all 4.4 By 2030, substantially	<p>Number of young people and adults in skills-development activities and programmes drawing on collections, for employment, decent jobs and entrepreneurship</p> <p>Increase in number of young people and adults in such</p>

<p>increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship</p>	<p>programmes</p> <p>Number and proportion of staff who have received training in the last year, to better support their contribution to the SDGs.</p> <p>Programs and processes in place to ensure the availability of a skilled workforce.</p>
<p>SDG 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all</p> <p>4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development</p>	<p>Numbers of people in each type of programme drawing on collections from different demographic groups.</p> <p>Increases in numbers of people in each type of programme from different demographic groups.</p> <p>Proportion of people involved in such programmes in relation to overall audience size.</p> <p>Evidence that learners have acquired knowledge and skills to promote sustainable development.</p>
<p>SDG 6. Ensure availability and sustainable management of water and sanitation for all</p> <p>6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially</p>	<p>Amount of pollutants, and reduction in pollutants, to water systems.</p> <p>Plans in place for the identification, reduction, replacement and recycling of hazardous chemical and materials, to prevent their release into water systems, with plans to eliminate their use as soon as possible.</p>
<p>SDG 6. Ensure availability and sustainable</p>	<p>Reductions in water use, increase in water recycling,</p>

management of water and sanitation for all 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	preventing water shortages in vicinity. Information on, programmes relating to, and partnerships relating to water use drawing on collections and collections-based institutions in place, to support efficient use of water.
SDG 7. Ensure access to affordable, reliable, sustainable and modern energy for all 7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	Proportion of energy that comes from renewable sources. Date to achieve net zero, and milestones towards that date.
SDG 7. Ensure access to affordable, reliable, sustainable and modern energy for all 7.3 By 2030, double the global rate of improvement in energy efficiency	Reduction in energy use. Upgrade of old equipment to more efficient equipment. Uptake of renewable sources of energy.
SDG 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all 8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed	Plans in place to increase resource efficiency, reduce consumption, and to decouple economic growth from environmental degradation.

countries taking the lead	
SDG 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all 8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment	<p>Number and proportions of staff working with collections in safe and secure working environments.</p> <p>Number of accidents and other health and safety incidents reported.</p> <p>Training and support provided for staff to ensure their wellbeing, health and safety.</p> <p>Education, awareness-raising and partnership programmes drawing on collections that address labour rights, notably those of migrant workers and others in precarious employment.</p> <p>Reduction of numbers and proportions of staff on short-term or zero-hours contracts.</p> <p>Fair pay policies and procedures in place to prevent exploitation.</p> <p>Procurement policies that ensure that collecting institutions make use of people who are in decent employment, and that avoid exploitation throughout the supply chain.</p>
SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation 9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	<p>Development of research-useful collections to support reliable, sustainable and resilient use by researchers and others.</p> <p>Number and proportion of collections facilities and stores that support economic development and human well-being.</p> <p>Number and proportion of collections facilities and stores that provide affordable and equitable access for all.</p> <p>Investment in collections facilities.</p> <p>Inclusion of collections information in regional and transborder initiatives, notably via digital access for discoverability.</p>

<p>SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation</p> <p>9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities</p>	<p>Number and proportion of collections facilities that:</p> <ol style="list-style-type: none"> 1. make efficient use of resources, with an ongoing drive for efficiencies and reductions in energy use and waste of all forms. 2. use clean and environmentally sound technologies, including climate-friendly energy sources and materials, with an ongoing commitment to reduce greenhouse gas emissions and waste of all forms. 3. adopt and/or prioritise collections-related processes and practices to reduce greenhouse gas emissions and waste of all forms.
<p>SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization</p> <p>9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending</p>	<p>Number and proportion of collections facilities that effectively support research and researchers.</p> <p>Number and proportion of staff who are appropriately skilled to undertake and support collections-based research.</p> <p>Expenditure on initiatives to enhance and upgrade collections facilities.</p> <p>Numbers of staff engaged in to supporting and developing research use based on collections.</p> <p>Number of initiatives to encourage innovation drawing on collections.</p> <p>Increase in number of research and development workers per 1 million people.</p> <p>Increase in public and private research and development spending being used to develop and make use of collections.</p>
<p>SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation</p> <p>9.A Facilitate sustainable</p>	<p>Plans in place to support development of sustainable and resilient infrastructure in developing countries through financial, technological and technical support, for example through:</p> <ol style="list-style-type: none"> i. joint projects,

<p>and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States.</p>	<p>ii. funding bids, iii. sharing equipment, collections and collections information as appropriate, iv. in order to support development of high-quality infrastructures for sustainable development, research and innovation.</p>
<p>SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation 9.C Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020</p>	<p>Number of collections facilities that provide access to ICT.</p> <p>Number of collections facilities that use digital programmes to connect people with heritage and sustainable development agendas.</p> <p>Number of programmes that support access to the Internet in least developed countries.</p>
<p>SDG 11. Make cities and human settlements inclusive, safe, resilient and sustainable 11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage</p>	<p><i>11.4.1 Total expenditure (public and private) per capita spent on the preservation, protection and conservation of all cultural and natural heritage, by type of heritage</i></p> <p>Plans, policies and procedures in place for the safe use of collections for a variety of purposes, protecting and safeguarding both collections and those who use them.</p> <p>Plans, policies and procedures in place for the identification, safeguarding and protection of cultural and natural heritage at risk.</p> <p>Collecting programmes in place to protect, safeguard and make use of cultural and natural heritage, addressing the needs of communities and stakeholders, and ensuring that collections can be an effective resource for sustainable development.</p> <p>Number and diversity of educational, awareness-raising, research programmes, and partnerships that aim to strengthen protection of cultural and natural heritage.</p>

