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Mapping GLAMs: creating a national dataset of GLAMs to develop a categorical climate-change risk assessment scale

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Abstract

Introduction. The PROTECCT-GLAM project aims to assess and address climate risks for U.S. galleries, libraries, archives, and museums (GLAMs). The project team began with creating a national dataset of GLAMs.

Method. The project team used existing datasets that required different auditing and manipulation techniques to align its data. Following the data normalization, the master file included 77,960 entries.

Analysis and Results. The project team used ArcGIS Pro to analyze a dataset of galleries, libraries, archives, and museums (GLAMs) for risk from sea level rise, finding 16,877 GLAMs within 30 kilometres of the U.S. coast, with California, New York, Maryland, Florida, and New Jersey having the highest numbers. They also assessed GLAMs per capita by state using 2020 census data, reporting results per 10,000 people.

Conclusion. The dataset creation was successful and is being utilized to create a five-point scale based on the average of five climate variables for each GLAM.

Introduction

For decades, climate scientists have attempted to warn society about potential significant threats related to a changing climate as an attempt to call for action. Unfortunately, many did not take the danger's immediacy seriously, and the risks have now moved from potential to present. According to the 2021 Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, widespread and rapid changes in the atmosphere, ocean, and biosphere have already occurred. The predominant evidence of these changes can be noticed in extreme behavior of heatwaves, heavy precipitation, droughts, and tropical cyclones, which will all continue to increase in severity and frequency into the future (IPCC, 2023). The nine U.S. regions considered by the Fourth National Climate Assessment all have increased threats from these events into the future, regardless of which future climate scenario is considered (Black & Brown, 2020).

More than ever, cultural heritage institutions must assess their unique climate change-related threats to their collections and missions as part of their disaster and emergency management plans. According to the 2019 heritage health information (HHI) survey, 58% of institutions do not have a disaster plan, with 75% lacking both a plan and staff training to implement a plan (IMLS, 2019). Furthermore, the HHI report indicated an increased attribution of damage between 2017 and 2019 due to water or moisture (56%), with natural disasters accounting for 10% (IMLS, 2019).

The PROTECCT-GLAM project attempts to address these challenges by developing a national categorical climate change risk assessment scale for galleries, libraries, archives, and museums (GLAMs). To meet this objective, the project team must first address the lack of a comprehensive geo-referenced dataset for all U.S. GLAMs. The following paper discusses this dataset's development and initial GIS analysis—specifically, identifying the number of GLAMs located within 5, 15, and 30 kilometers of a coastline and the number of GLAMs per capita in each state.

Literature review

Previous GIS analysis of GLAMs remains limited and explores the factors at play in the location of cultural institutions, specifically public libraries, rather than the potential impacts of climate change. Wan, Chen, & Zhang (2017) sought to develop a statistical model to aid in the placement of new libraries. In their model, they account for traffic, environmental factors, a library's constraint value, and the capacity limitation of the library. Similarly, Shorabeh et al. (2020) developed three major categories to consider when deciding where to build a new public library: centrality (population and accessibility), compatibility (air and noise pollution and comfort and security), and environmental (elevation, slope, and fault lines). Their findings indicate that optimal locations for public libraries are among areas with high population density, with ample access to transportation (nearby roadways and public transit) and security centers (police and fire stations, health resources, etc.).

Further, their results also showed that population and demographics were more critical in location decisions than accessibility, meaning that building libraries in areas with higher rates of illiterate population and student density is more beneficial than building libraries near roads or public transportation. Findings from a study investigating the relationship between accessibility and the utilization rate of public libraries support the conclusions of Shorabeh et al. (Zhao & Hong, 2023). In contrast with results from former studies, there was no evidence of a causal relationship between accessibility and utilization; in comparison, the findings showed that human factors, like motivation and customs and habits, play a more important role in public library utilization among their sample.

