**Contextualizing Map and Geography Library Collections as FAIR Research Data: A Case Study of Historical Landscape Photographs**

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Collection management techniques used in map and geography libraries to describe and provide access to materials ensure researchers can engage with collections as viable sources of research data. Many practitioners create frameworks to market these collections as potential sources of data, whether used alone or alongside other research data. These frameworks bear similarities to the FAIR data movement, where data producers are encouraged to make their data Findable, Accessible, Interoperable, and Reusable. I frame the historical landscape photograph collections of the American Geographical Society Library and the United States Geological Survey Library as FAIR research data, offering the potential to engage with trends, concerns, or concepts being explored by geographers. When highlighting the FAIRness of these collections, we have an opportunity to better understand how they may be used as standalone sources of data, as well as alongside other FAIR data sources in scientific research. As another FAIR data source, I use the DataONE Data Catalog to contextualize these photographs alongside present-day datasets from fieldwork in similar landscapes. I encourage map and geography libraries to understand how the FAIRness of their collections enable unique research opportunities, leveraging the momentum surrounding FAIR research data in open science/open research communities.

Keywords: American Geographical Society; United States Geological Survey Library; historical images; physical geography; FAIR; open data

# Introduction

Bidney and Piekielek (2018) write in defense of map and geography libraries among a rapid digitalization of geospatial research data, contextualizing the importance of these libraries, in part, alongside the benefit of using historical spatial materials in present-day research. Map and geography libraries maintain and provide access to a wide variety of collections, whether held on-site as physical objects and/or digitized for online access and use. These collections can provide historical context to a dynamically changing landscape, such as aerial photographs of glaciers from the mid-20th century, to more modern-day insight into a geographic area provided by GIS data. The potential for these collections to serve as rich data sources for research in multiple disciplines, but particularly geography, is immense. Two major map and geography libraries in the United States, the American Geographical Society Library (hereafter AGSL) at the University of Milwaukee-Wisconsin and the United States Geological Survey Library (hereafter USGSL), house significant collections of digitized and undigitized historic landscape photographs which represent rich sources of data. Standard cataloguing techniques including assigning descriptive metadata and thematic arrangement of materials help support the suitability for these collections to be used in research endeavors as sources of data in and of themselves. However, reiterating the message set forth by Bidney and Piekielek (2018), map and geography libraries are losing support at an alarming rate, and in this paper, I detail an opportunity and call-to-action in which we can further position these collections to be competitive as data sources in a changing scholarly landscape valuing open and reusable research data.

Fortin and Mueller (2013) note the efficacy of libraries to serve as viable research partners for scholars from any discipline, thanks to the development and curation of collections bridging both physical and digital formats, made available to researchers from multiple access points. In a scholarly landscape where conversations are increasingly turning towards transparency, open access, and open science, a movement centered around designing, performing, capturing, and assessing research through a lens of openness and connectivity (Vicente-Saez and Martinez-Fuentes 2018), researchers are attuned to seeking out data sources which are accessible, described with appropriate contextual metadata, and formatted for reuse. Data sources with these characteristics fall under the designation of FAIR: research data which are *F*indable, *A*ccessible, *I*nteroperable, and *R*eusable (Wilkinson et al. 2016). FAIR data can be broadly conceptualized through a lens of research data management (RDM), the process through which data are organized, described, stored, and shared throughout its lifecycle (Tang and Hu 2019). Similar to collection management and cataloguing techniques already adopted within map and geography libraries, RDM promotes the use of specific practices when working with research data including assigning descriptive metadata, formatting data for sharing and reproducibility, and making data open and accessible (and, ideally, making the data FAIR). Each of the FAIR Guiding Principles from Wilkinson et al. (2016) are detailed below:

**Findable:**

F1. (meta)data are assigned a globally unique and persistent identifier

F2. data are described with rich metadata (defined by R1 below)

F3. metadata clearly and explicitly include the identifier of the data it describes

F4. (meta)data are registered or indexed in a searchable resource

**Accessible:**

A1. (meta)data are retrievable by their identifier using a standardized communications protocol

A1.1 the protocol is open, free, and universally implementable

A1.2 the protocol allows for an authentication and authorization procedure, where necessary

A2. metadata are accessible, even when the data are no longer available

**Interoperable:**

I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.

