Cartographic Perspectives

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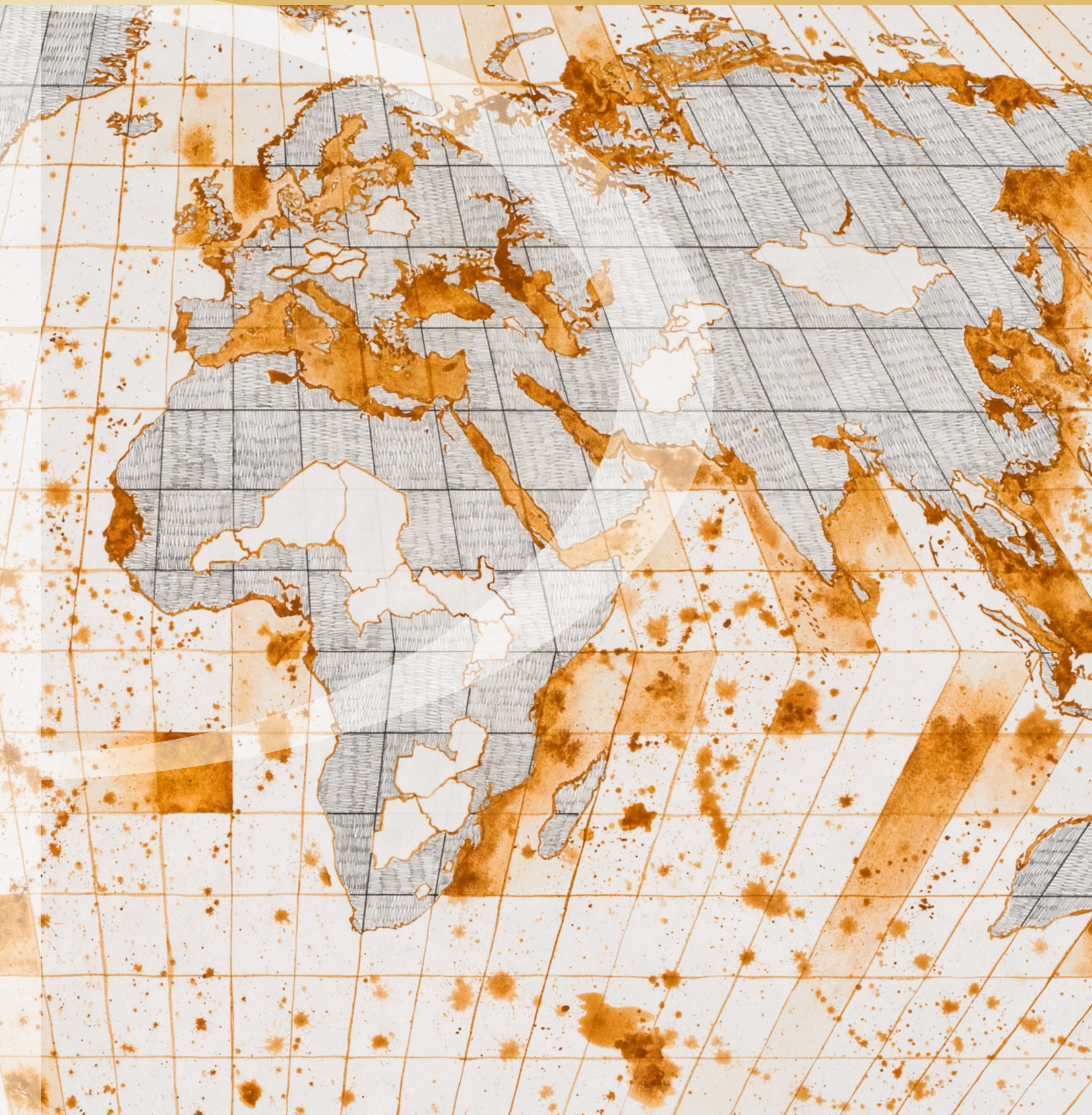
Number 85, 2016



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IN THIS ISSUE

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ABOUT THE COVER: *Detail from Tracey Clement's* Drowned World: Eckert Projection. *See* VISUAL FIELDS*, starting on page 33 for more.*

LETTER FROM THE EDITOR

One of the things I love about NACIS as an organization is that it draws in cartophiles from all corners of the mapping world, ranging from the technical to the artistic, including practicioners working in academia, government, and industry. Just as importantly, it provides a genuinely supportive space in which students can develop and learn. This is of utmost importance to our discipline and organization, as students are, in very real terms, our future. NACIS was the first professional organization that nurtured my own cartographic interests and this, I think, played an important role in my continued involvement with the community as my career developed, and in the benefits I've derived therefrom.

One of my goals as editor is to make sure that this supportive space extends to our journal so that students feel both welcome and encouraged to submit their work to one or another of our many sections. The majority of the content in *CP 85* comes from either current or very recently graduated students, so I hope this is evidence that we have made a good start in that regard. If you are a student who is reading this editorial and this issue of the journal, I hope that you might imagine submitting your own work to the journal.

Consider writing a peer-reviewed article about the research you are working on for your thesis; we even have a yearly prize to recognize the best student paper published in each year. My predecessor, Pat Kennelly, was instrumental in establishing this award. All you have to do to be considered for the award is to submit your article and have it accepted for publication in the journal; on that note, check out Joel Radunzel's **winning article** from 2015.

Or, if you're more practically minded, have you developed a new workflow for achieving a particular cartographic effect? You can share your experience in the *PRACTICAL CARTOGRAPHER'S CORNER*. If you are a graduate teaching assistant and you've found a good method for explaining a concept or technique, share that knowledge with us in the *VIEWS ON CARTOGRAPHIC EDUCATION* section. Those of you lucky enough to have jobs that keep your noses deep in a map library's treasures might consider suggesting to your supervisor that you profile some of your library's most interesting pieces in a *CARTOGRAPHIC COLLECTIONS* article. If you've got an artistic bent, share your beautiful creations in *VISUAL FIELDS*. Finally, if there's a book you'd like sitting on your own shelf, consider writing for our *REVIEWS* section. Any one of our section editors would be happy to support you in developing a contribution.

As this is the last 2016-dated issue of *CP*, I would like to take this opportunity to thank the following individuals who generously provided their time and expertise this publication year in reviewing manuscripts for the peer-reviewed section of the journal. The peer review process is critical (pun intended) for helping authors to improve the clarity of their thinking and the communication of ideas presented in their papers. It is exceedingly rare for a manuscript to be accepted without revisions, and the collective thinking that the peer review process harnesses helps all of our authors to improve their contributions.

Ola Ahlqvist
Natalia Andrienko
Roger Beecham
Sébastien Caquard
William Cartwright
Lorenz Hurni
Christoph Kinkeldey
James Kuiper
Mark Monmonier
Ian Muehlenhaus
Tom Patterson
Margaret Pearce
Amy Rock
Robert Roth
Sasha Savelyev
Denis Wood

In *CP 85*, you will find a peer-reviewed article by Carolyn Fish and Kirby Calvert. Their piece presents a competitive analysis of the functionality and design of urban-scale solar energy web maps that are used to assess the solar potential for an individual building. Such maps provide access to information that is important for potential solar system buyers to assess the cost-benefit balance of installing a system in a particular location. They identify best practices for solar energy web map design as well as offer suggestions for implementing additional solar planning tools that might support solar energy installation decisions among not only individual building owners, but also policy makers and utility operators.

In the *practical cartographer's corner*, Owen Stuckey presents a comparison of tools for creating cartographic animations of time series data in two commonly used GIS programs, ArcGIS and QGIS. His comparison found that while most animation types could be created in both tools, there are time and cost trade-offs. Whereas ArcGIS might be a preferred tool for working with large, frequently updated datasets, the simplicity of QGIS might be preferable for one-off animations.

In *visual fields*, Tracey Clement discusses her *Drowned World* map series, which represents sea level rise of 70 meters on the Earth's landmasses. She uses the properties of particular map projections, as well as an unusual material—rust—to focus the reader's attention on the implications of our actions for specific locations. An included time-lapse video provides an additional window into Tracey's artistic practice.

Four book *reviews* round out *CP 85*. Daniel Cole reviews Pinde Fu's book, *Getting to Know Web GIS*, published by Esri Press. Ann M. Hanlon provides an informative assessment of the strengths of *Abstract Machine: Humanities GIS*, by Charles B. Travis. Fábio Gil Rodrigues reviews Anette Miae Kim's book, *Sidewalk City: Remapping Public Space in Ho Chi Minh City*, which is about public place analysis, and which draws upon ideas from critical cartography. Finally, Mark Denil highly recommends Karl E. Ryavec's *A Historical Atlas of Tibet*.

Amy L. Griffin
Editor, *Cartographic Perspectives*

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Analysis of Interactive Solar Energy Web Maps for Urban Energy Sustainability

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Maps and geographic information systems (GIS) have become vital tools for decision-making, communication, and outreach in the domain of urban energy sustainability. One emerging example involves interactive online maps that allow users to assess rooftop solar energy potential on a building of interest. These maps are interesting in two ways: they are new forms of technology in and of themselves, and they have only become relevant with the changes in renewable energy technologies that allow individuals to participate in this new economy of energy production. The purpose of this study is to describe and analyze the cartographic representation and functionality of urban-scale solar energy maps in the United States. Using competitive analysis, we assess twelve interactive online maps to understand their: (1) design, (2) usage of visual variables and interaction operators, and (3) content, purpose, and goals. Across these three types of assessment, we find both a wide variety as well as some consistent themes. Our results also show that some maps followed cartographic conventions (Brewer 2016; Slocum et al. 2009) while others did not. Through our analysis we develop a set of best practices that can be used to improve the effectiveness and widen the functionality of online solar energy maps. In particular, we make recommendations on how to develop future online, interactive renewable energy maps in a way that keeps the end user in mind while communicating relevant information to a broader range of stakeholders involved in urban energy sustainability (homeowners, utility operators, city officials, and urban planners).

KEYWORDS: web maps; urban planning; solar energy; content analysis; competitive analysis

INTRODUCTION

Maps and geographic information systems (GIS) have become vital decision-making, communication, and outreach tools for local decision-makers. Advancements in interactivity and data sharing have improved their ability to generate and disseminate knowledge. An emerging application domain for maps and GIS is energy sustainability planning, which has two broad dimensions. One involves mapping the types and quantity of urban energy consumption to target energy efficiency investments and policy efforts (Webster et al. 2013). The second involves mapping renewable energy potential to identify and manage issues related to new forms of energy generation (Calvert et al. 2013; Resch et al. 2014). The former dimension is familiar to urban stakeholders, while the latter is a new domain to them; only recently have renewable energy technologies advanced sufficiently that these stakeholders can now participate directly in energy production. Energy sustainability planning web maps need to be designed for a public audience but provide complex information and calculations to their users.

Advancements to photovoltaic (PV) technologies are re-configuring stakeholder relations and bringing new social and technical challenges and opportunities to cities. Prospective developers now search within cities for PV electricity generation opportunities located near demand centers. Initially due to government incentives and now due to falling costs, homeowners find the PV business case to be compelling and are interested in becoming electricity producers as well as consumers (so-called "prosumers"). Both of these groups are primarily interested in site-specific production potential and the economic performance of PV systems, called *solar potential*. Solar potential is defined as the amount of solar energy that reaches a surface over a defined time interval influenced by terrain, shadows, and atmospheric factors on a surface (called solar irradiance), limited by the efficiency of the technology available to convert it into usable energy (Angelis-Dimakis et al. 2011). As these technologies become easier to install, utilities, willingly or not, need to adapt their infrastructure and operation practices to accommodate these new forms and sites of generation; they are interested in where new generation is likely to emerge and how power flows through the city will be affected. At the same time, urban planners must consider potential zoning issues to manage system siting and access to solar resources. City officials, meanwhile, have the responsibility of ensuring that PV development does not exacerbate, and perhaps even helps to improve, existing issues within the city such as poverty, environmental injustice, and cultural heritage.

Interactive web maps have the potential to facilitate and perhaps coordinate informed decisions within and between these stakeholder groups. Indeed, urban-scale energy resource mapping has become increasingly common, marked by the rise in online energy maps in cities across the world (see Kanters et al. 2014), as well as through growing literature on the subject (e.g., Calvert et al. 2013; Resch et al. 2014; Freitas et al. 2015). Studying best practices in terms of map design and functionality is critical to improving the decision-making and outreach capacity of these tools and, in turn, to providing urban stakeholders with the tools they require to facilitate the transition to renewable energy in a rapid and responsible way.

The purpose of this study is to describe and analyze the cartographic representation and functionality of available solar energy web maps developed by and for cities within the United States. We have two main objectives: first to add to the literature on cartographic design, representation, and interactivity of publicly available interactive maps using competitive analysis; second, to contribute to the literature and practice of energy geography and planning through benchmarking the development and use of geospatial technologies in urban-scale PV production. Our results are based on an analysis conducted in June 2016. We conclude by identifying "best practices" from which to establish guidelines and future areas of research that might improve the development of urban energy maps.

BACKGROUND

Generally speaking, research in energy mapping has focused on the development of spatial decision support system (SDSS) tools (e.g., Calvert et al. 2013; Resch et al. 2014) at the expense of studying the tools themselves. This is especially the case for urban solar energy. The most recent review of SDSS development by Freitas et al. (2015) examines the data and models used to develop urban-scale solar energy maps. Although critical to building effective maps, they do not focus on cartographic representation or functionality for the user. Kanters et al. (2014) provide the only review of front-end components of solar energy web maps, comparing them in terms of content displayed to the user: for example, the range of solar energy technologies considered by each map, or the land-use and land-cover categories used to limit the location of solar PV systems. In these studies, maps were assessed from an engineering and economic perspective. There is need to expand on these analytical approaches, and to evaluate the capacity of online solar energy maps to facilitate informed decisions by also taking into account how the tools make information available to the end user.

One method to achieve this is competitive analysis, which is often used to evaluate currently available software, hardware, or web products to inform future designs and to identify best practices. A competitive analysis is designed to be the first step in understanding services across a range of products. The results of this type of analysis can provide "ad hoc guidelines for approaches that seem to work and others that should be avoided" (Nielsen 1992, 14). Within cartography, Roth et al. (2015) used this method to evaluate currently available web maps for assessing sea and lake level differences, with the goal of examining best practices to create a map of their own.

This study also draws on content analysis, a systematic approach used to examine and compare modes and symbols of communication (Rose 2012). Content analysis relies on identifying a set of codes (Krippendorff 2013). These codes offer a systematic lens through which to examine a common set of themes. Ideally, once the codes are determined, anyone trained in the coding scheme will be able to assess the same sample set or apply the codes to a new sample

(Muehlenhaus 2010). Content analysis, however, does not allow the analyst to understand why the map was designed in a particular way or how a map reader cognitively encodes the information presented (Lutz and Collins 1993).

Content analysis has become a popular method in cartographic research, beginning with Edsall (2007), who used it to evaluate "maps in the wild" that had impacts on political discourse in the United States. He was followed by Muehlenhaus (2013), who used content analysis to evaluate the propagandist nature of political maps. Additionally, Muehlenhaus identified the appropriate use of visual variables, widely viewed as the building blocks of cartography, across his sample (Bertin 1983; MacEachren 1995). Kessler and Slocum (2011) were the first to use content analysis to compare cartographic design. They evaluated how design has changed and whether map design improved during the 20th century. The codes used in their study were derived from cartographic guidelines outlined in Slocum et al. (2009). Their analysis evaluated cartographic representation elements including: the title, legend, projection used, visual hierarchy, symbology, lettering, basemap, inset maps, and scale. Our study used competitive analysis and is informed by past studies using content analysis. It not only describes the similarities and differences across different maps (i.e., benchmarking), but extracts best practices that should be considered for future map designs (i.e., establishing guidelines).

METHODS

This study applies competitive analysis in order to achieve three main goals:

1. evaluate the design of interactive online solar energy maps;
2. assess the usage of their visual variables and map interaction operators; and
3. analyze the content, purpose, and goals of each map related to facilitating planning of potential rooftop solar projects.

We assessed the design of cartographic representation and map interaction in twelve interactive solar energy web maps (Table 1). Maps were included in the sample if they illustrated installed solar energy systems and/or allowed an individual to calculate solar energy potential. All of the maps were large-scale maps of urban or suburban locations in the United States. Additionally, all of the maps assessed in this study are web maps (e.g., not a static map such as an image). Three of the maps were developed in the now-outdated ActionScript for Flash developed by Adobe. The other nine were developed in JavaScript.

Of the twelve maps, two had the same design for multiple locations: Google Project Sunroof and Mapdwell Solar System. In these cases, the same design template was applied to multiple cities. We grouped these maps according to their developer, and assessed only one location each. The other ten maps were all designed for specific locales. Six of the maps were designed by Critigen. These were not considered to be one map as in the case of Google and Mapdwell, since Critigen's designs varied widely between cities. The remaining four maps were developed by local governments or local nonprofits.

Five groups of codes were developed for this study to assess: (1) map design, (2) use of visual variables, (3) use of map interaction operators, (4) the capability to allow a user to assess the solar potential of a particular building, such as

Map Name	Developer
Google Project Sunroof	*Google*
Green Riverside	*City of Riverside*
LA County Solar Map	*Critigen*
MadiSUN Solar Energy Map	*Critigen*
Mapdwell Solar System	*Mapdwell*
Metro Orlando Solar Map	*Critigen*
New Orleans Solar Calculator	*Critigen*
New York City Solar Map	*Sustainable CUNY*
Salt Lake Solar Map	*Salt Lake City*
San Diego Solar Map	*Critigen*
San Francisco Energy Map	*Critigen*
Tallahassee Interactive Solar Map	*City of Tallahassee*

Table 1. *Solar energy maps in the United States evaluated in this study.*

their own home, and (5) ability to view information about currently installed systems. With the exception of the first code group (map design), which used a Likert scale to rate design quality, these codes were primarily qualitative and assessed the presence or absence of a particular visual variable, map interaction operator, or capability. Code groupings 1 and 2 enabled an assessment of maps according to cartographic principles, while code groupings 3–5 enabled an assessment of the efficacy of the tools to facilitate and coordinate informed planning decisions within and between urban stakeholder groups.