The location of cultural institutions has important implications for their surrounding areas and those seeking to use their resources. In particular, the existence and construction of new museums have been shown to be a catalyst for growth in the area in which they are located. For example, in a study of the proximity of museums to the city centers of Barcelona, Paris, and Turin, (Paül i Agustí,

2014) found that while most museums are located within 2 km of the city center, those outside this radius have more significant impacts on their surrounding communities than those located within the radius and can be used by community leaders to spur social and economic change within their reach. These findings illustrate cultural institutions' role in their communities and their potential growth.

Despite these hopeful findings, however, cultural institutions often follow suit of other significant social and economic resources, meaning that areas with scarce access to these resources generally lack access to cultural institutions as well (Short et al., 2020). In their investigation of informal learning institutions (ILIs) locations across the United States, Short et al. found several '*ILI deserts*' worthy of attention. In particular, their findings show large areas among the Great Plains, the Southeast, and the Northwest with a low relative density of ILIs compared to their population. Further, these '*deserts*' often encompass areas with high poverty rates and low population density and disproportionately affect American Indian and Alaskan Native communities, with 0.95% of these communities lacking access to ILIs compared to the general population's 0.10%. This problem is not exclusive to these areas, however. In a study of Washington DC, Baltimore, Chicago, and Phoenix and their respective spatial accessibility of public libraries, Cheng et al. (2021) found that, with the exception of Phoenix, socially disadvantaged populations, including non-adults, minorities, and impoverished people, have to travel further distances to access public libraries. Combined, these studies indicate that demographics facing other societal and economic hardships across the country are less likely to have easy access to cultural institutions.

Methodology

To meet the PROTECCT-GLAM project's overall objectives, the project team needed to create a dataset that included the geographic, physical location of all GLAMs in the U.S. The project team began constructing the dataset by identifying the following existing external data files:

- 2018 Museum Data Files from IMLS Data Catalog (IMLS, 2018)
- 2020 Public Libraries Survey (PLS) from IMLS Data Catalog (IMLS, 2020)
- 2019 Archives RepoData at GitHub (Goldman, Tansey, & Ray, 2019)
- 2012 Academic Library Survey (ALS) Public Use Data File from the National Center for Education Statistics (NCES, 2012)
- 2023 Department of Defense Morale, Welfare and Recreation (MWR) Libraries Directory (US DOD, 2023)

Each external data file required different auditing and manipulation techniques to align its data to the PROTECCT-GLAM requirements. The following section summarizes the steps taken for each external data file.

Museum data files

The museum data files were last updated in 2018 and include three separate data files. The project team merged the individual files into a single data file with 30,177 entries. (Note: The project team discovered several duplicate entries later in the process, accounting for the disparity between the original number of entries and the final number in the data file.) The Museum Data File Documentation and User's Guide noted that the data file included 56 informational columns (Frehill & Pelczar, 2018). The original data included information based on IRS nonprofit data, IMLS administrative data, private foundation grants, professional organizations, and other public sources.

The project team removed all data columns except COMMONNAME, DISCIPL, GSTREET, GCITY, GSTATE, GZIP, GZIP5, LONGITUDE, and LATITUDE and assigned all entries a unique identification

with the prefix MU. The team then identified entries that did not include formal location addresses (e.g., those with P.O. Boxes or incomplete addresses) and entries without geo-references. This process marked 5,290 entries that required additional auditing and verification.

Public libraries survey data files

The project team utilized the most recently available Public Libraries Survey from fiscal year 2020. The source included three files. Of the three files, only the Public Library Outlet Data File included 17,509 public library service outlets. The Public Libraries Survey Fiscal Year 2020 Data File Documentation and User's Guide noted that the outlet data file included 41 informational columns (Pelczar et al., 2022). The original data included information based on state- and territory-based reporting units.

The project team removed all data columns except STABR, LIBID, LIBNAME, ADDRESS, CITY, ZIP, CNTY, LONGITUD, and LATITUDE and assigned all entries a unique identification with the prefix PL. The team then identified entries that did not include formal location addresses (e.g., those with P.O. Boxes or incomplete addresses) and entries without geo-references. This process marked 142 entries that required additional auditing and verification.