I2. (meta)data use vocabularies that follow FAIR principles

I3. (meta)data include qualified references to other (meta)data

**Reusable:**

R1. meta(data) are richly described with a plurality of accurate and relevant attributes

R1.1. (meta)data are released with a clear and accessible data usage license

R1.2. (meta)data are associated with detailed provenance

R1.3. (meta)data meet domain-relevant community standard

Koster and Woutersen-Windhouwer (2018) describe how the FAIR data principles from Wilkinson et al. (2016) are often difficult to fully ascribe to library collections (as well as collections in museums and archives) due to the nature of the materials and legal and/or technical barriers. When noting the FAIR principles listed above by Wilkinson et al. (2016), it is clear that they mainly pertain to the metadata associated with the data itself. Lafia and Kuhn (2018) reiterate the importance of strong metadata in promoting discoverability of research outputs, such as datasets, underlying academic scholarship. As Koster and Woutersen-Windhouwer (2018) note, however, it may not be common practice for library collection managers to ascribe “universal metadata standards and protocols that are necessary for exchanging or reusing information in a simple way” (para. 2). In light of that, the authors offer a set of guidelines for making these collections FAIR within common boundaries and limits that exist around these collections. The guidelines, which are detailed in the article in separate categories to apply to objects, metadata, and metadata records, are collated and summarized below:

**Findable**

Objects (physical and digital) have a globally unique persistent identifier

Objects are described with metadata

Metadata about specific objects are available via one or more searchable online repositories, catalogs, online databases, etcetera

**Accessible**

Sustainable storage (hardware, storage medium)

Open universal access protocols

Version management

Backups

Metadata specify information about an object’s availability, obtainability and/or access options

**Interoperable**

Digital objects are stored in preferred or acceptable formats

Metadata contain links/references to other objects/authority files, by using other global persistent identifiers

**Reusable**

Digital objects have a date-timestamp

Metadata specify the object’s provenance

Objects have a license for reuse, which is also available in a machine readable form

In this paper, I use these principles laid out by Koster and Woutersen to signify FAIRness in a library collection, and when I explicitly mention “FAIR” hereafter, I am specifically referring to these guidelines rather than those set forth by Wilkinson et al. (2016). Particularly in the case of historical collections in map and geography libraries such as historical landscape photographs, characteristics including descriptive metadata, thematic arrangement and documentation, and digital formats support the long-term value of these materials by increasing the likelihood they may be found and implemented within modern-day research projects. For example, Huang et al. (2018) describe techniques for revitalizing information found in historical documents using augmented, virtual, and mixed realities, made possible primarily through the preservation of and access to these historical objects. While the aforementioned characteristics which increase availability and reuse of the materials are, again, a result of standard collection management techniques, I propose we have an opportunity to leverage momentum around the FAIR data movement to highlight and market the FAIRness of collections in map and geography libraries to the broader scholarly community.

To summarize the outline of this paper, I first conceptualize the historical landscape photograph collections at the AGSL and USGSL as FAIR research data. I then describe how standard collection management practices in map and geography libraries support the FAIRness of these collections as research data. Then, as a way to demonstrate the research potential surrounding FAIR data, I frame how the FAIRness of these specific collections allows them to be used effectively alongside other FAIR research data, such as datasets in open data aggregators, in a mixed-methods approach for physical geography research. This approach details several case studies which demonstrate a process for making maximum use of the FAIRness of these collections. After outlining the case studies, I end this paper by initiating a call to action for map and geography libraries to understand and leverage the FAIRness of these materials in a manner that may increase scholarly engagement with map and geography library collections, particularly in fields calling for more use of open, FAIR data.