Two independent coders trained in the coding scheme assessed each map based on the first three code groups. Before coding, they discussed the codes, and agreed on code definitions based on the cartographic literature. Code groups 4 and 5 were assessed by a single coder. Only one coder was necessary here because these were simple assessments of the presence and absence of content afforded to the user and did not require any triangulation of interpretation.

MAP DESIGN

To assess the adherence of the maps to cartographic principles, we began with the codes outlined by Kessler and Slocum (2011) and updated them for the purpose of this study. Because their study focused on static maps, while ours focused on interactive maps, some codes were removed while others were added. The codes for evaluating the design of the maps are shown in Table 2. Because the

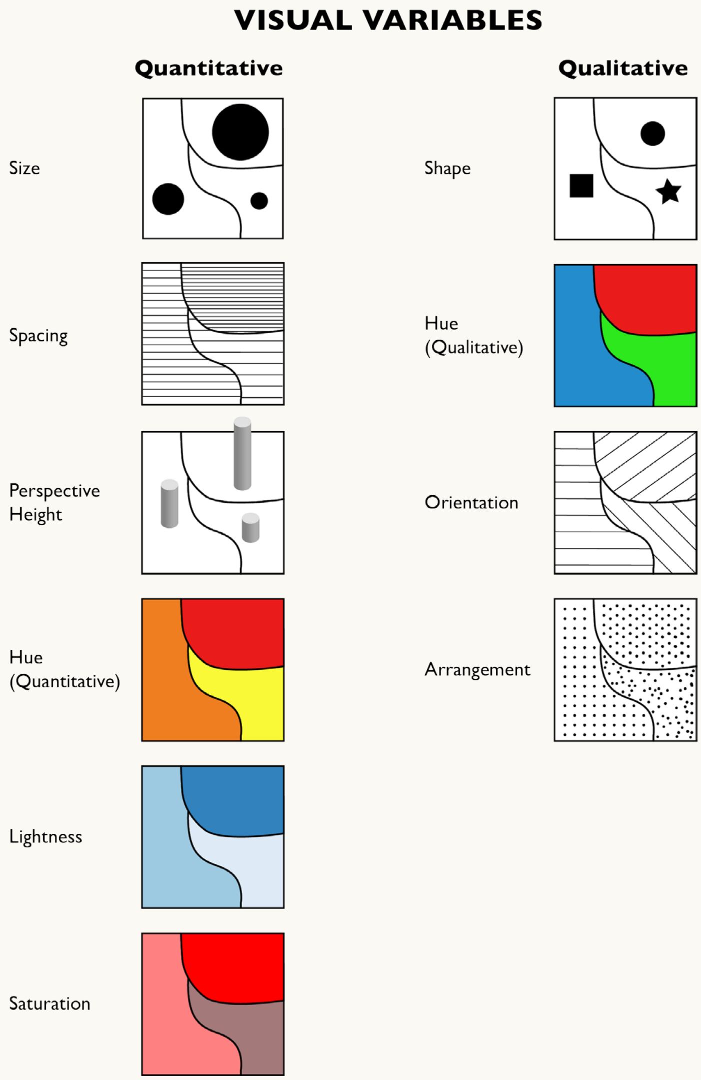

Figure 1. *The visual variables (based on Slocum et al. 2009).*

Code	Explanation
Symbology Design	*Logical design decisions were made (e.g., a logical progression of colors was used).*
Visual Hierarchy	*The map has suitable visual hierarchy. Is thematic information emphasized over basemap information? Is there a suitable hierarchy for marginalia elements?*
Symbology Coordinates with Basemap	*Does the thematic information coordinate with the basemap in terms of color harmony and readability?*
Readability	*Is the lettering and other text readable?*
Legend Design	*Is the legend clear? Does the legend account for all of the symbology on the map?*
Splash Page	*Is the splash page useful and aesthetically pleasing?*
Tutorial	*Is there a tutorial? Is it useful? Is it aesthetically pleasing?*
Pop-ups/Sidebar	*If there are popups or a sidebar, are they useful and well designed?*

Table 2. *Codes for design assessment.*

codes were applied using a nine-value Likert scale, the scores from the two coders were averaged into a single assessment. The two coders were both trained in cartographic design principles (e.g., Brewer 2016; Slocum et al. 2009) and assigned codes based on Kessler and Slocum's (2011) similar study. Some of the codes allowed "not applicable" as a potential code when a particular element was not present in the maps. Applying a code of "not applicable" was based on unanimous agreement among the coders.

VISUAL VARIABLES

The visual variables, first described by Bertin (1983), are seen as the building blocks of cartographic representation. There are nine widely accepted visual variables. The variables of hue, saturation, and lightness all are color variables, while the other six variables are: size, shape, spacing, orientation, arrangement, and perspective height (Figure 1; Slocum et al. 2009).

The coders independently coded for the use of the visual variables. A variable was coded as being included in the map only if used to depict thematic content (e.g., solar energy potential); if not used, or used only in the basemap, the variable was coded as being excluded. Any differences in the coding of the visual variables were discussed until a consensus agreement was made on the presence or absence of the visual variable.

INTERACTION OPERATORS

The interaction operators are the counterparts to the visual variables for interactive maps. There are seventeen interaction operators (Table 3; see also Roth 2013). Understanding which operators are consistently used across a specific type of map can illuminate to the cartographer or web designer what types of interactivity are expected by users, and which interactions are useful to developers and designers.

Independently, the coders examined each of the maps, assessing which operators were included in the map or interface design. Following the coding, the coders assessed agreement and discussed differences. Any differences were reevaluated jointly until the coders came to consensus about their usage.

Code	Explanation
Import	*Load a dataset into a map*
Export	*Produce a map for use outside of the visualization*
Save	*Store the changes a user may have made in a visualization for later use*
Edit	*Alter the data underlying the map*
Annotate	*Add markings or text to the map or map interface*
Reexpress	*Change the type of thematic map used to display the data*
Arrange	*Rearrange the location of the views in a coordinated view*
Sequence	*Produce maps in sequence, such as small multiples*
Resymbolize	*Alter symbolization (e.g., change colors, adjust classification scheme)*
Overlay	*Reorder or toggle layers (similar to a GIS table of contents)*
Reproject	*Change the map projection*
Pan	*Change the center location of the map*
Zoom	*Change the scale or resolution*
Filter	*Query the map to show only the results from the query*
Search	*Enter a specific term to identify an answer (e.g., search for an address in a map)*
Retrieve	*Identify details by clicking or brushing over contents of a map (e.g., a popup display)*
Calculate	*Compute an answer based on an input*

Table 3. *Interaction operators (from Roth 2013).*

DECISION-SUPPORT AND SYSTEM ASSESSMENT FUNCTIONALITY

The maps in this study allowed users to assess solar potential (a planning task), retrieve information about currently installed systems, or both. As such, two sets of codes were

Code	Explanation
Solar Surface	*Shows a surface of solar irradiance either across the whole map or on rooftops*
Assess Potential by Address	*Allows user to assess potential for PV by entering an address*
Draw Potential System	*Allows user to draw a polygon in the location and shape of a potential solar system*
Click on Building for Potential	*Allows user to click directly on a building to get solar potential for that structure*
Assess Cost or Savings	*Allows user to assess the cost or savings of a system once they have clicked on a building or drawn a polygon*
Assess Production Potential	*Allows user to view the production potential of a system once they have clicked on a building or drawn a polygon*
Assess Environmental Benefits	*Allows user to assess the environmental benefits of a potential system once they have clicked on a building or drawn a polygon*
Savings Based Planning	*Allows user to determine how much they want to save in order to plan their potential system*
Investment Based Planning	*Allows user to determine how much they want to invest in order to plan their potential system*
Generates Report for User	*Gives the user a report they can print and possibly show to a solar installer*
Connect to Solar Installer	*Connects the user with potential solar installers in the area*

Table 4. *Solar Planning assessment codes.*

Code	Explanation
View Installed Systems	*Allows user to view locations and information about currently installed solar systems located within their location*
Size (kW)	*The kW size of the installed system*
Output (kWh/year)	*The energy output per year for an installed system*
Cost	*The cost of the installed system*
Savings	*The yearly or monthly savings of an installed system*
Installer	*The installer of the solar system*
Add System to Map	*Allows the user to add their own solar system to the map via a web form*

Table 5. *Assessment codes for Viewing Current Solar Systems.*

developed. The first assessed solar potential by rooftop (Solar Planning assessment codes, Table 4). These codes were designed to understand the extent to which tools could facilitate informed decisions. Toward this end, we paid particular attention to the range of criteria that would influence decisions (e.g., cost, savings, production potential, and environmental benefits) and how information is calculated (e.g., ability to draw a potential system on a rooftop, or print out a report for a solar installer).

The second set of codes related to assessing the geographic distribution of currently installed systems (Viewing Current Solar Systems codes, Table 5). Understanding the spatial distribution and other factors about currently installed systems may encourage potential PV buyers to invest in a system. For this, we developed a set of codes to assess the capability to provide relevant information about where other solar PV systems had been installed throughout the city, the name of the installer, and the size of the installed system. Additionally, some maps allowed users to submit information about their own system as a form of data crowd-sourcing.

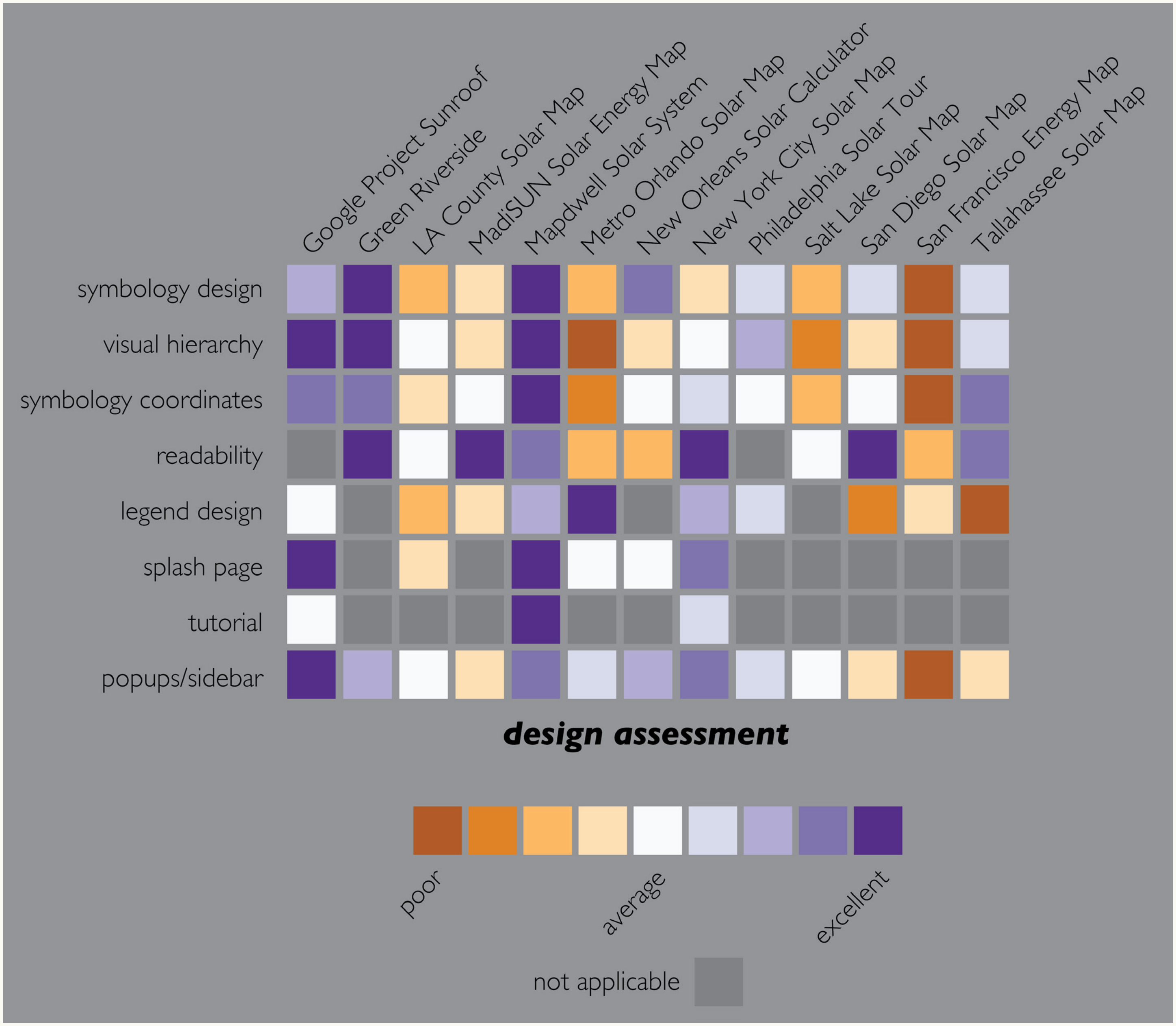

__Figure 2.__ Design code scores.

RESULTS

MAP DESIGN

The design of the maps varied across the sample (Figure 2). Some maps had consistently high scores across the design codes (e.g., Mapdwell Solar System [Figure 3] and Google Project Sunroof), and some scored consistently poorly across the design codes (e.g., San Francisco Solar Energy Map). Ideally a map would perform well across all codes. Many of the maps in the sample had a mix of high and low scores. For example, the Metro Orlando Solar Map scored poorly on the design of the actual map

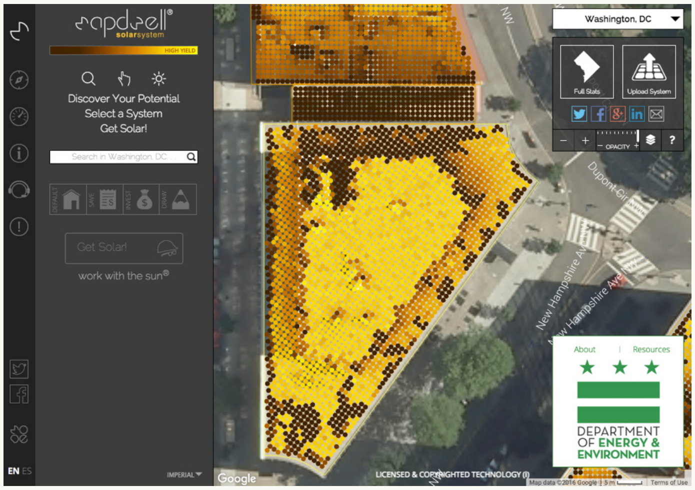

__Figure 3.__ The Mapdwell Solar System scored very well on the design codes.

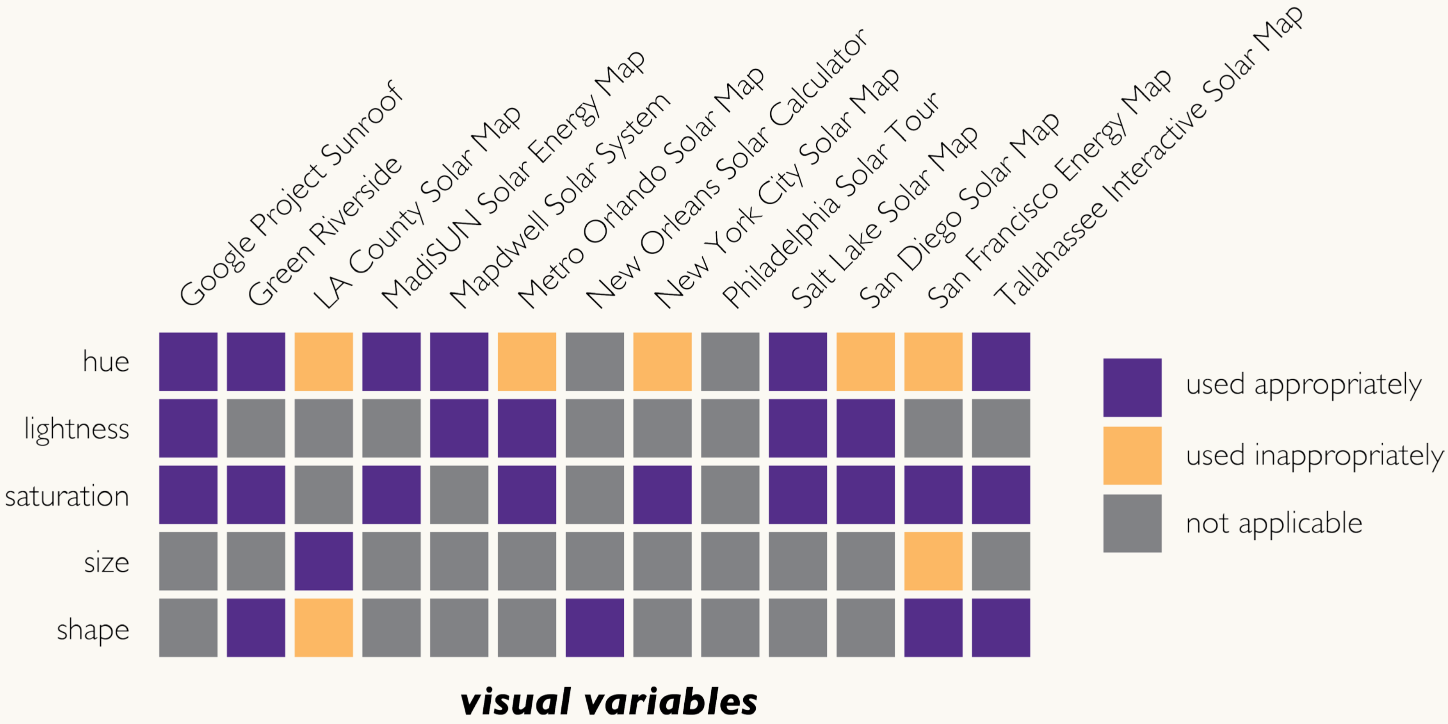

Figure 4. Usage of the visual variables. Several visual variables (spacing, orientation, arrangement, and perspective height) were never used and thus are not shown.