Repository data (RepoData) for United States archives

The project team downloaded the most recent RepoData JSON file on August 30, 2022, from GitHub. The source comprises a single data file with 25,771 unique entries and 24 informational columns. The original data included information from 138 archival organizations collected between 2017 and 2019 by Ben Goldman, Eira Tansey, and Whitney Ray (2019).

Since RepoData is an active data file and to provide the RepoData team with updated entries, the project team retained all of the original data columns. It assigned all entries a unique identification with the prefix ARC. The team then identified entries that did not include formal location addresses (e.g., those with P.O. Boxes or incomplete addresses) and entries without geo-references. This process marked 8,132 entries that required additional auditing and verification.

Academic libraries data files

The project team utilized the most recently available Public Libraries Survey, which was published in 2014. The team exported the Microsoft Access information into an Excel data file with 4,261 unique entries. As noted in the *documentation for the academic libraries survey* (ALS) *Public Use Data File: Fiscal Year 2012*, the data file included 180 informational columns (Phan, Hardesty, & Hug, 2014). The original data included information collected by the National Center for Education Statistics (NCES) with assistance from the American Library Association's Office of Research and Statistics.

The project team removed all data columns except UNITID, INSTNM, ADDR, CITY, STABBR, and ZIP, assigning all entries a unique identification with the prefix AL. The team then identified entries that did not include formal location addresses (e.g., those with P.O. Boxes or incomplete addresses) and entries without geo-references. This process marked all 4,261 entries as having formal addresses without geo-reference.

MWR library data

The department of defense morale, welfare, and recreation (MWR) Libraries data were extracted from the DOD MWR website directory. The directory included 12 separate fields; the resulting data file included 196 unique entries. The project team removed the 67 libraries outside the United States, resulting in 129 entries. Additionally, the team removed all data columns except: BASE; LIBRARY; ADDRESS; CITY; STATE; and POSTALCODE and assigned all entries a unique identification with the prefix MWR. None of the directory entries included geo-references.

Data verification and updating

The project team extracted the 17,954 entries requiring additional verification or updating from each of the data files:

- Museum: 5,290
- Public Libraries: 142
- Archives: 8,132
- Academic Libraries: 4,261 (only required georeferenced)
- MWR Libraries: 129 (only required georeferenced)

Members of the project team reviewed and corrected each entry, followed by a secondary quality review by two team members. Limited entries whose physical location could not be verified were removed from the data file. Following the verification process, the individual data files were recompiled with the updated entries.

Data file compilation

The team identified the required data elements for the final PROTECCT-GLAM data file based on the available information shared by most GLAM data files and normalized the individual data files accordingly. The final data file included the following elements: a unique identifier, the original data source assigned identifier (if available), the original data source, the repository name, street address, city, state or territory, zip code, county or parish, repository type (each entry is assigned a primary and secondary type), latitude and longitude of the repository, the user id of who last updated the entry, and date of last revision.

Combined data file

Following the data normalization, the project team compiled all the data files into a single master file, resulting in 77,960 entries. The team conducted a final review to remove 4,602 duplicate entries. During the review process, the research team retained duplicate entries listed within both museum and archival repositories with the interpretation that the archival entry refers to the museum's archive. The final PROTECCT-GLAM data file includes 73,358 unique entries.

Analysis and results

After its creation for initial visualization and spatial analysis, the project team imported the dataset into ArcGIS Pro. The initial analysis focused on GLAMs most at risk for potential sea level rise by identifying all GLAMs located within 5, 15, and 30 kilometers of the U.S. coast. As noted in Table 1, a combined total of 16,877 GLAMs are within 30 km of the coast. The states with the highest number of GLAMs within 30 km are California (2,672), New York (2,566), Maryland (1,304), Florida (1,290), and New Jersey (1,159).