**The FAIRness of Historical Landscape Photograph Collections**

Historical landscape photographs are valuable forms of data as they provide temporal context to trends and problems currently exhibited on Earth’s surface. For physical and human geographers alike, it is common to use historical photographs in *repeat photography* projects in which images of past landscapes are recreated in present-day photographs (Bass 2004; Lemmons et al. 2014; Rossetto 2019). This method is used to understand and monitor landscape change (Burton et al. 2011) resulting from a variety of factors including those which are cultural, economic, and/or environmental in nature. While myriad research opportunities for human geographers using repeat photography exist within map and geography libraries, in this paper I highlight the opportunities in these spaces for physical geography research. I focus on physical geography research due to the extensive historical photograph collections at the AGSL and USGSL relating to environmental processes. In the case studies, I apply a unique approach to repeat photography in which the modern photograph of a geographic area is replaced by data capturing present-day characteristics of the landscape, with inspiration from physical geographers who have studied environmental processes using historical landscape images either as standalone data sources or together with field-based data collection methods (see Butler and DeChano 2001; Moseley 2006; Hendrick and Copenheaver 2009; Meyer and Youngs 2018). Butler and DeChano (2001) studied environmental landscape changes in Glacier National Park, Montana using repeat photography to assess topographic change resulting from anthropogenic causes, fire-suppression, and glacial recession. More recently, Meyer and Youngs (2018) combined repeat photography with traditional fieldwork methods to understand landscape change in Yellowstone National Park.

In research projects such as these, historical landscape photographs, particularly those found within archived collections, are able to be used as viable research data due to their accompanying metadata providing geolocation, temporal reference, and other useful context, as well as their open availability. Although these characteristics may not always be explicitly tied to the FAIR data principles (and, rather, simply may be a result of standard collection management techniques), adherence to these principles increases the efficacy for these collections to be used not only as standalone sources of data but also alongside other FAIR research data, such as data found in open data repositories such as figshare, Zenodo, and open data aggregators such as the DataONE Data Catalog. Ideally, data found within these repositories and aggregators include metadata, documentation, codebooks, licensing, and other contextual information to support, guide, and promote their reuse within a new research project, rendering the data compliant with FAIR standards. Supporters of reusing open data claim it minimizes redundant scientific research efforts (Patel 2016), promotes innovation, and provides greater access to research outputs, potentially leading to increased citations (Ray 2013). The proliferation of open data repositories and aggregators has skyrocketed among the FAIR and open science movement, leading to specialized data repositories and aggregators for virtually any academic discipline of study in the world. As a case study to highlight the historical landscape photograph collections at the AGSL and USGSL as FAIR research data for environmental physical geography research, I use the DataONE Data Catalog[[1]](#footnote-2), an aggregator of open environmental and earth sciences data, as an additional FAIR data source to contextualize alongside these collections in a case study of FAIR data reuse. While I could have presented case studies that use these historical photographs as standalone data, I chose to include the DataONE Data Catalog to demonstrate how FAIRness of library collections supports data reuse in a variety of research techniques, including mixed-methods research.

The AGSL is located within the University of Wisconsin-Milwaukee Libraries system, and is the official library of the American Geographical Society (hereafter AGS). The AGS is the oldest professional geography association in the United States, whose mission is to “advance and promote geography in business, government, science, and education” (AGS 2019). The AGSL initially formed in the 1850s to support research endeavours using geographical and statistical information, alongside collections of charts, maps, and globes. Presently, the AGSL collections include not only these geographical artefacts, but also GIS data and expansive collections of historical photographs of landscapes across the world. As the website for the AGSL states, “Many photographic images in the AGS Library are parts of distinct photographic collections that reflect a broad range of times, places and activities.” While the AGSL contains extensive digital collections of images accessible to researchers regardless of their location[[2]](#footnote-3), there are also vast resources for in-house photographic collections not available online. The USGSL offers a digital repository of historical landscape images from the 1800s-on. This repository includes imagery pertaining to water resources, climate change (visualized through, for example, changes in glacial composition over time), and impacts on topography by human-built infrastructures[[3]](#footnote-4), as well as undigitized photographic collections at their physical location in Denver, Colorado. Collections at both institutions are FAIR due to their findability both in-person (through finding-aids, support from librarians, etc.) as well as online (through digitization); their accessibility to researchers; their assigned metadata with facilitates interoperability with other forms of FAIR research data; and the potential to reuse the collections as data sources in a variety of geographic research projects due to geolocation, provenance, and metadata.