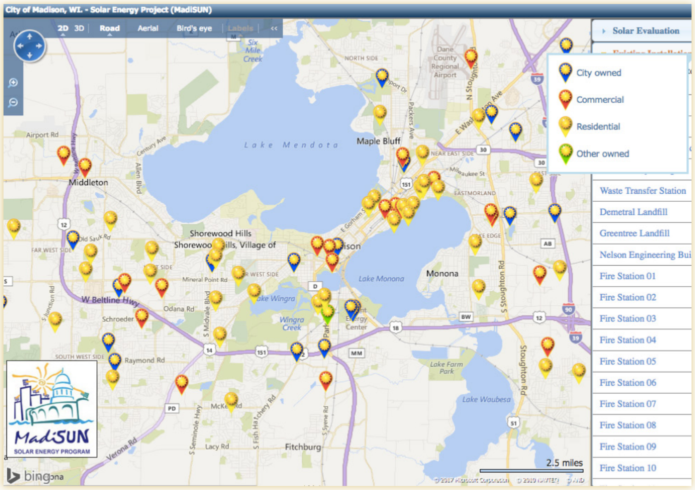

Figure 5. In the MadiSUN map, hue (qualitative) is used to illustrate differences in the ownership of solar installation projects.

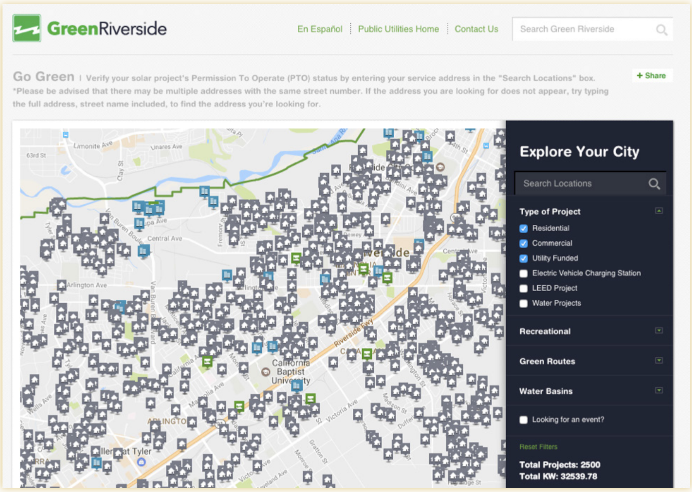

Figure 6. The Green Riverside map uses shape and hue (qualitative) to illustrate the different types of solar installations in the city.

(symbology, visual hierarchy, symbology coordinates with basemap, and readability); however, the legend and other marginalia were well designed.

VISUAL VARIABLES

Understanding how the visual variables are used in a set of maps helps to identify what elements are necessary or expected in a map (Figure 4). The most commonly used visual variable was *hue* (n=11). Hue is useful for illustrating both qualitative and quantitative data; however, when used for quantitative data, it needs to imply order through the colors. Six of the maps used hue appropriately (e.g., Figure 5), while five of the maps did not. When hue was used incorrectly it was through the use of color schemes that did not imply order while illustrating quantitative data (e.g., spectral color schemes or random color choices). *Lightness* is a quantitative visual variable and was used appropriately in all cases. In some of these cases, it was used in isolation and in others it was used with hue to redundantly illustrate differences. *Saturation* is a difficult visual variable to parse out from the other aspects of color and was only used redundantly with hue or lightness. On five maps, point symbols marking currently installed solar systems used the variable *shape* to designate different types of installations, sometimes in combination with hue as a redundant visual variable (Figure 6). Two maps used *size*. Though it is a quantitative visual variable, on the San Francisco Energy Map size was used to illustrate a qualitative difference: types of solar installations. On the LA County Solar Map, size was used in combination with hue as a redundant visual variable to illustrate rooftop solar irradiance. In this case, it was used correctly to show quantitative differences.

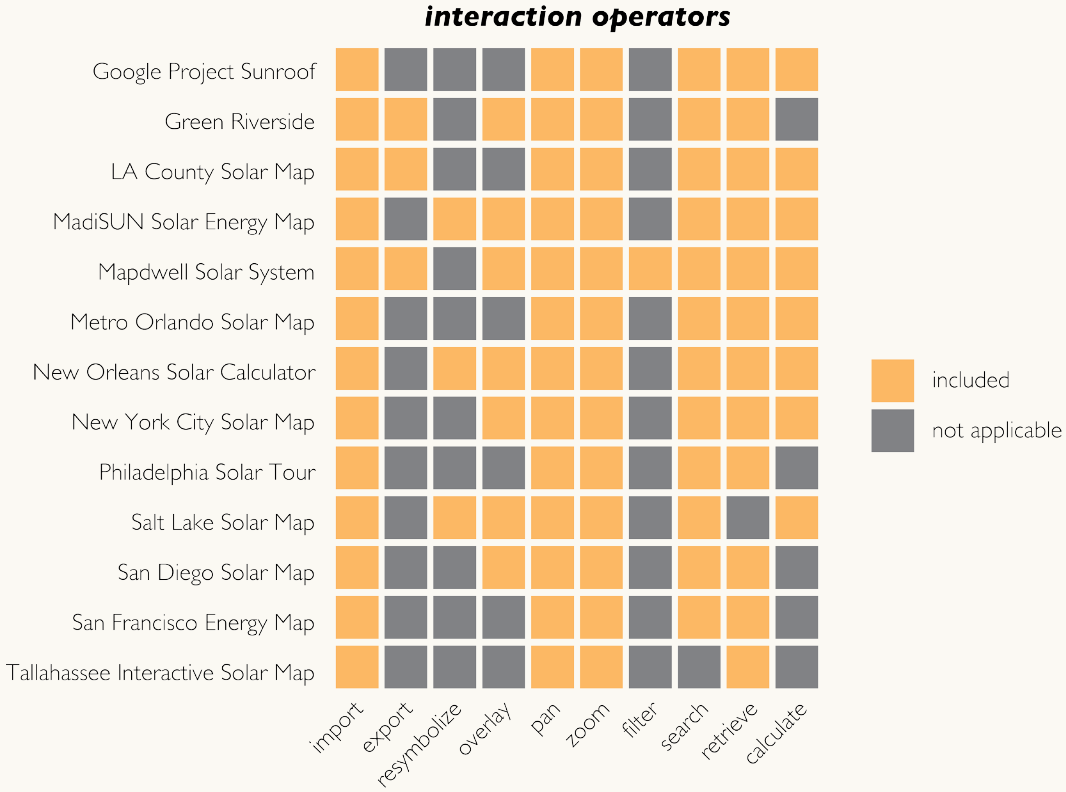

Figure 7. Usage of the interaction operators. Several interaction operators (save, edit, annotate, reexpress, arrange, sequence, and reproject) were never used and thus are not shown.

INTERACTION OPERATORS

The results from the assessment of the interaction operators are illustrated in Figure 7. The interaction operators *import*, *pan*, and *zoom* were used in every web map analyzed in this study (n=12). The *search* and *retrieve* operators were each used in all but one of the maps (n=11): the Tallahassee Interactive Solar Map did not have a search box, and the Salt Lake Solar Map was the only map to not use the retrieve operator (often a mouse-over or click resulting in more information in the form of a pop-up or sidebar).

The *export* operator was only found in three of the maps in the study, typically generating a downloadable report that the user could bring to a solar installer for more information. *Resymbolize*, in the form of an opacity change, was used in three of the maps. More than half of the maps allowed for the *overlay* operator (n=7). In most cases this operator was used to toggle the display of a solar irradiance surface. In the remaining cases, all of the layers had a toggle function that acted much like a traditional desktop GIS's table of contents. The *filter* operator, allowing the user to filter the visible results based on their own input, was found only in the Mapdwell Solar System. Finally, the *calculate* operator was used in eight of the maps (e.g., Figure 8), typically for calculating solar potential for a rooftop.

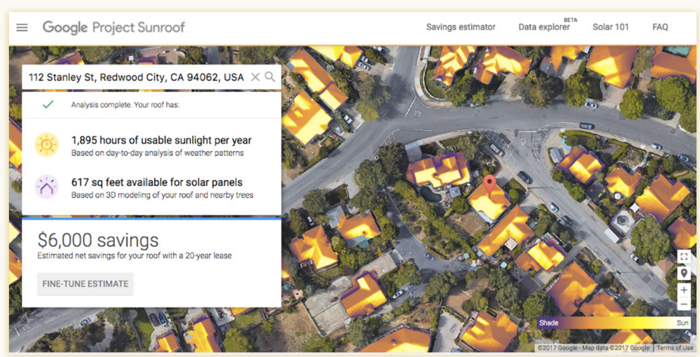

Figure 8. Google's Project Sunroof allows users to calculate their own solar potential by searching for an address.

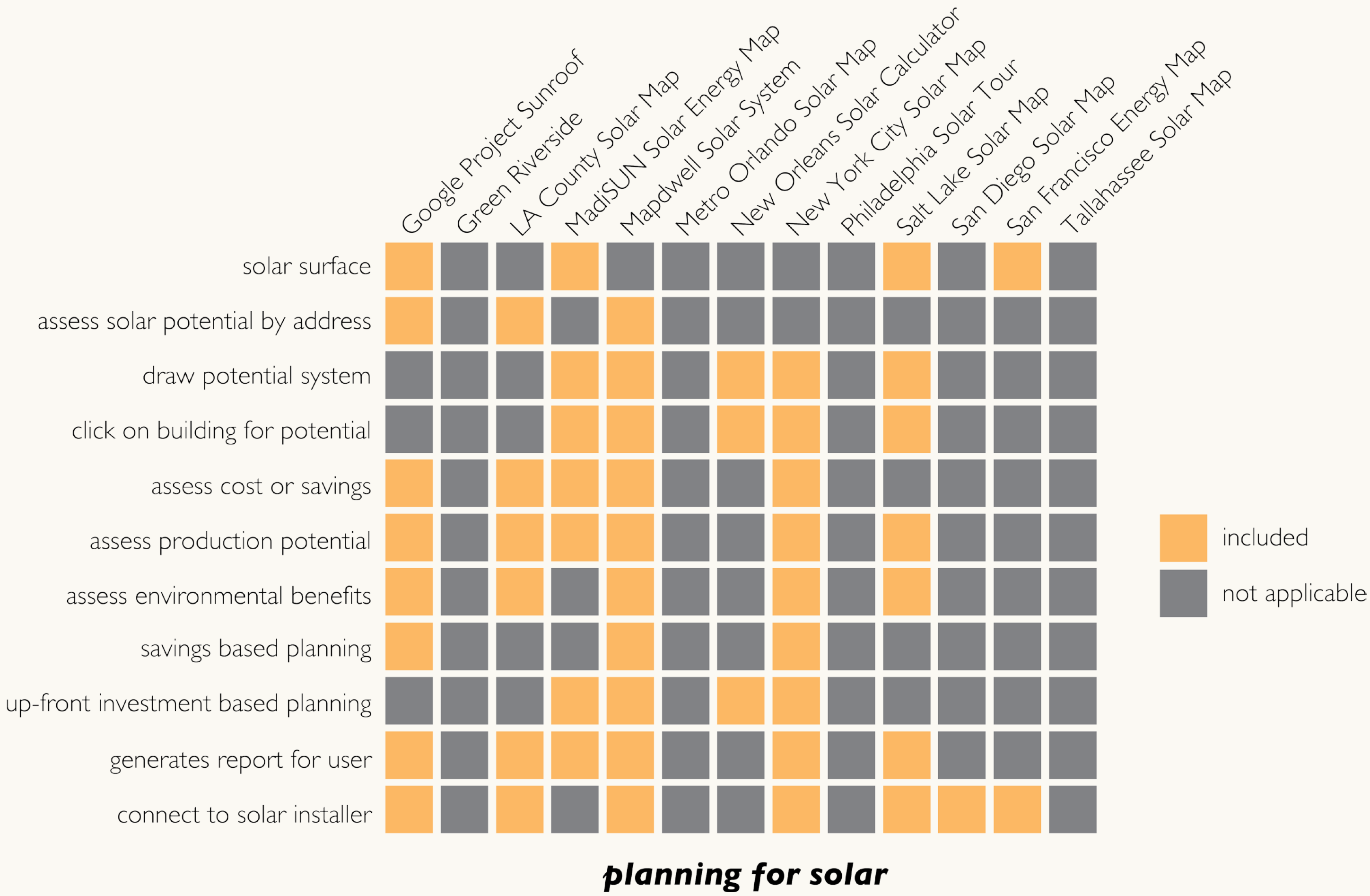

__Figure 9.__ Results of the Planning for Solar assessment. Note that this study did not investigate how irradiance was calculated.

PLANNING FOR SOLAR

In allowing a user to calculate solar potential on a rooftop, a map may prompt a user to realize the economic and environmental benefits of installing solar PV systems. We analyzed the twelve maps for their capability to allow users to assess solar potential for a rooftop (Figure 9). Across the sample, the maps afforded users several means by which to do so. Four maps provided the user with a *surface of solar irradiance* (Figure 10). In three maps, the user could *assess solar by address* by entering an address and receiving a calculated assessment of PV potential. The *draw* code assessed whether a map afforded the user a tool to draw the ideal size and location for solar PV on a rooftop (Figure 11). This functionality was found in five maps, which then calculated PV potential for the user-drawn polygon. These same five maps also afforded users the option to simply *click* on a structure and calculate PV potential for an entire roof area.

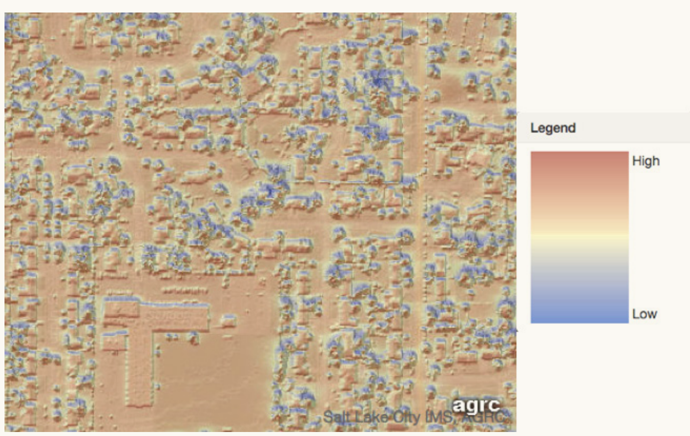

__Figure 10.__ The Salt Lake Solar Map, illustrating the solar irradiance across the entire city.

A number of the maps provided users with potential cost ($), savings ($), production (kW), or environmental savings (CO_2 reductions) after they either searched for an address, clicked on a building, or drew a potential system on a rooftop. Five maps allowed users to *assess potential costs and savings* of systems they searched for or drew. Six maps provided estimates on *production potential* in kW. This is a useful metric because it does not require the developer to account for the changing prices of energy. Finally, five maps afforded the user the ability to understand the *environmental benefits* of their potential installation in terms of reduced CO_2.

Some maps in the sample were designed to allow the user to input their desired *potential savings* (n=3), *up-front investment* (n=4), or both (n=2), instead of simply being given information based on their search or drawing. Savings-based planning allowed users to indicate the amount they wanted to save in order to identify the system size needed, and in some cases (e.g., Mapdwell), the roof location to get them the best "bang for their buck." In the case of tools that focused on up-front investment, users could type in the amount they wanted to spend and the system calculated the size that was possible under that budget constraint. This type of functionality is different than assessments of savings, cost, production, or environmental benefits in that it does not force the user to draw first and assess cost and savings second: users can tell the tool how much they can afford or how much they want to save in order to find out what type of system they might be able to install.

In helping users make the next step towards installation of a rooftop PV system, several tools *generate a report* to bring to a solar installer or to share with others (n=6), and/or

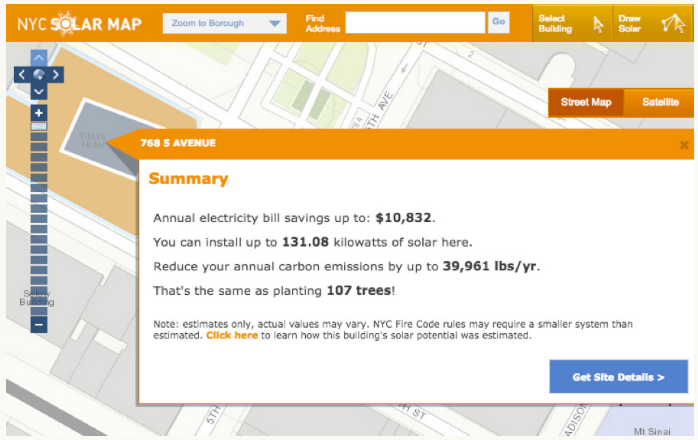

Figure 11. The New York City Solar Map's calculations after drawing a potential system with the draw tool.

connect users to solar installers in their area through hyperlinks located in the web map (n=7).

CURRENT SYSTEMS ASSESSMENT

The results from the current systems assessment are illustrated in Figure 12. Of the maps in the sample, nine maps provided users with the capability to *view currently installed systems* in terms of the *size* of the system in kilowatts (e.g., Figure 13). Significantly fewer of those, only three, provided insight into the total *output* over the course of the year. Only one map provided the *cost* (Metro Orlando Solar Map), while one showed the *savings* (LA County Solar Map) of the installed systems. Several maps (n=6) provided users with the name of the *installer*. Since users may want to understand more than simply where currently installed systems are located, cost, savings, and installer may be important factors for potential future prosumers. Finally, five maps provided users the ability to *add their own system* to the map.