Repository Type	5 km	15 km	30 km
Archives	2458	3702	4740
Libraries	2054	3555	4625
Galleries & Museums	3915	5886	7512
Total	8427	13143	16877

Table 1. Number of GLAMs located within 30 km of a U.S. coast

Secondary analysis focused on the number of GLAMs per capita in each state using the 2020 U.S. census data. For this analysis, the per capita is reported at the per 10,000 level (see Table 2).

State	Archives	Libraries	Galleries & Museums	All GLAMs
ME	8.43	2.12	3.77	14.32
VT	3.19	3.23	4.20	10.62
ND	3.41	1.40	3.20	8.01
NH	1.44	1.86	2.42	5.72
IA	1.56	1.97	1.84	5.38
DC	1.74	0.65	2.42	4.81
NE	1.60	1.53	1.65	4.78
AL	2.95	0.73	0.83	4.51
WY	0.21	1.51	2.77	4.49
SD	0.19	1.85	2.36	4.40
KS	1.02	1.47	1.62	4.12
AR	2.25	0.90	0.95	4.09
MT	0.49	1.29	2.24	4.02
AK	0.33	1.45	2.07	3.85
NY	2.08	0.67	1.00	3.76
RI	1.43	0.77	1.49	3.69
WV	1.15	1.13	1.28	3.56
PA	1.60	0.65	1.15	3.41
MS	1.62	0.92	0.78	3.32
MA	0.94	0.83	1.37	3.13
NM	0.99	0.81	1.27	3.06
WI	0.78	0.92	1.34	3.03
OK	1.23	0.70	1.08	3.01
MN	1.02	0.82	1.10	2.93
MO	0.86	0.79	1.12	2.76
CT	0.29	0.79	1.38	2.45
LA	0.65	0.85	0.76	2.27
OH	0.46	0.77	1.04	2.27
ID	0.30	0.91	1.04	2.25
NC	0.91	0.52	0.70	2.14
MI	0.45	0.74	0.92	2.11
OR	0.25	0.66	1.18	2.09
IL	0.35	0.74	0.90	1.99
HI	0.34	0.50	1.10	1.94
SC	0.63	0.56	0.69	1.88
VA	0.30	0.56	0.98	1.84
DE	0.15	0.47	1.21	1.84
IN	0.12	0.77	0.91	1.81
GA	0.63	0.49	0.58	1.71
NJ	0.37	0.55	0.75	1.67
CO	0.09	0.59	0.99	1.67
KY	0.08	0.62	0.93	1.63
MD	0.23	0.41	0.93	1.57
WA	0.11	0.57	0.82	1.51
AZ	0.44	0.41	0.56	1.42
TN	0.16	0.54	0.70	1.40
TX	0.31	0.38	0.56	1.25
UT	0.26	0.48	0.46	1.21
CA	0.08	0.40	0.61	1.09
FL	0.12	0.34	0.48	0.94
NV	0.02	0.34	0.50	0.86

Total	**0.68**	**0.64**	**0.90**	**2.21**

Table 2. Number of GLAMs per 10,000 people in each state

Conclusion and future directions

The PROTECCT-GLAM project team successfully created a national dataset of GLAMs and conducted a preliminary analysis using ArcGIS Pro. Additional analysis will incorporate data on five variables, including hurricane wind occurrence & storm surge inundation, three feet of sea level rise, inland flooding occurrence, temperature exceeding 23-27^{0}C occurrence, and dew point exceeding 9.3^{0}C occurrence. The resulting data will be compiled into a five-point scale based on the average of the five variables for each GLAM.

Limitations

The information within the data file was based on external data files, and all associated limitations apply to the combined data file. Although the project team reviewed and updated data entries, the fluid nature of repositories inherently leads to out-of-date information. More importantly, community based GLAMs and those from underrepresented communities are not adequately included in the initial data file.

The PROTECCT-GLAM project team will address these limitations by openly distributing the data file and requesting that GLAM community members submit missing institutions or revisions to included institutions via the project website.

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