I contextualize data from modern-day environmental fieldwork, represented through datasets currently found in the DataONE Data Catalog,alongside these historical photographs in case studies concerning pressing environmental concerns, including degradation of glacial landscapes, the impact of climate change on natural hazards and disasters, and landscape modification through deforestation[[4]](#footnote-5). Combining these photographs with present-day datasets is a research technique enabled by the FAIRness of the historical photograph collections *and* the open datasets, including free access, open file formats, and the application of descriptive metadata and provenance.Given that physical geography has a rich history of data-driven research and data sharing (Leonelli et al. 2015), highlighting the FAIRness of these photographs and open datasets may embolden physical geographers to continue exploring the efficacy of historical photographs as complementary data sources for fieldwork-based research producing quantitative datasets, and ultimately providing an additional opportunity to support researcher engagement with map and geography libraries in a scholarly landscape that increasingly values FAIR research data.

Finally, while not a major focus of this article, it is imperative that I highlight the connections between this research and the *collections as data* initiative (Always Already Computational 2017) which asserts that any digital materials, such as those within digital collections, can potentially serve as data that can be engaged with computationally in a research project if several curation benchmarks are met. As I expand upon in the conclusion of this paper, situating these collections among the *collections as data* initiative is a logical next step for this research, but is not explored in this paper as it is important to *first* understand the FAIRness of these collections, which ultimately supports their efficacy for use under a *collections as data* framework.

**Method**

In [date, removed for peer-review anonymity], I undertook fieldwork on-site at the AGSL and digitally “at” the USGSL in which I explored historical photographs from both map and geography libraries in three main subject areas: (1) glaciers and glacial landscapes, (2) natural hazards and disasters, and (3) deforestation. I identified these subject areas for physical geographers by using recently published articles from several scholarly journals in physical geography (*Physical Geography*; *Progress in Physical Geography: Earth and Environment*; *Journal of Geography & Natural Disasters*, etc.) as signifiers of topics of current importance in the field, and determining if there were collections available at the AGSL and the USGSL sufficiently representing these topics. There were no significant collections of photographs at one or both institution(s) pertaining to other physical geography research areas to warrant their inclusion in the case studies. It is important to note that all images from the AGSL were scanned by AGSL staff specifically for this project and were not initially located in digital format, while all USGSL images were obtained in their digital formats.

In the case studies, alongside each group of photographs, I highlight complementary present-day data sources from fieldwork in similar regions housed in the DataONE Data Catalog. To locate these datasets, I used two approaches: (1) I entered the topic area in the text search function in the Data Catalog (in this case, glaciers, natural hazards, and deforestation); (2) I used the spatial search feature in the Data Catalog to find datasets in similar regions to those shown in the historical photographs.

Finally, to complete the case studies, I contextualize each photograph alongside a relevant dataset and identify aspects of their FAIRness which would allow them to be used concurrently in a physical geography research project.

**Case Studies**

The photographs included in the following case studies represent FAIR research data due to their adherance to the FAIR data principles first proposed by Wilkinson et al. (2016) and adjusted by Koster and Woutersen-Windhouwer (2018) to be more relevant for library, archive, and museum collections. Below, I demonstrate the manner in which these materials can be considered FAIR:

**Findable:** All photographs are findable either through online repositories or in-person holdings with finding aids and adequate documentation to support quick location of any given image, with the ability to be scanned into digital format. The photographs are described with metadata that help provide context to what is shown in the images.

**Accessible:** Metadata specify information about an object’s availability, obtainability and/or access options at both the AGSL and USGSL

**Interoperable:** The digital photographs are stored in preferred or acceptable formats, and metadata contain links/references to other objects/authority files, by using other global persistent identifiers.

**Reusable:** The digital objects have a date-timestamp present in the metadata, while the physical photographs at the AGSL contain a date-timestamp either on the back of the photograph or in the metadata. The metadata specify the object’s provenance. Within collection limits, the photographs have a license for reuse.

The framing of the FAIRness of these photographs helps provide context to the case studies outlined below, particularly when connecting the photographs to revelant datasets within the DataONE Data Catalog.

Glaciers and glacial landscapes

Physical geographers often engage with environmental issues surrounding glaciated landscapes and the impacts of climate change and other anthropogenic factors, including ecotourism, on the health and sustainability of said landscapes (Murtaza and Romshoo 2017; Rabatel et al. 2017; Kaushik et al. 2019). Both the AGSL and USGS Library feature digitized and undigitized photographic collections pertaining to glacial landscapes, providing a historic view of glacial extent across the world. These images are FAIR in that they contain provenance, metadata, and other documentation that allows for a researcher to easily access them and connect them to a geographic area and temporal context.