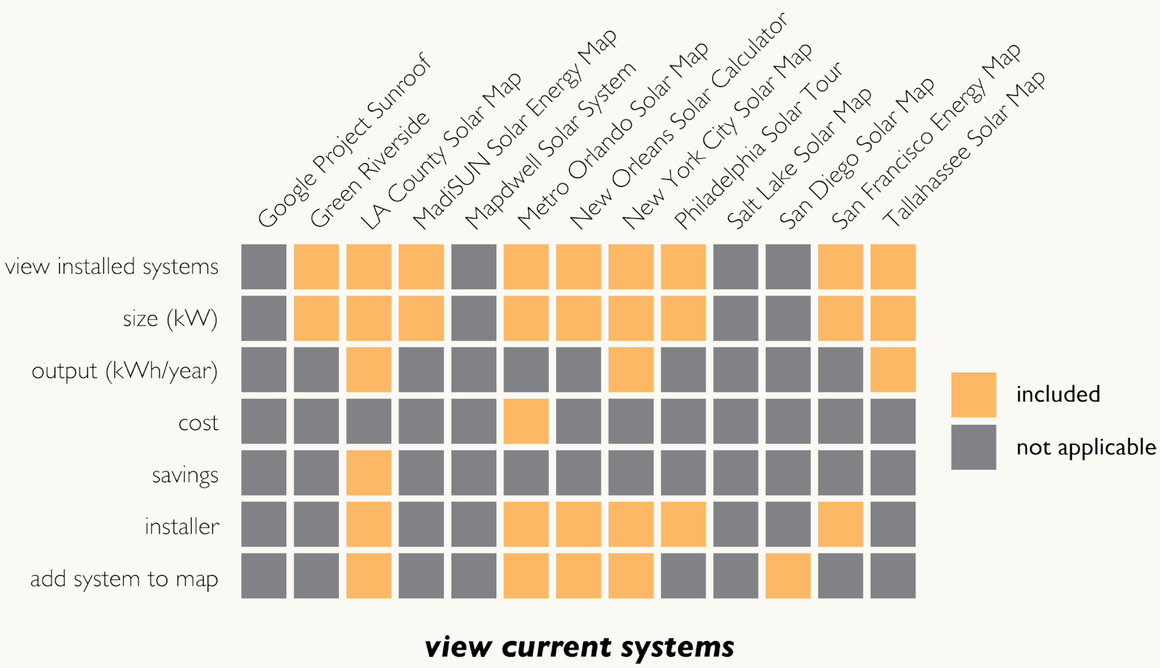

Figure 12. Assessment results for the Viewing Current Solar Systems codes.

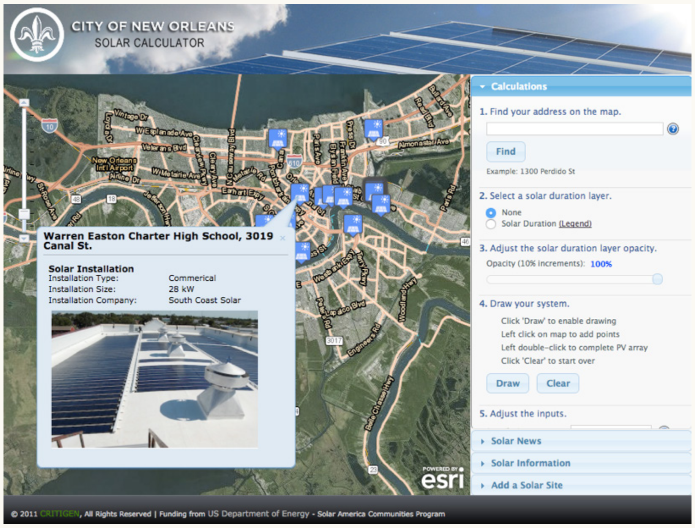

Figure 13. The New Orleans map allows users to explore information. This map also allows users to input parameters to calculate their own solar potential.

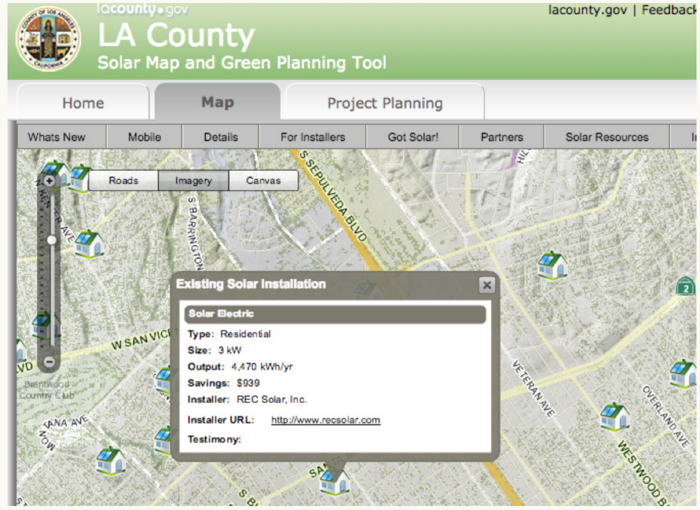

Figure 14. The LA County Solar Map provides users with a large amount of functionality to understand currently installed systems in the area.

The LA County Solar Map scored best on providing users with information about current systems (Figure 14). While this map did not score well in the design codes described earlier, it afforded a lot of functionality for its users.

DISCUSSION: BEST PRACTICES FOR SOLAR ENERGY WEB MAPS

Solar energy web maps afford users the tools to assess PV potential in a rapid, meaningful way. The results of our analysis suggest that good map design and useful map functionality are not necessarily correlated: maps scoring high on design did not necessarily score high on functionality, and vice versa. Depending on intent of the map, adherence to particular functionality codes differed. Some maps focused on allowing users to calculate electricity production potential, while others focused on providing users a map of currently installed systems. Because both of these functionalities are useful in decision making, it would be helpful for future designs to have both capabilities. After analyzing maps for their adherence to codes, we identified several best practices.

MAP DESIGN

The codes identified in this research can act as guidelines for future interactive solar energy map designers (Table 2). Specifically, four codes are particularly useful to ensure these maps are well designed. These four codes are: symbology coordinates with basemap, readability, legend design, and design of the popups or sidebar.

Coordinating thematic and basemap layers is difficult. While this is not a new issue in cartography (e.g., Spiess 1970), with easily interchangeable basemaps now available in web maps, this is an aspect of design that cartographers need to consider when developing urban-scale spatial decision support systems. These interchangeable basemaps are often composed of annotated imagery, thus designing thematic layers that coordinate well with the underlying basemap is a primary determinant of design quality. The high level of detail and variety of colors found in imagery make it difficult to design thematic layers that contrast sufficiently. Often, simplified basemaps are suggested instead (Brewer 2016; Spiess 1970); however, in the case of solar energy web maps, imagery provides the resolution required to assess modeled results under real-world conditions (location, weather, etc.). It is also easy to use in common web mapping applications such as Google Maps. Thematic layers composed of highly saturated colors are often best with imagery because they stand out, despite the challenges they may offer designers. The Mapdwell Solar System product does the an excellent job of this, by coordinating highly saturated colors with a consistent color scheme. The San Francisco Energy map, on the other hand, scored poorly in this aspect, as there is little coordination between the visual hierarchy of the map layers, making each difficult to discern. How to design the visual hierarchy of maps where thematic layers are salient enough for effective reading (Fabrikant and Goldsberry 2005), without taking away from the visual aesthetics or beauty of the map is an active question in cartographic research (Kent 2005).

Readable text and good legend design are important on both static and interactive maps. Ensuring type is readable across all cases of interaction with a web map is presently a challenge for cartographers (Jenny et al. 2008). Additionally, legends now need to be dynamic and adaptive alongside the interactive map (Sieber et al. 2005), taking into account how layers in the map change as the user interacts with it (Dykes et al. 2010).

Finally, the interactive solar maps examined in this study often included the *retrieve* operator, which gives the user "details on demand" (Shneiderman 1996) when they click or mouse over areas of the interface or map. Popups and sidebars were well designed when they followed basic design principles (as described in Tufte 1983): visual hierarchy, balance, unity, typography, and color coordination with the rest of the map interface. The best example of this was in the Mapdwell Solar System, which provided users with clear designs adhering to cartographic guidelines (Slocum et al. 2009).

As maps offer more interactivity, cartographers face new challenges in planning for a variety of scales, geographies, and changes that a user might make. In this way, the cartographer has less control over the design. Adherence to underlying data is also a constraint. These maps are scalable and thus planning for every type of geography or change a user makes is challenging. While designing for every case is difficult, it is necessary in these highly interactive web mapping environments. Cartographers might have more success if they limit the capabilities of these web maps by reducing interactivity to avoid having to design for multitudes of use cases (Tufte 1990).

VISUAL VARIABLES

The maps in this sample used only a subset of the visual variables. Some of the maps used them correctly (e.g., quantitative variable for quantitative information) while other maps did not. Future maps would do well to ensure the correct usage of the visual variables for the type of data displayed. Indeed, the more recently deployed maps in the study (e.g., Mapdwell and Google) used the visual variables more appropriately, suggesting that design and use of visual variables are becoming more important as more of these maps are designed and deployed. In many cases, the variables were also used redundantly — for example, using size and color to show areas on a map that had better or worse solar potential. This redundant usage often helps users discern between different features (Retchless and Brewer 2015).

MAP INTERACTION OPERATORS

Several map interaction operators were widely used in maps of solar energy, including search, retrieve, pan, zoom, import, and calculate. These six operators were found to be more useful in the case of solar energy web maps than the other eleven operators. The search operator afforded users the ability to easily find their home within the map without panning and zooming. This is necessary if the goal is to allow users to assess the energy potential of a particular building. The retrieve operator was likewise important because it allowed the user to query the map for more information. This is necessary for maps that allow users to assess solar potential and information about currently installed solar systems. The pan and zoom operators were found in every solar energy web map analyzed in this study, permitting users to move around the subject area. It is hard to imagine a web map of solar energy potential that does not include these capabilities. Finally, an import operator is automatically executed in every map at loading time as it brings in the pertinent data layers such as a solar irradiance surface or a buildings polygon layer. These systems work best with data already loaded and tailored to the users' specific needs. Unlike a traditional desktop GIS, web maps are most effective in terms of their ability to facilitate informed decisions when their tools, data, and functionality focus on a specific case as opposed to affording the user ultimate control.

SOLAR PLANNING TOOLS

Maps that allow users to assess solar potential stood out in the sample. The capability to not only view general solar potential in a location, but to calculate solar potential across a specific rooftop may help with decision making and lead to wider implementation of solar energy systems.

Maps that allow users to click on any building to compare solar potential, as opposed to those that required the user to know a specific address, were especially helpful. This meant users were able to pan and zoom around the map and assess solar potential for every structure represented on the map. This is useful to a solar energy developer who is interested in identifying clients' buildings with strong solar potential, or a utility system operator interested in identifying rooftops within a specified distance of a node on the electricity grid. Additionally, some of the maps allowed users to draw on a rooftop to assess solar potential for an isolated area of the building. This is useful because it allows a homeowner to assess potential on only the part of the roof where they may want to install a PV system. Future maps could include this functionality not only for rooftops but also for any area seen fit for solar development within the city.

Some maps allowed users to analyze all aspects of system potential (cost, savings, energy production, and environmental benefits). Providing site-specific information about the multiple benefits of solar is important, because prospective investors (homeowners and third-party developers) are increasingly motivated to deploy PV systems based on both economic and environmental benefits. Although these benefits are only a portion of the ultimate PV investment decision (Graziano and Gillingham 2015), they are the perhaps most tangible arguments for installation (Islam and Meade 2013). In addition, for some users, cost will be the most important decision criterion, while for others savings will be the motivating factor.

Another best practice in this grouping was the display of options to connect with an installer. By connecting them directly with a solar installation company or offering a list of companies, map users can more easily realize the economic and environmental benefits of a system at their location of interest. Those maps that allowed the user to print a report might also help in connecting users and installers. If the goal of these maps is to encourage users to think seriously about installing a PV system, providing information about all aspects of system potential, benefits of solar, costs, and solar installation services is ideal for allowing users to make the most informed decision possible.

None of the maps enable a user to calculate potential for multiple rooftops or multiple systems simultaneously; clearly, they were designed to inform homeowners or developers about individual systems. As a means of helping to encourage PV adoption in urban settings, informing homeowners is necessary but by itself insufficient, given that so many other groups have a direct stake in, and influence on, the homeowners' decisions. For a utility operator or policymaker, it is important to be able to retrieve production potential and economic feasibility over wide areas at multiple sites, since the area of interest for these stakeholders is much more extensive. A mapping system that allows a user to identify those areas of the city that may be considered profitable under a specific set of economic conditions (e.g., price of electricity, or tax rebate) would be helpful for utilities and planners to anticipate new development, and help to foster and manage homeowner investment decisions. The combination of multiple different ways to select areas for solar potential calculation is useful. Drawing polygons or selecting a city block can allow community or local government groups to identify undeveloped land for solar, while selecting specific buildings is useful for individuals assessing the potential for solar installation on their own building's rooftop.

CURRENT SYSTEMS ASSESSMENT

The likelihood of adopting PV technology is influenced not only by favorable characteristics in the built environment, but also by peer effects. All else being equal, the existence of a system installed on a neighbor's roof is a strong determinant in shaping a homeowner's decision to build their own (Graziano and Gillingham 2015). Visibility (i.e., proof that these systems can work in the area) and social interaction (i.e., conversations between neighbors about the benefits and overcoming challenges), not to mention the desire to fit into a new sub-group of early PV adopters are all part of the "peer effect." With this in mind, online solar maps that include information about existing systems (e.g., the LA County Solar Map or the Green Riverside Map) are likely to be more effective than maps that only provide information about a hypothetical system. Thus, the functionality of simply allowing users to view currently installed systems may be sufficient, however additional information about nearby solar installations may also be persuasive. Future research on the effectiveness of these maps with users would benefit from examining what information is most important to users about their neighbors' installed systems. However, providing information such as this opens questions about privacy for homeowners and businesses who have already installed solar PV systems. Finally, the ability for a homeowner to add their currently installed system provides the user with a way to "show-off" their system and may be yet another way to encourage both the installation of solar as well as use of the map (Floreddu and Cabiddu 2012).

FUTURE DIRECTIONS

The maps evaluated here provide insight into best practices for future solar energy web maps, based on a systematic coding system. We have identified several additional elements that would be worthwhile to incorporate in future maps.

The maps using JavaScript, and its wide variety of libraries, were all newer, faster, easier to use, more capable, and featured better overall design than Flash applications. JavaScript currently has many advantages, including broad usage, accessibility of code examples, and avoidance of proprietary plug-ins. One disadvantage of JavaScript is the need to test and maintain code against different Internet browsers, as well as keep it up-to-date, to avoid broken map interaction capabilities. Many of the maps in this study were designed by contractors for local governments and thus are not maintained as often as necessary. Future maps would benefit from maintenance, which suggests that cities and other stakeholders would need to provide an operational budget for these tools. Finally, while we did not explicitly evaluate system performance in these tools, future evaluations would benefit from evaluating responsiveness and performance of these types of tools, because users are more likely to continue to use a web application if it performs well (Palmer 2002).

Google and Mapdwell have shown that their systems are scalable. Both groups have developed design and functionality platforms that are now being implemented in several cities. Developing a standardized "plug-and-play" platform is critical to expanding the coverage of these maps. Templates that can be shared with local government officials and other stakeholders provide an easy and quick way to increase the number of locations where users have access to these types of maps (Brewer 2003). Templates can have design choices already made, requiring new developers to simply plug in their own local data for a quickly developed map (Esri 2013).

The online maps in this study illustrate an improvement in the use of cartographic design guidelines in more recently deployed maps (Mapdwell and Google). However, continued adherence to cartographic conventions (e.g., the correct usage of the visual variables) is suggested for better understanding of the mapped information by users. Additionally, the design of the interface is perhaps of equal importance with the design of the map, and requires cartographers and web developers to work together.

Developers of these types of web maps must strike a balance between providing enough functionality to their users in terms of interaction operators, solar planning tools, current systems assessment, and web design.

Finally, the online solar energy maps in this study were designed explicitly for the homeowner: only a single rooftop can be analyzed at any one time, and electricity generation and savings are modeled over an annual timeframe. On the other hand, utility companies and urban planners would benefit from maps with a different suite of functions and outputs. For instance, being able to identify all rooftops that would be profitable under a specific tax rebate might be helpful for a policymaker to determine optimal financial incentives. The capability to model the expected power output from multiple rooftops over shorter timescales might be helpful for the utility company to better understand where they may need to upgrade infrastructure to accommodate future PV systems. Although most of these maps have been designed to raise awareness and provide homeowners with a pre-feasibility analysis, there is great potential to leverage these tools in order to assess the spatial interdependencies between homeowners, policy makers, and utility companies.

That said, designing online systems for multiple user groups is challenging. These maps need to be scalable — they cannot be designed for one particular city without the ability to change geography within the interactive map. However, planning and designing for every type of geography or change a user can make is challenging. On the one hand, cartographers might have more success if they limit the capabilities of these web maps by reducing interactivity to avoid having to design for multitudes of use cases (Tufte 1990). On the other hand, in order for these systems to be useful, they need to increase their capabilities. Finding a balance is a key area for future research.

CONCLUSION

Rooftop PV systems have become popular ways for energy consumers to become energy producers. They offer exciting economic opportunities to individuals and environmental opportunities to society more generally. Unlike other types of energy, solar has a particular advantage of being spatially dispersed and micro-scalable, allowing for production of energy in the locations that use it most.

The case of solar energy provides a wealth of mapping opportunities for cartographers and GIScientists. It is not a spatially homogeneous subject; there are limits on where PV systems are viable. Mapping the spatial distribution of solar energy is one opportunity for cartographers, but with the advent of interactive web maps, we are no longer limited to a simple, static representation of solar potential. Indeed, we can provide users with opportunities to explore the map in ways that may influence decision making (MacEachren 1994).

Competitive analysis provided a useful way to understand current capabilities, with the goal of developing best practices for these types of maps (Rose 2012). Based on our analysis, best practices include:

1. adherence to basic cartographic principles;

2. flexibility for the user to model "what if" scenarios, including the ability to delineate their own system, and/or to input specific technical and economic data;

3. sharing information about existing systems; and

4. sharing information about credible solar installers.

Designers of solar energy web maps will find these useful as future guidelines. This is critical at a time when solar web maps are expanding their geographic reach and as the technologies appear to be approaching a dominant model that, according to our analysis, may not be optimal; as of May 2016, Google's Project Sunroof covered more than 43 million households in 42 states (Pyper 2016). Looking forward, there is both a clear opportunity and a need to develop more comprehensive systems, particularly in terms of designing for multiple stakeholder groups rather than just homeowners. This will require careful collaboration between researchers, municipalities, and other stakeholder groups such as utility companies and solar developers.

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A Comparison of ArcGIS and QGIS for Animation

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I compare two GIS programs which can be used to create cartographic animations—the commercial Esri ArcGIS and the free and open-source QGIS. ArcGIS implements animation through the "Time Slider" while QGIS uses a plugin called "TimeManager." There are some key similarities and differences as well as functions unique to each plugin. This analysis examines each program's capabilities in mapping time series data. Criteria for evaluation include the number of steps, the number of output formats, input of data, processing, output of a finished animation, and cost. The comparison indicates that ArcGIS has more control in input, processing, and output of animations than QGIS, but has a baseline cost of $100 per year for a personal license. In contrast, QGIS is free, uses fewer steps, and enables more output formats. The QGIS interface can make data input, processing, and output of an animation slower.