SDG 11. Make cities and human settlements inclusive, safe, resilient and sustainable 11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	Plans in place to reduce negative impacts on air quality, and volume and forms of waste. Plans in place to eliminate waste of all forms as soon as possible.
SDG 12 Ensure sustainable consumption and production patterns SDG 12.2 By 2030, achieve the sustainable management and efficient use of natural resources	Reduction of material footprint in terms of reductions in consumption of biomass, fossil fuels, metal ores and non-metal ores.
SDG 12 Ensure sustainable consumption and production patterns 12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment	Quantities, and reduction in quantities, of chemicals of all kinds, including chemicals used in maintenance of collections facilities, and chemicals used in care and preparation of collections, and all wastes throughout their life cycle, reducing release to air, water and soil. Plans in place to eliminate the use and release of hazardous chemicals into the natural environment as soon as possible.
SDG 12 Ensure sustainable consumption and production patterns 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse	Quantity and reductions in quantity of waste of all kinds, including avoidance/prevention of waste production, reuse, and recycling. Quantity of material recycled in comparison with quantity sent to landfill. Increases in recycling rate in comparison with landfill.
SDG 12 Ensure sustainable consumption and production patterns 12.6 Encourage companies, especially large and	Clear visions, strategies and plans in place for all aspects of sustainability – environmental, social and economic (people, planet, prosperity)- across all areas of activity.

transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	<p>Visions, strategies and plans relating to sustainability to be publicly available and incorporated into planning documents.</p> <p>Commitments to be in line with local, regional, national and/or international targets and ambitions.</p> <p>Incorporation of sustainability into reporting for funders and other stakeholders, including the public. Reporting to include commitments and progress towards targets.</p>
SDG 12 Ensure sustainable consumption and production patterns 12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities	Incorporation of sustainability considerations into procurement, in terms of advertisement and invitation to tender, contracts, and selection criteria for suppliers.
SDG 12 Ensure sustainable consumption and production patterns 12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	<p><i>12.8.1 Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment</i></p> <p>Extent to which global citizenship education and education for sustainable development (including climate change education) are mainstreamed in formal, informal and non-formal education programmes and activities drawing on and related to collections.</p>
SDG 13. Take urgent action to combat climate change and its impacts 13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries	Plans in place for near and longer term to actively adapt to climate-related hazards and natural disasters.
SDG 13. Take urgent action to combat climate change and its impacts 13.2 Integrate climate change measures into national policies, strategies and planning	National organizations, institutions and networks relating to collections and collections-based institutions to have integrated climate change measures into policies, strategies and planning relating to collections and collections-based institutions, including funding and other resourcing considerations.

<p>SDG 13. Take urgent action to combat climate change and its impacts 13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning</p>	<p>Plans in place to enhance positive contributions to addressing climate change through use of collections. Plans in place to ensure collections, collections institutions and broader society can adapt effectively to climate change.</p> <p>Plans in place for effective education and awareness raising on climate change mitigation, adaptation, impact reduction and early warning.</p> <p>Plans in place to reduce negative contributions of collections-related functions, e.g. measuring greenhouse emissions with plans and targets in place to reduce them.</p>
<p>SDG 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels. 16.6 Develop effective, accountable and transparent institutions at all levels</p>	<p><i>16.6.2 Proportion of the population [audience/users/non-users] satisfied with their last experience of public services</i> Access to information, and accountability policies and mechanisms, in place.</p> <p>Effective institutional arrangements, both for own working and for working in partnership with other sectors, in place.</p> <p>Plans and arrangements in place for extraordinary circumstances such as natural and human-caused disasters.</p> <p>Effective arrangements in place to fulfil legal and social obligations and responsibilities.</p> <p>Effective arrangements in place for transparent communication and reporting of institutional performance.</p> <p>Effective arrangements in place for transparent decision-making and accountability.</p>
<p>SDG 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels. 16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international</p>	<p>Adopt and implement constitutional, statutory and/or policy guarantees for public access to information.</p> <p>Plans in place, and plans implemented to enhance public access to information relating to collections.</p> <p>Plans in place, and plans implemented to support fundamental freedoms, in line with human rights, national and international agreements and legislation.</p> <p>Plans and procedures in place for public access to</p>

agreements		information relating to the operation and management of collections-based institutions. Complaint mechanism in place for public to use where public access to information and fundamental freedoms not supported or fulfilled.			
SDG 17. Partnerships for the goals 17.14 Enhance policy coherence for sustainable development		Proportion of policies that incorporate sustainable development considerations, linking to SDGs and indicators Incorporation of policy considerations from outside the collections sector into policies of collections-based institutions, to facilitate partnerships and effectiveness.			
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7	8	9	10	11	12
13	14	15	16	17	