The Albert Lincoln Washburn Papers at the AGSL feature, in part, historic postcards of glacial landscapes across North America. Washburn (1911-2017) was a career geomorphologist and executive director of the Arctic Institute of North America, and is world-renowned for his work in glaciated landscapes impacted by climate change (McNerthney 2007), as well as periglacial research. During his career, he identified several factors contributing to periglacial processes, including climate and microclimate, topography, rock and soil composition, time, and human activities (Washburn 1980). Here, I detail a process in which a researcher can make use of the FAIRness of these materials in research on climate and human activities as a driver for periglacial change and glacial landscape alteration. Warmer temperatures associated with climate change impact the extent and overall size of glaciers, causing severe consequences for not only surrounding landscapes but also ecosystems across the entire world (Kronenberg 2013). Human activities such as glacial

tourism and outdoor recreation also intersect with studies of glacial landscapes, as glacial retreat impacts tourist experiences at these sites. Further, climate change-induced impacts on glaciers may necessitate additional human intervention in glaciated landscapes to allow for continued tourism, introducing potential vulnerabilities to the overall health of the glacier(s) (Welling et al. 2015). Modern-day glacial research navigates these social and environmental systems through fieldwork and sociocultural assessment. The AGSL and USGSL both house historic photographs of glaciers in areas of interest to present-day scientists, in which their associated metadata and provenance offers an opportunity to juxtapose these images alongside data collected on-site at the glaciers. For example, **Figure 1** is a postcard featuring Athabasca Glacier in Jasper National Park and its glacial extent in 1938. This image is an example of FAIR research data in that its associated metadata grounds it in a geographical and temporal context, allowing it to be used as a visual record of glacial extent in Jasper National Park. Further, its description by AGSL curators helps aid in the findability and access of the photograph.

Insert Figure 1: AGSL Albert Lincoln Washburn Papers: Athabasca Glacier, Jasper National Park, 1938.

Parks Canada (2015) defines several categories of recreational activity at Jasper National Park, including mountain biking, traction kiting, and guided and interpreted canopy tours. These recreational activities, by proxy, require additional construction of facilities and infrastructure such as parking lots and visitor centers. The images of glacial landscapes in Jasper National Park in Alberta, Canada from the early twentieth century complement the dataset from Ladle et al. (2018) on the impact of human outdoor recreation in Jasper National Park on grizzly bear and black bear co-occurrence. Although these research artifacts focus on different aspects of the ecosystem in Jasper National Park (glacial landscapes and black bear species distribution), the connecting thread is the impact of human outdoor recreation on the ecosystem of the park. Geographers undertaking research on Jasper National Park as well as national park ecosystems in general would benefit by presenting a multi-lens view of these landscapes as impacted by human intervention and climate change.

The DataONE Data Catalog provides access to a dataset from Amundson et al. (2017) on subglacial discharge in southeast Alaska. This dataset is the product of fieldwork employed to understand retreat of Northern hemisphere marine-terminating glaciers and how the retreat contributes to sea level rise, specifically addressing fieldwork taken place at LeConte Glacier in southeast Alaska. The photograph of Nelchina Glacier from 1952 (**Figure 2**) from the USGS Library, also in southeast Alaska, complements this dataset through visual

evidence of glacial extent that scientists may compare to the present-day extent of glaciers in the same regions, such as LeConte Glacier. Without elements of FAIRness provided by both the dataset and the photograph, it would be difficult to understand how to co-locate both of these digital objects into a single research project. Together, their FAIRness allows the researcher to provide more context into glacial extent over time in this geographic area.

Insert Figure 2: USGSL William J.R. Collection: Nelchina Glacier, Alaska, 1952.