KEYWORDS: Time Slider; TimeManager; cartographic animation; time series

INTRODUCTION

Beginning in the late 1930s, the medium of film was used to create, duplicate, transport, and display animated maps (Peterson 2000). However, these methods required large amounts of time and resources to create, and distribution and display were complicated, and thus their application was still limited. Because of more recent advances in the digital storage, manipulation, and transmission of maps, animation has become more widely used in cartography.

Animated maps can either be temporal or non-temporal (Peterson 2000). Examples of temporal animation include changes in agricultural yields by year, the shifting locations of crime in a city by time of day, or the progression of weather events (Gula et al. 2015). On the other hand, a non-temporal animation might involve a fly-through (where a viewer is taken along a route by progressively stepping between frames) or a classification animation (where the same map is classified in various ways in quick succession). Some argue that all animations are temporal: even "non-temporal" animations take up a span of time—there is "presentation time" as opposed to "real time." For the purposes of this comparison, only real time temporal animations were explored.

My objective is to evaluate the differences in the creation of a time-series animation between two popular GIS programs: ArcGIS and QGIS. ArcGIS, a commercial program by Esri, is quite likely the most widely used GIS program in the United States. QGIS is open-source and supported by a large user-base of cartographers, GIS developers, and hobbyists; it is the most widely-used GIS program in the world. Both programs create animations using spatio-temporal plug-ins unique to their program architecture (Kratochvílová 2012). Previous studies have compared ArcGIS and QGIS on broad categories (Friedrich 2014), and different open-source solutions for time series mapping (Sutton and Olson 2013).

THE STRUCTURE OF A TIME-SERIES DATASET

To create an animation in either program, first a field within a dataset must be formatted as a date (Table 1). The date can have both calendar date and time information, and the format can be varied by program and for different scales of precision (from year to second). Table 1 shows an example of a time-series dataset: a Microsoft Excel

City	Country	Date	Tournament	Latitude	Longitude
Yinchuan	China	12/9/2016	World Cyber Arena 2016	38.487194	106.230909
Boston	United States	12/3/2016	The Boston Major 2016	42.360302	-71.059906
Los Angeles	United States	12/7/2016	The Summit 6	34.052234	-116.243685
Montreal	Canada	11/10/2016	Northern Arena BEAT Invitational	45.500714	-73.563254

Table 1. The attribute table of a temporal dataset shapefile.

spreadsheet with latitude and longitude coordinates of tournament locations, and another field with the date each event took place. You can then export these city coordinates as a point shapefile, which can be used by both ArcGIS and QGIS. Next, the shapefile can be manipulated within each program's spatio-temporal plug-in.

DATA INPUT

ARCGIS TIME SLIDER

To activate the Time Slider plug-in, a dataset must be time-enabled. As seen in Figure 1, open the properties of the shapefile layer, navigate to the "Time" tab, and check the box next to "Enable time on this layer."

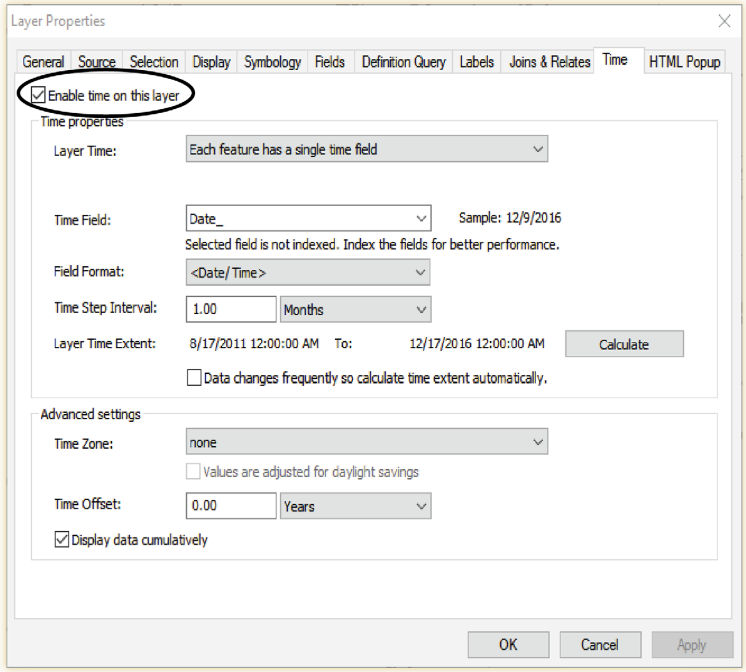

Figure 1. Enabling time on a layer in the ArcGIS Time Slider dialog box.

QGIS TIMEMANAGER

Enable the TimeManager plug-in through QGIS's Plugins menu (Figure 2). First-time users will have to download the plugin.

Once the TimeManager plugin is installed, it creates the TimeManager toolbar in the main project window. When the TimeManager Settings button is clicked on the toolbar (Figure 3), it brings up a new window with options for selecting the layer with time information. At the right of the window, choose "Add layer" to bring in a vector file, or "Add raster" to bring in a raster image (Figure 4). There's also the option to remove a layer that is being animated.

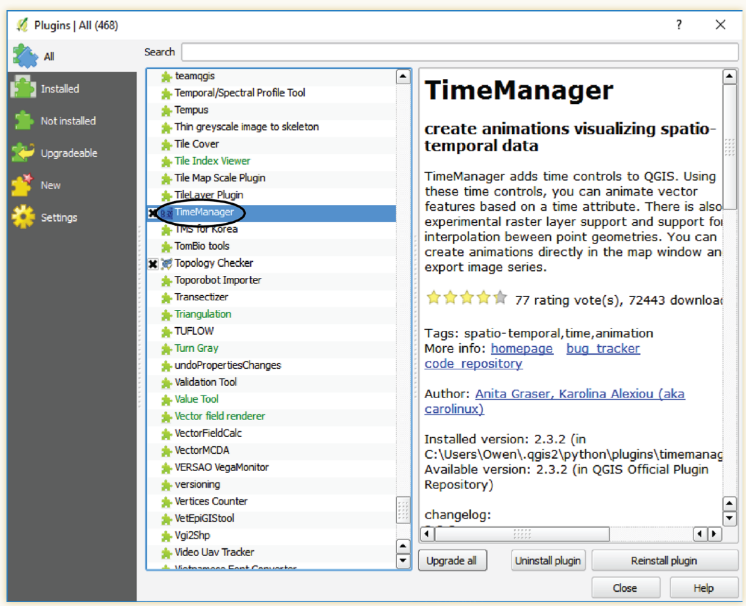

Figure 2. The QGIS Plugins menu, from which the TimeManager plugin is added.

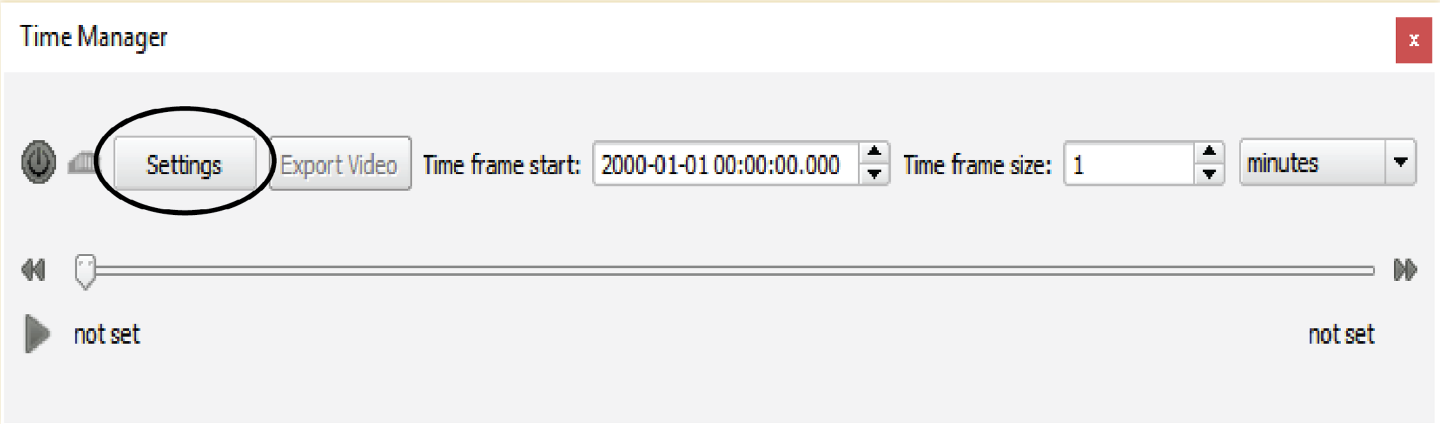

Figure 3. The QGIS TimeManager toolbar. The Settings button is used to access the layer selection dialog.

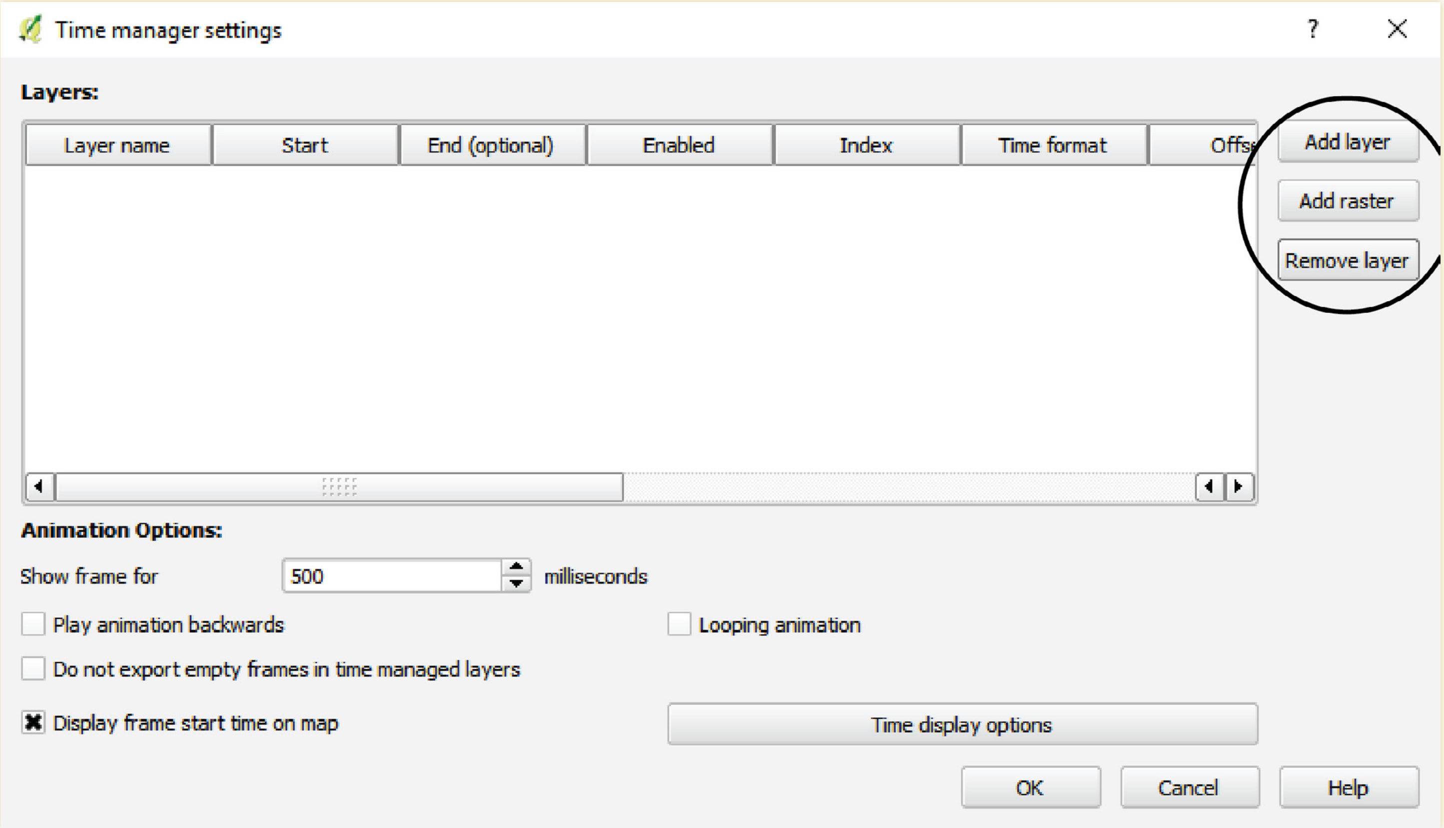

Figure 4. The Add Layer, Add Raster, and Remove Layer functions are used to choose the layer to be animated.

PROCESSING OF DATA

ARCGIS TIME SLIDER

The "Layer Time" field in Figure 1 allows either a single time for each event, or a beginning time and ending time for each event. The second option lets you show durations of events within the time-series animation. Next, select the field that has time information. Pick one field (or two, if your data have beginning/ending times) and then the format of the field. Higher degrees of precision can be specified if the data allow such accuracy. Next, decide on the "Time Step Interval." This option sets the time that passes between each frame of the animation. The setting will depend on the difference in spacing between the events in time: the greater the spacing, the longer the Time Step Interval needed to effectively animate the appearance.

With Time Slider, you can automatically generate the recommended Time Step Interval with the "Calculate" button. If the data needs a higher or lower number than this value, an interval can be manually entered. There is also an option to change the Time Zone, if all the events fall into a single zone. Set an offset for the time if the data were gathered in a single zone but need to be represented in another zone. The final setting in the Time tab sets the animation to display the data cumulatively, which allows the points to stay in place as new dates display new events. Otherwise, the default setting is singular, where each time interval displays its individual events, which then disappear as the new interval begins.

QGIS TIMEMANAGER

Once "Add layer" is selected, the shapefile can be chosen, along with the field in the data that indicates the Start time (Figure 5). Next, the End time is set. If the option for "No End Time" is set to "Accumulate," the animation will accumulate features as with the "display data

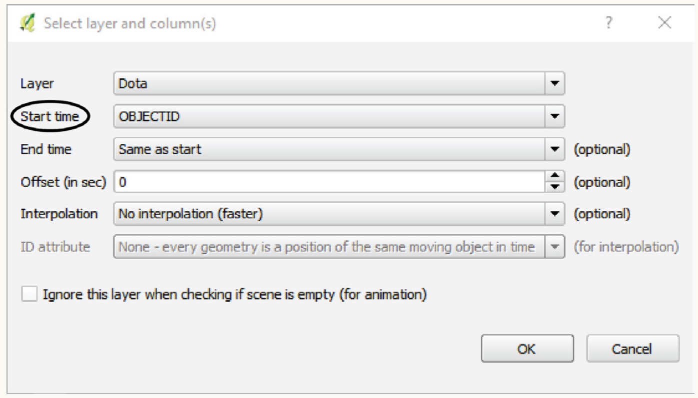

Figure 5. *The QGIS Select Layers dialog, where the user must indicate the Start time.*

cumulatively" option in ArcGIS. There is also an option to specify a time offset, as well as interpolation, which is a feature that ArcGIS does not implement. Interpolating values of a time series does not add any real data, as the interpolation process is not the same process that generated the other (non-missing) values in the series (Nga et al. 2012), and great care is needed in employing it. If there are continuous events with long gaps between consecutive observations, these gaps can be filled with interpolated positions to get uninterrupted movement traces. Using this option will create an additional point layer in the QGIS project that contains the interpolated positions.

ANIMATION SETTINGS

ARCGIS TIME SLIDER

Once the settings are applied, the Time Slider toolbar can be used. The Time Slider toolbar is activated by clicking the Time Slider button on the Tools toolbar (Figure 6); this toolbar is enabled by default when opening a new map document. The Time Slider toolbar is seen in Figure 7—the button on the left enables or disables time on the current map, while the one on the right button presents additional options.

The Time Slider Options dialog allows for changing the Time Display, Time Extent, Playback, and Other options. In the Time Display tab, the time zone and Time Step Interval can each be specified again or changed. The next option in the tab, Time Window (Figure 8), gives the ability to selectively display portions of the total dataset that is time-enabled. The options at the bottom of the tab to display the date and time format let you customize how

Figure 6. *The Tools toolbar with the Time Slider button.*

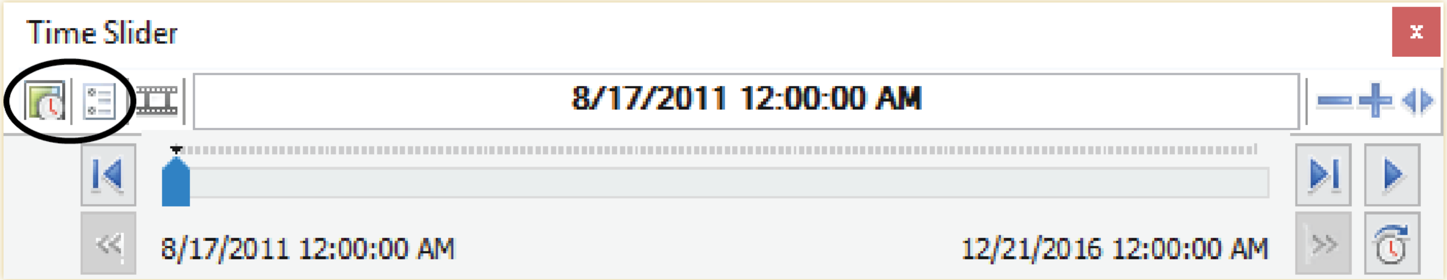

Figure 7. *The Enable Time button and Time Slider Options buttons, indicated on the Time Slider toolbar.*

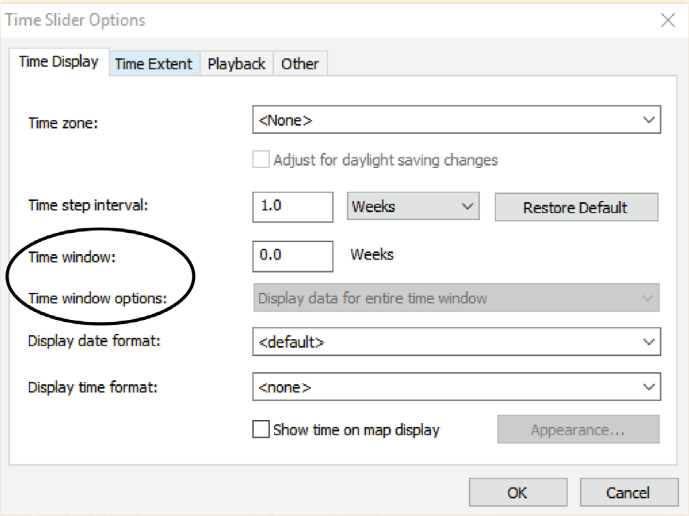

Figure 8. *ArcGIS Time Slider Options dialog box with the Time Window options circled.*

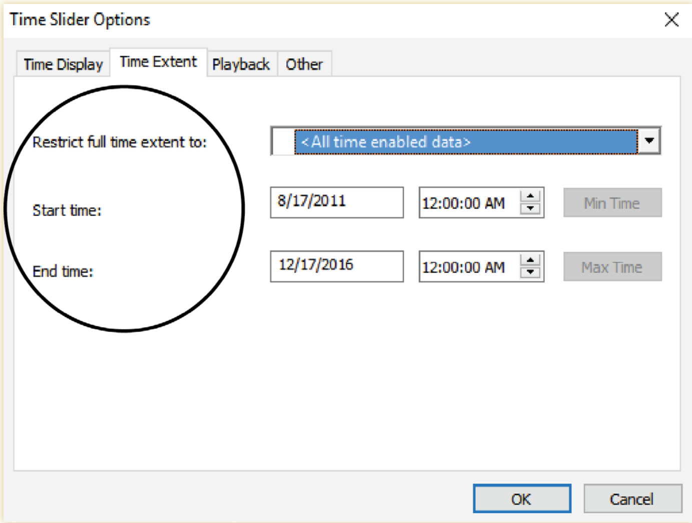

Figure 9. *The Time Extent window gives the user the ability to show portions of the data.*

they appear within the Time Slider. You can also display the timestamp on the map by checking the "Show time on map display" box and customize it by clicking on the "Appearance" button.

Using the Time Extent tab (Figure 9), you can select a date range, and a start and end, from the existing data. Restrict the amount of data that is animated by using the Time Window options. This gives you the ability to display data outside the Time Step Interval, within a window that is greater than the Time Step.

The Playback tab (Figure 10) provides several options for controlling how the animation runs. You can select a slower or faster speed using the slider tool, though no specific speed can be indicated. However, you can select "Play in specified duration (seconds)" to indicate a time within which the whole animation must complete; this will adjust the frame rate. Next, the animation can be repeatedly looped, or even played in reverse, using the "After playing

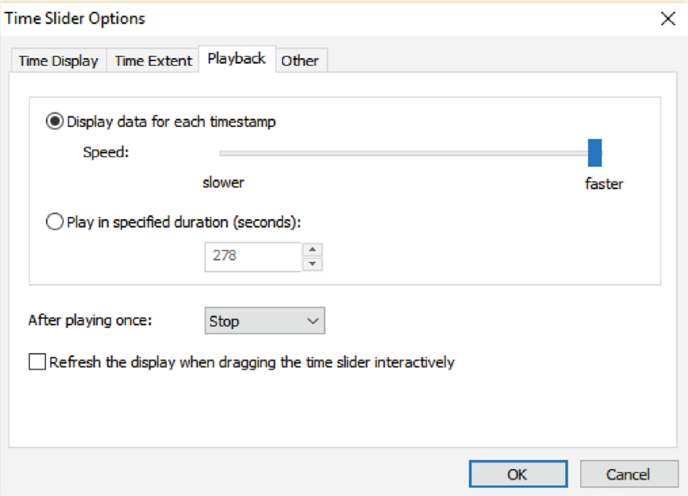

Figure 10. *The ArcGIS Time Slider Playback tab allows speed, duration, repeat, and refresh settings to be changed.*

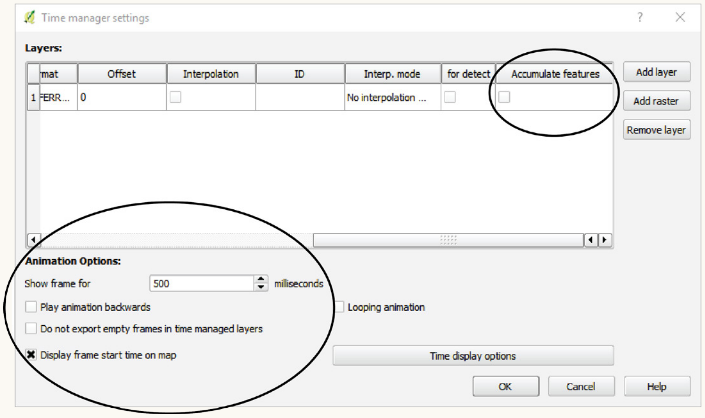

__Figure 11.__ Animation options within the TimeManager plug-in.

once" dropdown menu. By selecting the "Refresh the display when dragging the time slider interactively" checkbox, the display will refresh automatically to show the results at the time of interaction, rather than staying static and waiting for the new input. By default, the display changes only after moving and releasing the slider.

Finally, in the Other tab, it's possible to make the Time Slider window transparent in the animation. This effect could be used if data would be obscured by the display of the Time Slider window. This feature is an example of the Time Slider's advanced animation customization.

QGIS TIMEMANAGER

QGIS likewise offers some options to customize your animation, found at the bottom of the Time Manager Settings. You can determine how long each frame will be visible, whether the animation goes in reverse, whether the animation repeats through a loop, or whether blank frames will be removed upon export of the animation (Figure 11). You can also display the frame start time on the map, which overlays text in the animation showing the date and time of each time-interval step. In the Time Display Settings window, selected by pressing the Time Display Options button, a variety of text options can be selected, including the font of the time display, the size of the font, the format of the time shown, the placement of the time display, and the time display's text color and background color. Unlike ArcMap, in QGIS, the time display cannot be made transparent in the map window.

INTERACTION

ARCGIS TIME SLIDER

The Time Slider toolbar, seen in Figure 12, gives the ability to skip to the previous time stamp, skip to the next time stamp, scroll back in time, scroll ahead in time, see the full time-extent, and increase or decrease the time extent in the animation. This allows you to customize the animation before exporting it to a video or as a series of images.

The Time Slider toolbar also provides the option to enter Live Mode, where it is possible to visualize the most recent

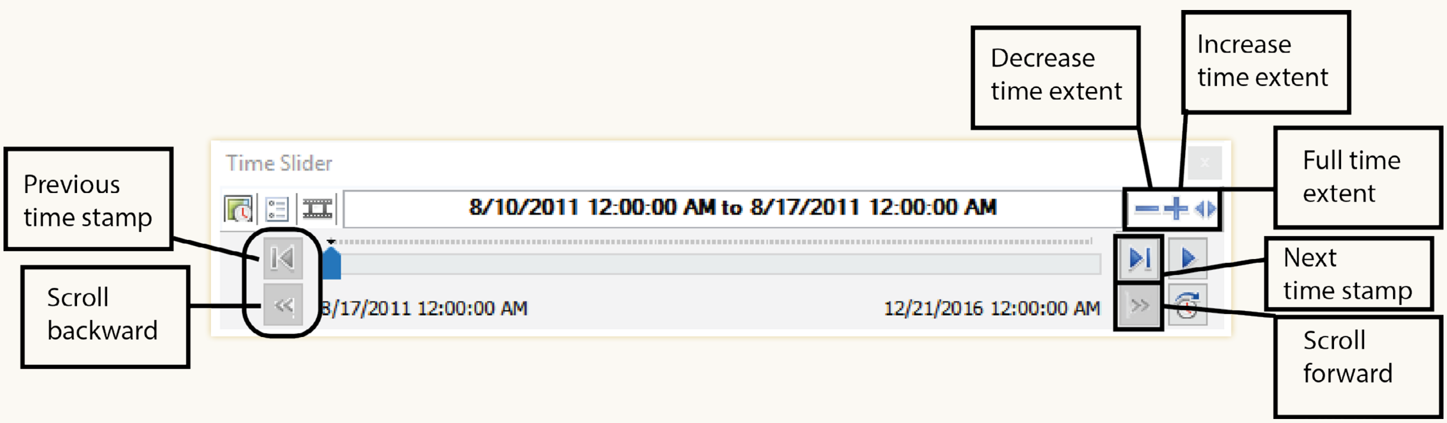

__Figure 12.__ The Time Slider toolbar with skip next/back, scroll forward/backward, increase/decrease time extent, and full time-extent buttons.

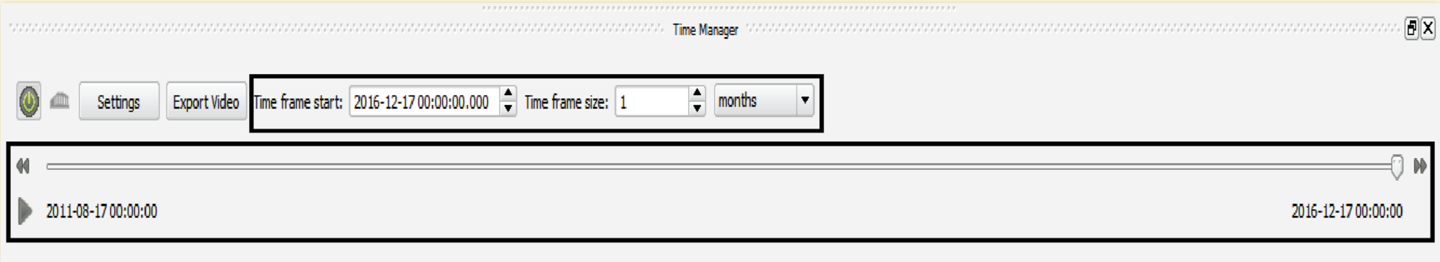

Figure 13. The QGIS TimeManager toolbar in the data window.

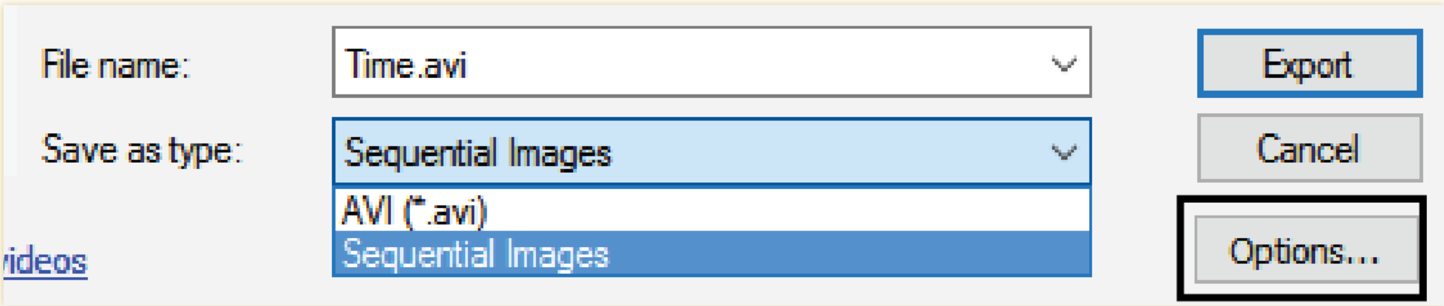

Figure 14. The ArcGIS Time Slider Export Video window, and the Options button for further customization.

changes to the data for automatic updates. No similar feature is available in QGIS.

QGIS TIMEMANAGER

On the TimeManager toolbar (Figure 13), the extent of the data is chosen, and the size of the time frame—from microseconds to years. Also, scroll buttons and a slider enable navigation through the data.

OUTPUT

ARCGIS TIME SLIDER

The Time Slider allows the export of the animation as an .avi video file, or as sequential JPEG images, both of which can be found in a dropdown in the Export Animation dialog box (Figure 14). Sequential images can then be used in other software to create animations. The AVI video format is uncompressed, which can lead to large file sizes. In the Exporter Options menu (Figure 15), selected with the Options button, there are a variety of choices including custom video resolutions, off-screen recording, and the creation of a video layer.

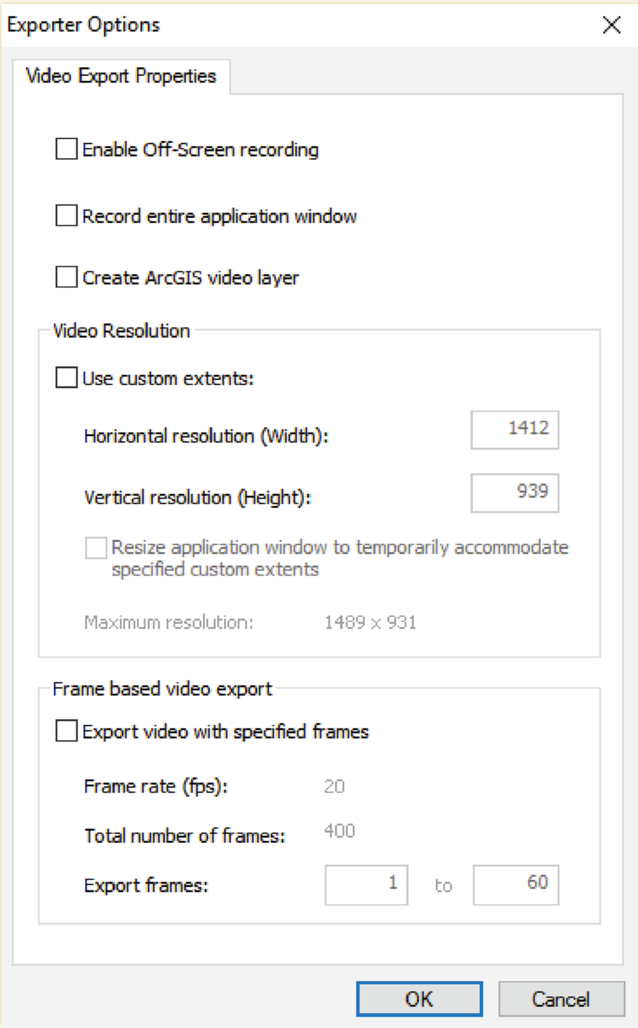

Figure 15. Additional video format settings within Esri's Time Slider Export Video dialog.

QGIS TIMEMANAGER

When exporting the animation as a video, select Export Video on the Time Manager toolbar, and choose either Frames only (.jpeg), Animated .gif, or Video (.mpeg) (Figure 16). This is where the animation frame delay is chosen to indicate how long the animation will stay on a frame before moving to the next frame.

A unique feature of QGIS is the Archaeological Date Time—a button (Figure 17) on the toolbar that gives the option to display times in the XXXX BC or AD format (Figure 18), which is useful when showing an animation of data that spans the year 0.

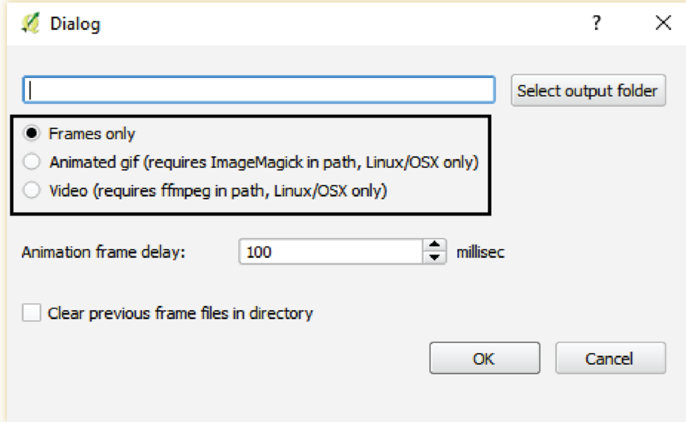

Figure 16. The QGIS TimeManager Export Video Dialog box, with the export format choices indicated.

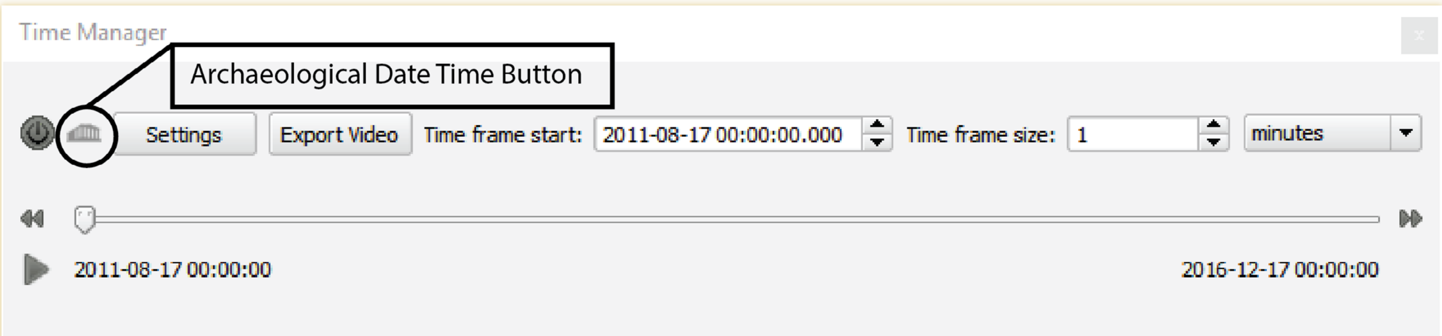

Figure 17. The Archaeological Date Time Button on the Time Manager toolbar.

RESULTS

Table 2 summarizes the comparison of ArcGIS and QGIS, while in Table 3, the unique features of each program are compared. To generate an animation, ArcGIS required more steps, offered greater control, has a higher cost, and exports in one format fewer. QGIS had fewer steps, was faster, has zero cost, and exports to more formats. In my opinion, QGIS also offered a less intuitive method for setting frame rate and timing than ArcGIS.