Natural hazards and disasters

Physical geographers study the impacts of climate change on flooding frequencies and overall floodplain dynamics (Collins et al. 2014; Šraj et al. 2016). As they study modern-day flood patterns, it is often advantageous to explore the impacts of historical flooding events (Birkeland 2002; Hewitt & Liu 2010), whose visual extent has been heavily documented in photographs available at the AGSL. The catastrophic flooding of western North Carolina on July 14-16, 1916 is described in detail by Bell (1916, 9):

*“It happened suddenly. The wind blew; the clouds divided and poured torrents; earth and boulders that had been resting on the mountain sides for hundreds of years went tearing down, carrying death and destruction in their wake; branches, creeks and rivers became roaring torrents sweeping down the valleys taking everything before them. It was all over in three days but in that time a damage of millions of dollars had been done to farms, railroads and industrial plants and a hundred and more men, women and children had been sent to eternity, some of them swept away and never being heard from. Railroads and factories were rebuilt but many of the farms, ruined and washed, will remain as marks of the great flood for time to come*.”

Bell’s description of the natural disaster evokes *mental* images of both physical and emotional destruction as a result of the flooding. However, the addition of historical images with metadata providing a datestamp that connects them to the time of this disaster enhances the narrative and reiterates the impacts of natural disasters on human-built landscapes. **Figures 3 and 4** highlight photographs available from the AGSL documenting the property damages incurred from the flooding.

Insert Figure 3: AGSL Photographic Collection: Flooding in Western North Carolina, 1916.

Insert Figure 4: AGSL Photographic Collection: Flooding in Western North Carolina, 1916.

The DataONE Data Catalog provides access to a dataset and metadata record for a project from the USGS informing management of floodplain conservation lands on the Missouri River, including calculations of important metrics including floodplain depth, extent, frequency, duration, and time of inundation (Bulliner et al. 2017). Historical images of flooding reiterate the necessity for continued research on floodplains and flooding, and complement the rationale of the fieldwork producing these datasets.

Volcanic eruptions are not inherent natural disasters, but only become so (at least in our narrative) when they disrupt normal activities in a human-built environment. Physical geographers studying volcanic landscapes often explore the consequences of these natural events on environmental landscapes as well as human landscapes (Oppenheimer 2003). The USGS Library features several collections of photographs documenting historical volcanic eruptions and their impacts on not only the natural environment but the human-built environment as well. **Figures 5, 6, and 7** demonstrate the impact of volcanic eruptions on anthropogenic landscapes, namely the accumulation of ash on vehicles, burning of human-built structures, and downing of power lines, respectively.

Insert Figure 5: USGSL USGS/HVO Collection: 1955 Eruption of Kilauea Volcano, March 1, 1955.

Insert Figure 6: USGSL USGS/HVO Collection: 1960 Eruption of Kilauea Volcano.

Insert Figure 7: USGSL USGS/HVO Collection: Eruption of Kilauea Volcano in 1983; flow breakout from 1984.

Alongside studying the anthropogenic impacts of eruptions, modern-day physical geography fieldwork in volcanic landscapes seeks to understand the impacts of eruptions on natural environmental processes. The DataONE Data Catalog highlights a dataset from the fieldwork of Ladefoged et al. (1987) which entailed an archaeological survey of lava flow damage in the Kalapana Extension of Hawaii Volcanoes National Park, partnered by a full metadata record providing geolocation, appropriate metadata, and temporal context. While this dataset is two decades old, it nevertheless provides evidence that historical photographs of volcanic landscapes from the USGSL supply further historical visual evidence of the impact of eruptions on human and physical environments.

Deforestation

Across the world, but particularly in the tropics, deforestation poses an immense threat to biodiversity and environmental stability amidst global climate change (Leblois et al. 2017). Physical geographers undertake research on deforestation in a variety of areas from several angles, including rates of land cover change and fragmentation in the Amazon (Marsik et al. 2011), soil erosion in tropical forests of Guatemala (Beach 1998), and forest fragmentation in national parks in Bhutan (Sharma et al. 2017). The methods employed in these projects are heavily steeped in fieldwork, yielding data which physical geographers can use to tell stories about present-day deforested landscapes. However, because these projects often involve reading landscape dynamics such as land cover change and forest fragmentation *over time*, historical images of these landscapes may provide additional visual context to modern-day research projects on deforestation.