The ArcGIS suite is a powerful tool that is well suited for enterprise environments, and the Time Slider plug-in reflects this orientation. The options for Live Mode, Interactive Updating, and Dynamic Video Layers would be beneficial for large datasets that are frequently updated, such as climate or species data. The option to record the entire window gives an analyst the ability to create a video of the entire ArcGIS program, instead of just the data view. The Enable Off-Screen recording option is

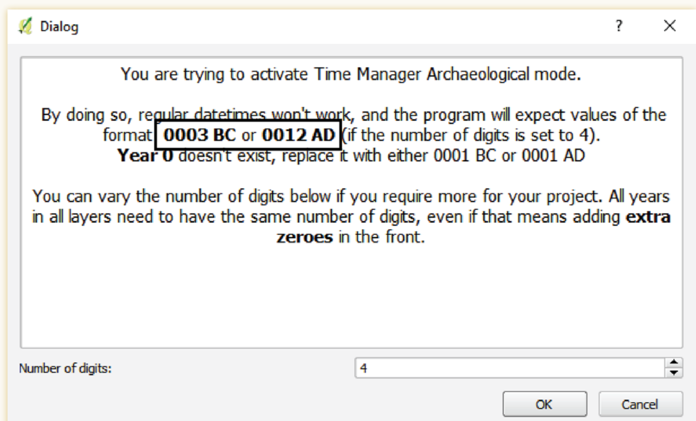

Figure 18. The QGIS Archaeological Date Time dialog box, explaining the required date format.

useful to continue working while the animation is exporting. With the exception of graphs, windows opened on top of the ArcMap application will not appear in the exported video. Finally, the ability to export videos with custom

	ArcGIS	QGIS
Unique Features	8	6
Cost	$100 per year for personal license	Free
Output Formats	2: JPEG and AVI	3: JPEG, GIF, and MPEG
Video Format	AVI (uncompressed; ArcGIS offers options for compression)	MPEG (compressed)

Table 2. *A summary of the time-series plug-ins' unique features, cost, output formats and video format.*

resolutions, custom frame extents, and the AVI format give ArcGIS the edge over QGIS in customization.

ArcGIS uses the AVI format for video export. Video stored in AVI format is uncompressed and retains its original quality, but because there is no compression, the file size of an AVI video can be extremely large. The AVI format supports a wide range of video and audio formats and variable frame and bit rates. It does not support menus or streaming. These features make AVI an excellent format for storing and editing video, but a poor format for distributing video via the Internet or physical media. With ArcGIS, choose the compression codec when exporting AVI files to avoid the impractical file sizes generated with this format. Nearly all AVI files have an integrated codec to reduce file size.

QGIS TimeManager incorporates features that aren't offered in the ArcGIS suite, such as the option to interpolate the data during the animation, raster layer support, and the archaeological date function. QGIS's open source format and compact program size make it ideal for one-off projects and smaller GIS operations. The fact that QGIS requires fewer steps and has more output formats makes it efficient for producing simple animations. QGIS also uses the more portable MPEG video format. MPEG is an older, compressed video file format that is commonly used to distribute video on the Internet and DVDs.

Features	ArcGIS	QGIS
Step Interval	X	X
Cumulative Display	X	X
Time Offset	X	X
Time Display	X	X
Colored Display/Fonts	X	X
Frame Spacing	Auto/Manual	Manual
Font Formatting	X	X
Animation Loop/Reverse	X	X
Time Zone/Extent/Window	X	
Transparency of Display	X	
Interactive Display Updating	X	
Live Mode	X	
Video Layer	X	
Record App Window/Off Screen	X	
Custom Resolution/Frame Export	X	
Interpolation		X
Raster Layer Support		X
Archaeological Date/Time Option		X
Empty Frame Erasure		X

Table 3. *Summary of features between ArcGIS Time Slider and QGIS TimeManager.*

CONCLUSION

Animated maps are a powerful medium for the communication of change in mapped phenomena over time. Both Esri's ArcGIS and QGIS effectively animate time. ArcGIS has more control over the animation, but is costlier. QGIS offers a faster method with less customization and has options for interpolation and archaeological dates. For cost and simplicity, QGIS is an impressive alternative to ArcGIS for the creation of temporal animations.

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Mapping The Drowned World

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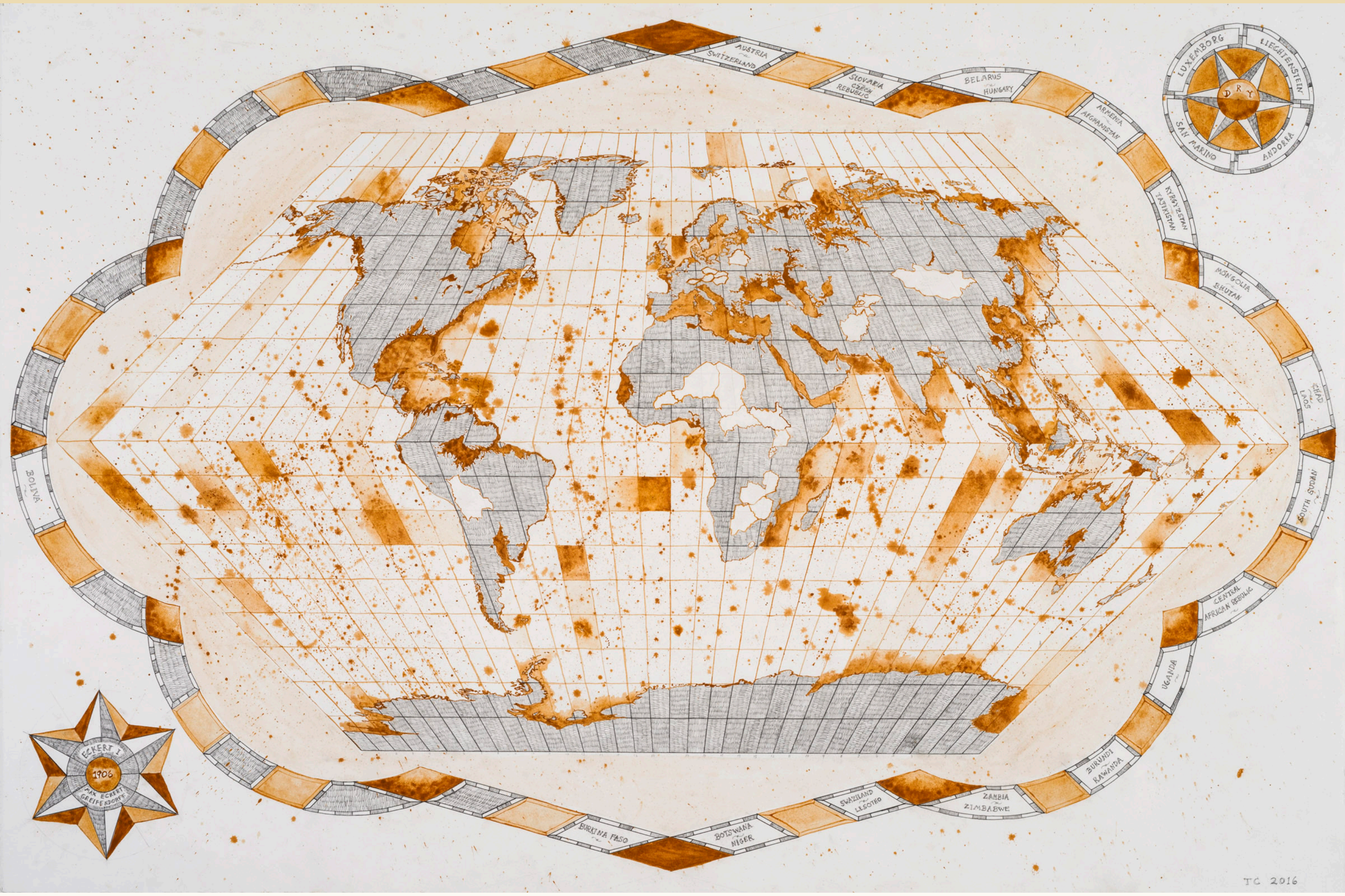


Tracey Clement, Drowned World: Eckert Projection, *2016, pencil and rust on paper, 47.5in × 31.5in.*

My *Drowned World* maps are part of a broader creative project inspired by J. G. Ballard's 1962 book, *The Drowned World*. In this slim science fiction novel, Ballard presents vivid, startling and disturbing post-apocalyptic imagery of a submerged city, strangled by vines and patrolled by carnivorous reptiles. Written during the perpetual slow-burning crisis of the Cold War, Ballard was responding to the fears of his age. Maps are artifacts deeply embedded in the cultures that make them and the conditions of their time, and my *Drowned World* maps chart the anxieties of our current crisis: climate change.

In this series of drawings I have represented an ocean level rise of 70 meters (approximately 230 feet) on five different world map projections: Petermann Star, Eckert (I), Bonne, Fuller, and Loximuthal. The figure of 70 meters is speculative and is not based on a specific study. My artworks picture planetary geography re-shaped in ways that echo Ballard's post-apocalyptic vision, but they are also grounded in the real: ocean levels are already rising.

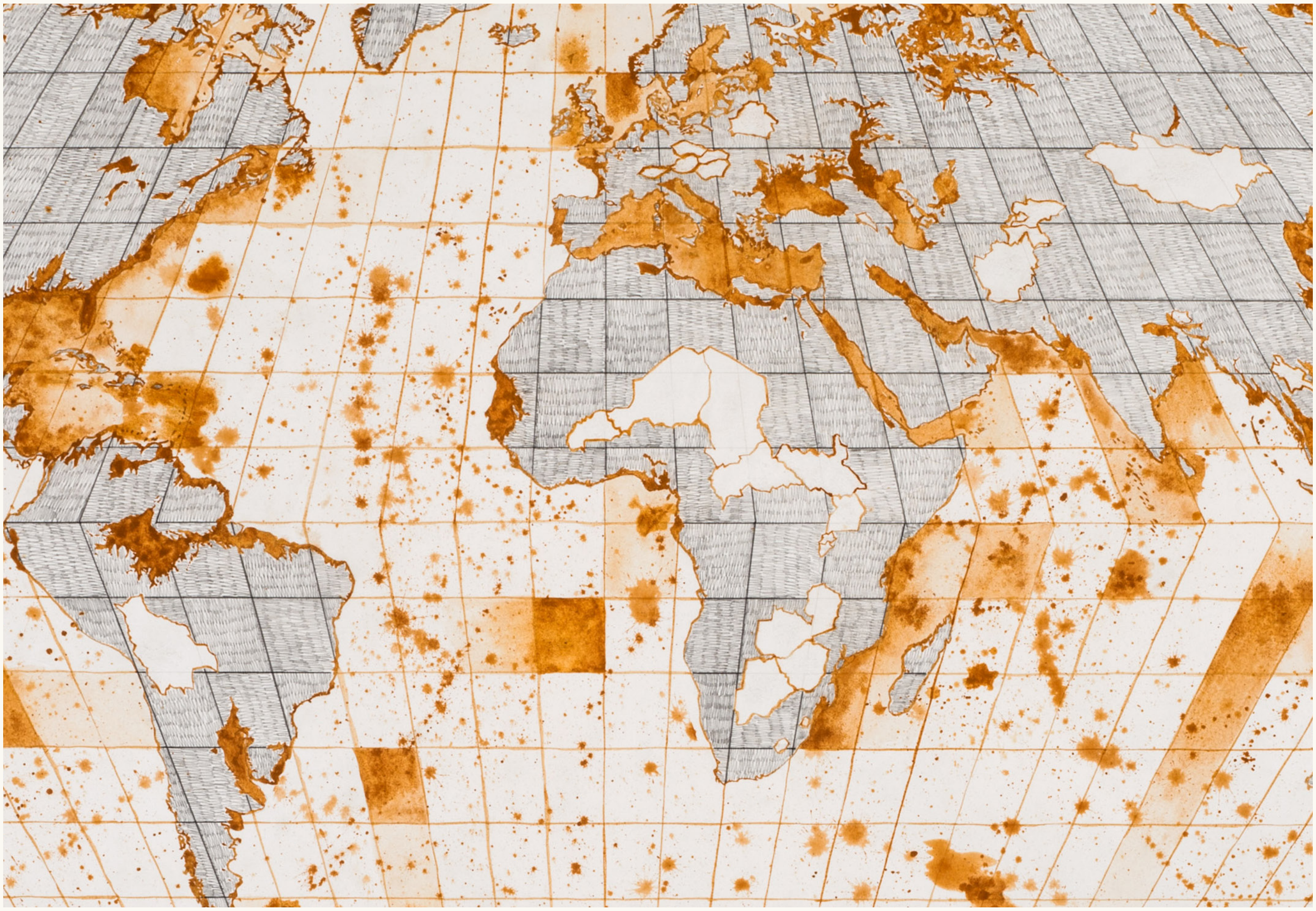
Each *Drowned World* map focuses attention on particular landmasses. For example, in both *Drowned World: Bonne Projection*, 2015, and *Drowned World: Eckert Projection*, 2016, Africa is dead center, dwarfing both Europe and North America; this offers a much more accurate, and politically potent, representation of its actual landmass than is found on many other maps.

Maps are not neutral. They are always staking a claim or making a point. In addition to drawing on the narrative potential culturally embedded in cartography, my *Drowned World* maps also make use of the conceptual weight inherent in materials and processes.

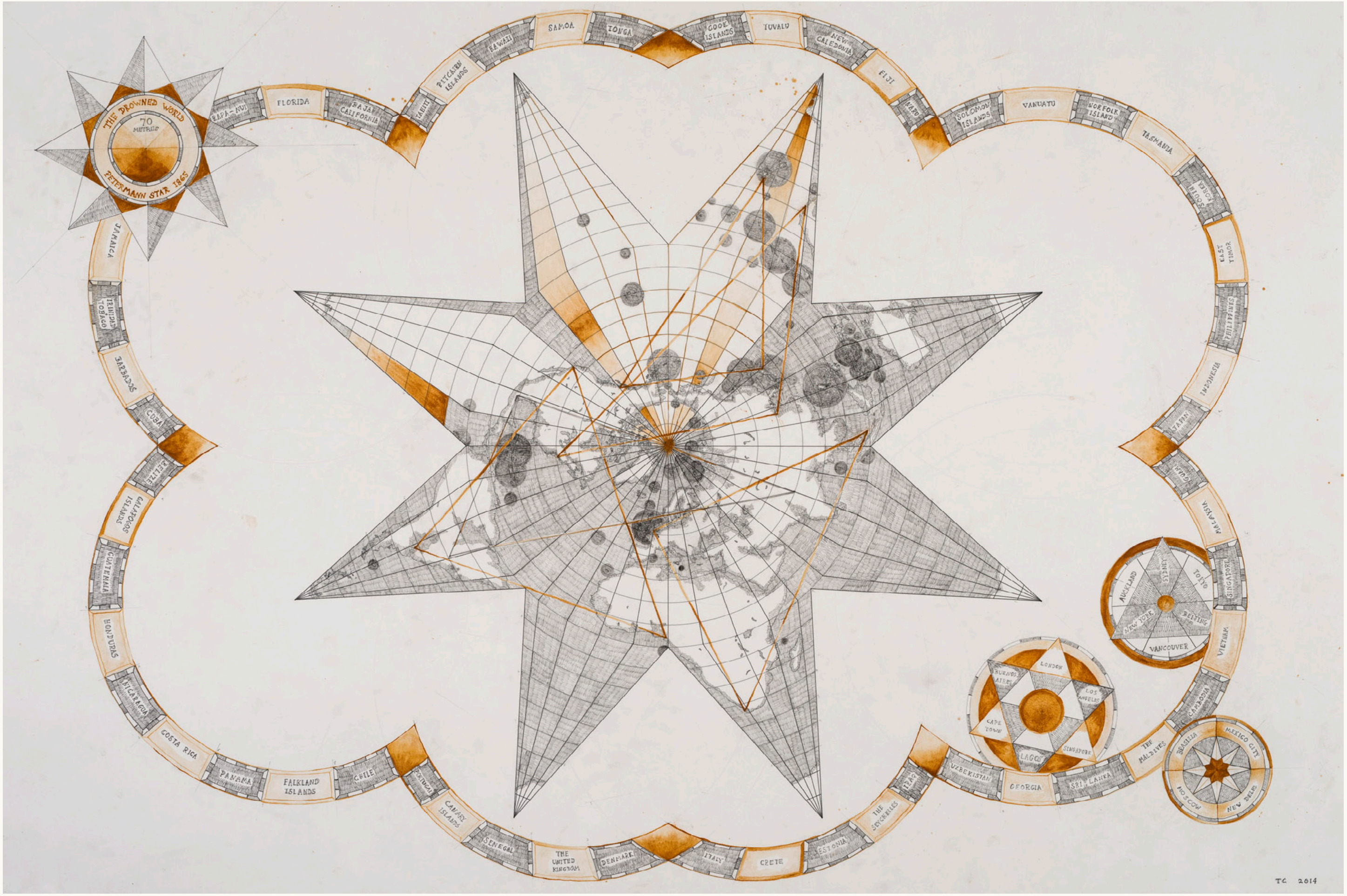
The material used to paint to these maps is ferric oxide, otherwise known as rust. Made from iron, a naturally occurring mineral that has been ripped from the earth, smelted, extruded, and oxidized, rust is symbolic of the widespread human attitude that nature is simply a resource to be exploited. When the rusty oceans of these drawings encroach onto land, we are asked to face our own complicity in creating climate change.