The Daniel W. Gade collection at the AGSL features photographs from the fieldwork and travels of Gade (1936-2015), who was professor emeritus of Geography at the University of Vermont with specialties in the cultural geographies and ecologies of Latin America and deforestation ecologies of Madagascar. His research endeavors included extensive fieldwork, an underpinning that continues to define his legacies across the geographic discipline (AAG, 2015). Among several other topics, Gade’s collection of fieldwork photographs include images of deforested landscapes in Madagascar (**Figures 8 and 9**). According to Gade (1996), the “Highlands of Madagascar form one of the bleakest landscapes in the non-arid tropics: devoid of native trees or animals, scarred by relentless erosion, and covered with floristically impoverished grasses” (p. 101). Although Gade uses highly descriptive language to describe the deforested landscapes of the island, photographic evidence of these landscapes increases the emotional and intellectual impact of these statements. Further, as international agencies such as the Belmont Forum and National Science Foundation increasingly advocate for research on pressing environmental issues relating to climate change (NSF 2018; Belmont Forum 2019), the loss of biodiversity and carbon sequestration associated with deforestation is likely to be a topic explored more by scientists.

Insert Figure 8: AGSL Daniel W. Gade Collection: Deforestation in Madagascar, 1983.

Insert Figure 9: AGSL Daniel W. Gade Collection: Deforestation in Madagascar, 1983.

While the DataONE Data Catalog does not currently reference datasets specifically concerning deforestation in Madagascar, the dataset from Bungard (2019) on species traits and occurrences for Malagasy amphibians intersects with broader topics in community dynamics, range changes, endangered species, and climate change vulnerability assessments. The impacts of deforestation in Madagascar closely align with these topics, as losses of forest biomass present dangerous ecological and biological consequences (Omeja et al. 2011). Therefore, these examples from the Gade Collection at the AGSL complement datasets found in the DataONE Data Catalog, reinforcing a call for using historical photographs as context alongside present-day scientific fieldwork and data collection.

While the main focus of these case studies is physical geography research, it is important to note that Gade’s photographs and research surrounding deforestation in Madagascar also lend insight into the myriad environmental and social consequences of colonialism, a topic of interest for human geographers. Destructive burning practices in Madagascar, a country that gained independence from French colonization in 1960, can be traced to policies and consumptive practices from French colonial administration (Gade 1996). Environmental and social justice scholars continue to explore the impact of commercial and industrial agriculture on colonized landscapes previously supported by sustainable Indigenous land use practices (Welch et al. 2013). Historical photographs of deforestation, such as those shown in Figures 5 and 6, support these research endeavours with visual evidence of the detrimental consequences of colonization on Indigenous landscapes. Again, these research opportunities are *unlocked* by the FAIRness of these collections.

Physical geographers seeking historical images of deforested landscapes may also seek out the USGSL for applicable photographs which are FAIR due to their metadata, digital format with access rights, and provenance. The Gilbert G.K. Collection at the USGSL features an image from Placer County, California in 1906 highlighting a roadside affected by deforestation and overgrazing (**Figure 10**).

Insert Figure 10: USGSL: Gilbert G.K. Collection: Deforestation and overgrazing impacts on roadside in Placer County, California. 1906.

While these photographs provide important visual context to the information available within these open datasets, it is important to note the limits of these images as research data in these contexts. As a result of descriptive metadata, digital access, and collection organization and documentation, these images are FAIR research data. However, particularly within these aforementioned case studies, the images mainly serve as additional visual context to fieldwork data on topographical change, and in and of themselves may not offer the same computational opportunities as the quantitative data. However, this does not limit the efficacy of their use alongside other FAIR data sources; rather, they offer an opportunity to engage in innovative research in which we can expand our notions of what constitutes “data,” and encourage us to apply unique methods in physical geography research. Further, in these case studies I have primarily focused on the use of metadata, description, and provenance to enable greater FAIRness of the historical photographs that supports their use alongside other FAIR data sources from the DataONE Data Catalog. However, it is also important to note that the digital format of these images (another aspect of the FAIRness of these data sources which allows for easier accessibility and reuse) further enables these images to serve as data sources in and of themselves. Again drawing connections to the collections as data initiative, which is not fully explored in this paper but is a notable topic for future study, digital materials such as digitized historic photographs can be engaged with computationally as data sources for research projects if several curation and access benchmarks are met.

**Discussion and Conclusion**

In light of consolidation and closures of several map libraries across the world (Keller 2001; Andrew and Weimer 2016; Bidney and Piekielek 2018), it is imperative for map and geography libraries to leverage trends and momentum in the current research landscape to promote their collections as viable research data. In this paper, I have described how standard collection management procedures used by map and geography libraries including assigning descriptive metadata, documentation and arrangement, and in some cases providing digital access to materials, contributes to the FAIRness of these collections when conceptualized as research data. I then demonstrated how the FAIRness of these collections render them to be used alongside other FAIR data sources, such as open data from the DataONE Data Catalog. I contextualized historical landscape photographs from the AGSL and USGSL alongside this modern-day open data in case studies using a unique take on repeat photography to present a holistic view of three prevalent topics within physical geography research, providing both temporal and visual records of landscape modification and change over time. The presence of accurate and descriptive metadata for each photograph helps connect the image to both a geographical and temporal context, allowing for easy location of relevant open datasets within the DataONE Data Catalog. Further, the digital formats of these photographs enables new ways to engage with these images. As FAIR data, these sources nicely complement each other and build a foundation for producing transparent and open research in the geographical sciences. It is imperative for map and geography librarians to consider the ways in which their application of metadata standards, documentation, provenance, and physical and digital access to the materials increases the FAIRness of their collections, and how this can impact the research opportunities available to scholars visiting their establishments.

I reiterate that it is not my intention to distill FAIR data practices down to a mere marketing ploy – FAIR data practices represent a highly researched and carefully designed set of principles aimed maximizing the use of research data. Rather, because standard collection management procedures in map and library collections closely mirror the FAIR data principles, by highlighting case studies in which these techniques maximize the FAIRness of the collections, map and geography libraries have an opportunity to leverage their collections’ FAIRness to increase engagement with their materials as scholarly communications across multiple disciplines continue to call for more openness and transparency in scientific research. Thus, I would like to initiate a call-for-action for map and geography libraries to think about how their collection management techniques support their collections in serving as FAIR research data, and consider how their collections may be used alongside other FAIR data sources, including but not limited to, open data repositories and aggregators. As a point of future research, it would be helpful to further understand how map and geography libraries can maximize engagement with open data repositories and data aggregators such as the DataONE Data Catalog. By starting with understanding the FAIRness of map and geography library collections, this paper has set a foundation for such future research to occur.   
 Finally, while it is important to note that not all map and geography libraries host historical photograph collections as substantial as those found at the AGSL and USGSL, the explicit purpose of this paper was to highlight cases in which collection management techniques used for historical photograph collections enable these collections to serve as FAIR research data. Future research may apply the same conceptual framework to other collections held at map and geography libraries, such as globes, paper maps, and other resources, assessing their FAIRness and how such a designation may be marketed to their relevant scholarly communities.

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**Figure Captions**

Figure 1: AGSL Albert Lincoln Washburn Papers: Athabasca Glacier, Jasper National Park, 1938.

Figure 2: USGSL William J.R. Collection: Nelchina Glacier, Alaska, 1952.

Figure 3: AGSL Photographic Collection: Flooding in Western North Carolina, 1916.

Figure 4: AGSL Photographic Collection: Flooding in Western North Carolina, 1916.

Figure 5: USGSL USGS/HVO: 1955 Eruption of Kilauea Volcano, March 1, 1955.

Figure 6: USGSL USGS/HVO: 1960 Eruption of Kilauea Volcano.

Figure 7: USGSL USGS/HVO: Eruption of Kilauea Volcano in 1983; flow breakout from 1984.

Figure 8: AGSL Daniel W. Gade Collection: Deforestation in Madagascar, 1983.

Figure 9: AGSL Daniel W. Gade Collection: Deforestation in Madagascar, 1983.

Figure 10: USGSL Gilbert G.K. Collection: Deforestation and overgrazing impacts on roadside in Placer County, California. 1906.

1. https://search.dataone.org/data [↑](#footnote-ref-2)
2. https://uwm.edu/libraries/agsl/agsldigital/ [↑](#footnote-ref-3)
3. https://library.usgs.gov/photo/ [↑](#footnote-ref-4)
4. When I refer to deforestation in this context, I am speaking towards widespread deforestation of forest lands for purposes including industrial agriculture, and not towards the sustainable Indigenous burning practices were disrupted by colonial policies. [↑](#footnote-ref-5)