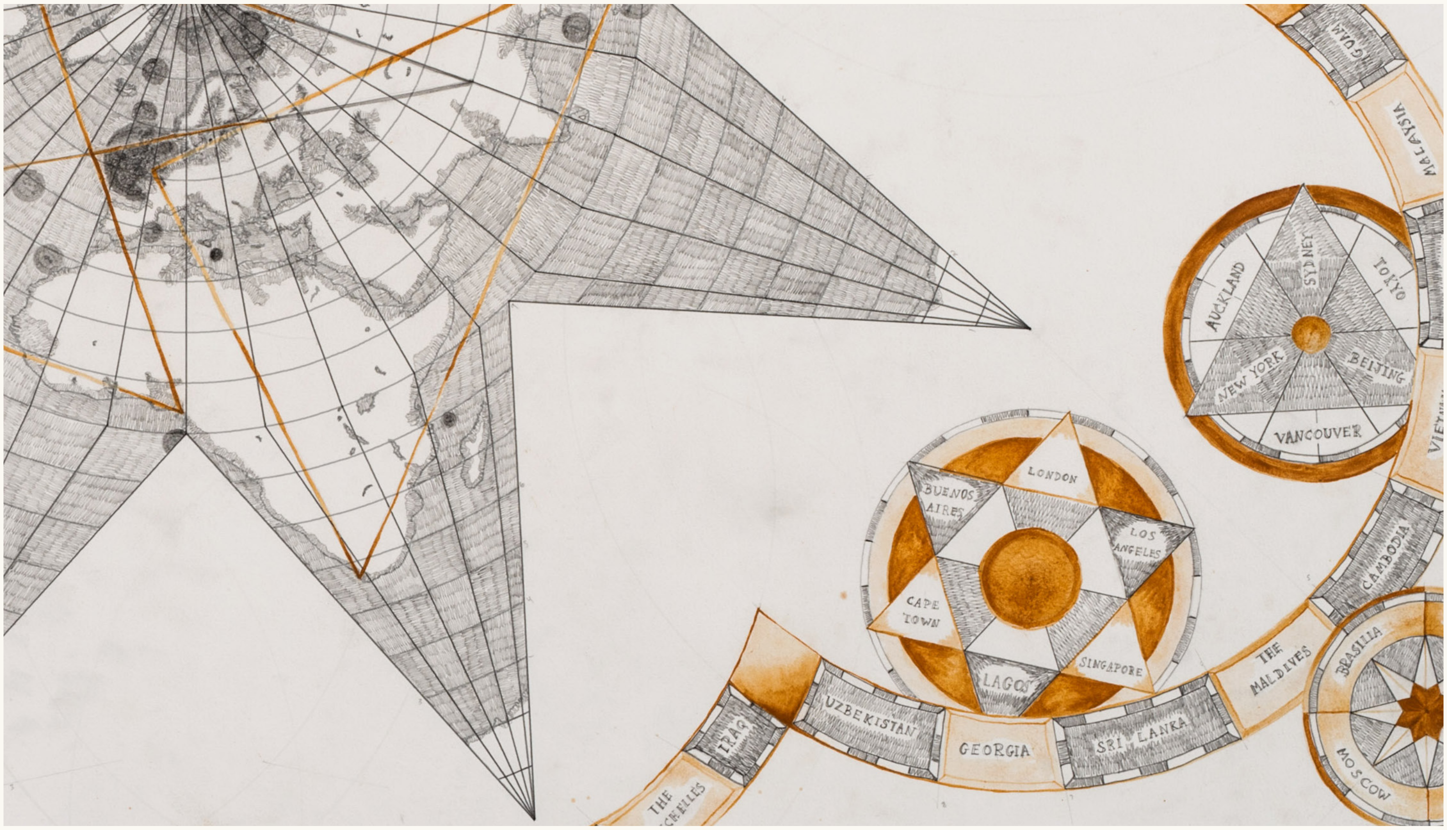
In some of my drawings a graphite pencil is used to "drown" the world instead of rust. The effect is similar, but in these instances it is the action of drawing rather than the qualities of the material that carries the weight of the message. The cross-hatched nature of the pencil marks is clearly labor-intensive. It literally takes dozens of hours to "drown" the world in this way.

In fact, both the painting and the drawing are very labor-intensive. The time-consuming nature of my *Drowned*

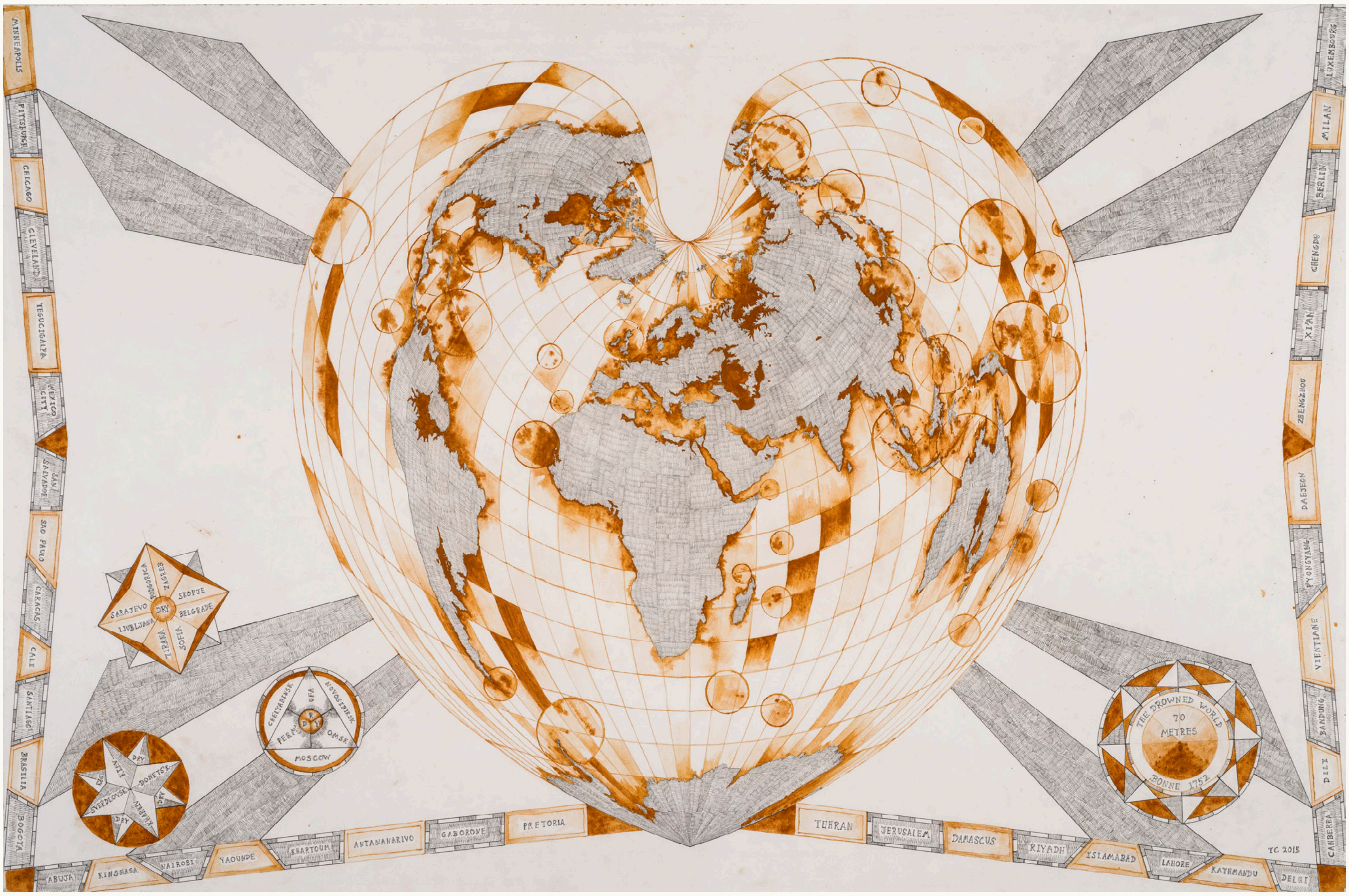


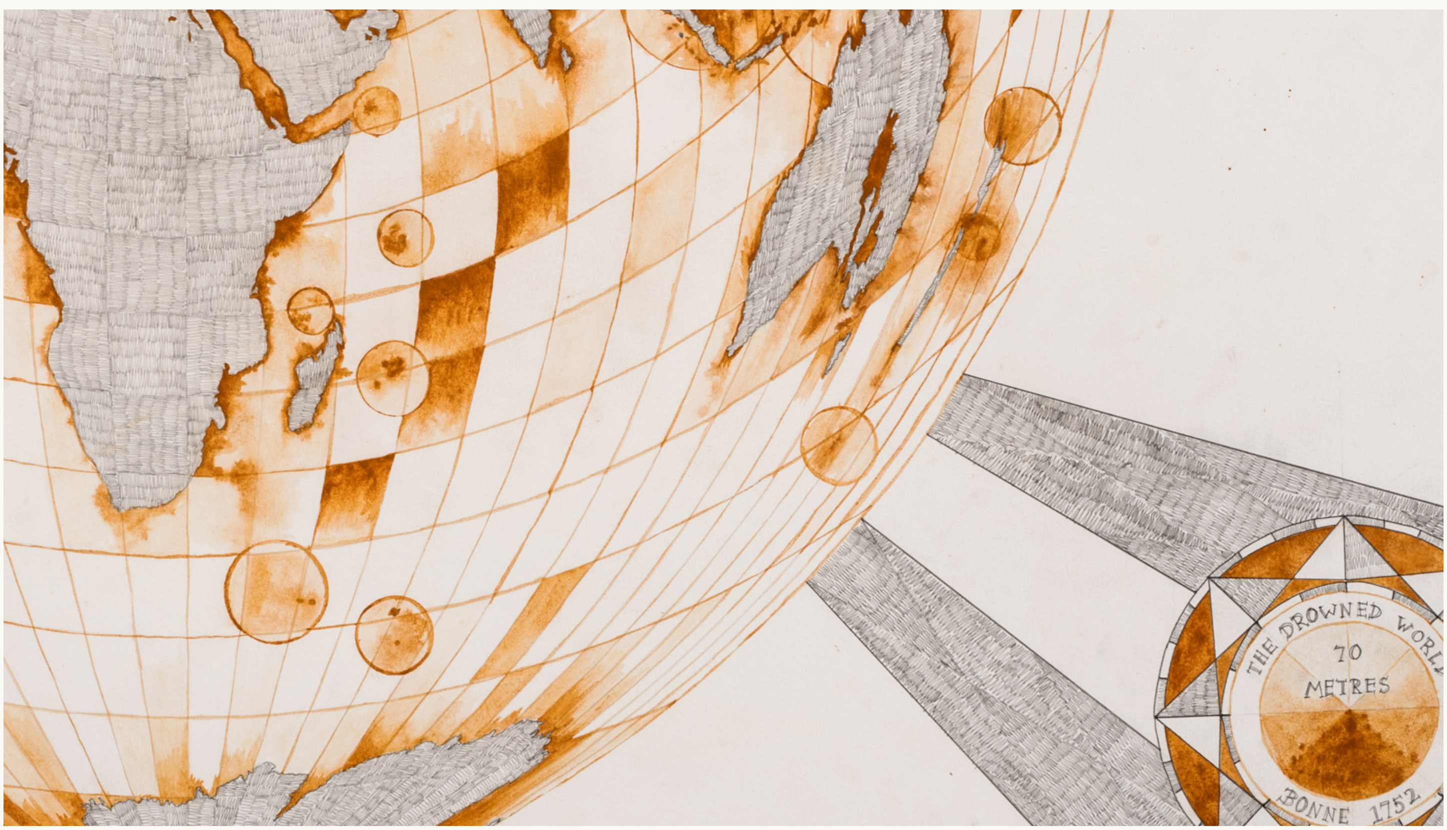
Tracey Clement, Drowned World: Eckert Projection *(detail), 2016, pencil and rust on paper, 47.5in × 31.5in.*





Tracey Clement, Drowned World: Petermann Star *(plus detail), 2014, pencil and rust on paper, 47.5in × 31.5in.*





Tracey Clement, Drowned World: Bonne Projection *(plus detail), 2015, pencil and rust on paper, 47.5in × 31.5in.*

World maps is a deliberate strategy. Our current crisis did not just happen: it took centuries of dedicated labor, ruthless exploitation of the natural environment, manic consumerism, and blatant disregard for the consequences of our actions to reach this moment in time.

Tracey Clement is an artist, arts writer, and Ph.D. candidate in Fine Art at the University of Sydney. Her current research responds to J. G. Ballard's novel, The Drowned World, *with a particular focus on imagery of the ruined city. Clement has exhibited widely, both in Australia and overseas, and her writing is published regularly in numerous art and design magazines.*

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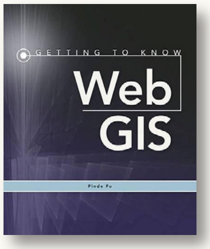
Visual Fields focuses on the appreciation of cartographic aesthetics and design, featuring examples of inspirational, beautiful, and intriguing work. Suggestions of works that will help enhance the appreciation and understanding of the cartographic arts are welcomed, and should be directed to Section Editor Matt Dooley: **mathew.dooley@uwrf.edu**.

GETTING TO KNOW WEB GIS



By Pinde Fu.

Esri Press, 2015.

378 pages, 464 color figures, 3 appendices, online resources. $84.99, paperback.

ISBN: 978-1-58948-384-2

Review by: Daniel G. Cole, Smithsonian Institution

The author describes *Getting to Know Web GIS* as

> a workbook, with detailed, step-by-step exercises, that teaches readers how to share resources online and build web GIS applications easily and quickly. It is a practical manual for classroom lab work and on-the-job training for GIS students, instructors, GIS analysts, managers, web developers, and a broad range of GIS professionals. (x)
>
> Unlike books that focus on individual products, this book teaches GIS technologies as a holistic platform, from the server side to the browser, mobile, and desktop client side…[and it] addresses the pros and cons of the available development options and helps you to make the best choices based on your requirements and resources. (ix)

These statements are quite ambitious, in that they are applicable to anyone dealing with GIS; frankly, though, the holistic claim is aimed at Esri customers.

The book includes a preface, 10 chapters, and three appendices comprising credits for images, data, and server data. Each chapter ends with questions and answers, assignments, and online Esri resources. Data used in the tutorials are downloadable from **downloads2.esri.com/ESRIPress/bookResources/WebGIS/WebGIS/setup.exe**. Good cross-referencing exists between the chapters.

Chapter 1 involves the building of a web app with ArcGIS Online (AGO), which is fine, but at this point, the reader cannot proceed without the updated book supplement, which is a 29-page PDF document. In other words, this book was outdated shortly after it was published. The only chapters that had no updates were chapters 8 and 10.

The second chapter provides more information on AGO layers, maps and apps. Fu introduces best practices of web GIS app design, including using available base maps from AGO. He also shows adding layers from eight different formats, and identifies the tools provided by AGO. He discusses how the user design should be fast, with the use of caching, database tuning, partitioning and load balancing; easy, with an intuitive GUI and not too many buttons and layers; and fun, with the integration of photos, charts, videos and animation (41–42). The tutorial for this chapter provides a CSV file. Because the book advocates the use of Excel “to create and edit your CSV data” (9), at this point, I suggest that he reference the recent article by Buckley and Rojas in *ArcUser* magazine (48–49), “Always and Never When Formatting Excel Tables.” As someone who has had to repeatedly deal with GIS users who improperly format their Excel spreadsheets, the caveats in that paper should be required reading.

Chapter 3 discusses geospatial web services and time animation. It outlines the differences between dynamic service layers and feature layers, along with the choice of four Esri GIS products: ArcGIS for Server, ArcGIS for Server in the Cloud, ArcGIS Online for Organizations, and Portal for ArcGIS. Further, the author provides a workflow to publish map services so that one can prepare, edit, share, and verify the spatial data. The tutorial here is the first of a number of exercises involving the use of ArcGIS for Server. In this chapter, the student is taught how to build a website of the combined natural disasters of earthquakes and hurricanes, complete with a time slider.

The fourth chapter gives instructions on how to use and build cached map services along with comparison web apps. Fu notes the benefits of cached map services and points out their differences with tiled map services including vector tiling and raster pyramids. He identifies the Web Mercator projection as the coordinate system to use, not because it is the best, but because that is what Google, Microsoft and Esri are using. The author then lays out four scenarios for data storage and how to register a data store; this is followed by a discussion on planning a map cache, encompassing the choice of the right tiling scheme, designing the map for each planned viewable scale, anticipating cache creation time, and planning to deploy using a compact storage format. Finally, he compares several ArcGIS Online app templates: spyglass, swipe, and side-by-side. The exercise involves the creation of a GIS web app comparing the spatial patterns of California's topography with its forests.

Chapter 5 covers feature services and volunteered geographic information (VGI). Fu wisely points out that "feature services support both read and write functionality" (159), which is useful for collecting VGI and allowing web users and clients to edit data and workflows while preserving data integrity through the limiting of choices and preventing invalid data entries. Lastly, Fu discusses publishing feature services with ArcGIS for Server and ArcGIS Online for Organizations, along with editor tracking so that more accountability and quality control can be maintained. This chapter's tutorial consists of creating an ArcGIS Online for Organizations publisher account, publishing a hosted feature service, defining feature templates, creating a web map and defining editable fields, and, lastly creating a web app for VGI collection.

Chapter 6 deals with the Web AppBuilder for ArcGIS, which permits building web apps without programming, a feature that should make many potential users happy. The key features of this tool include: it creates web apps with HTML and JavaScript without the necessity of plug-ins; the web apps are adaptive to all screen sizes; it supports 2D and 3D; numerous out-of-the-box widgets are available; it works with both ArcGIS Online and Portal for ArcGIS; and the tool provides a framework to develop extra widgets, etc. The core widgets encompass 20 different tools, enabling the user to have access to plenty of functionality. The exercise comprises the creation of a basic web app involving the natural disasters content used in Chapter 3, building additional widgets into the website, and deploying the application.

The seventh chapter addresses spatial analytics online and geoprocessing (GP) services. GP services are equated to desktop geoprocessing: "think of a GP service as a toolbox and its tasks as tools within that toolbox" (226). Fu lists the capabilities of GP services, including: summarize data, find locations, data enrichment, analyze patterns, use proximity, and manage data. Once the GP services are published, any of these tools can be shared along with any applicable models, from ModelBuilder, or scripts, from Python or ArcPy. The accompanying exercise helpfully involves designing a GP model in ArcMap, running the model, publishing the results as a GP service, exploring the GP service in the services Directory, and using the GP service in Web AppBuilder for ArcGIS.

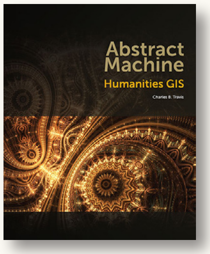
Chapter 8 provides an introduction to using the ArcGIS API for JavaScript so that apps can be customized. The author points out that since JavaScript runs on the browser side, it is more popular (and probably better) than Adobe Flash and Microsoft Silverlight. But he wisely adds that you need to know HTML for packaging and Cascading Style Sheets (CSS) to style content. Regardless, Fu notes that a JavaScript API interacts with GIS servers as well as provides GIS functions; and it presents responses from servers to end users and interacts with them. He also states that the ArcGIS API for JavaScript provides many classes and lists the most common ones with their accompanying properties, methods and events. Two good suggestions that he makes include: playing with the samples in the ArcGIS API for JavaScript sandbox, and using IntelliSense to spot typos and other mistakes. The tutorial for this chapter involves building an app through the adaptation of a given sample, deploying the app to your web server, debugging the app, and adding dijits to the web app.

Chapter 9 involves learning about mobile GIS as used on smartphones and tablets. He identifies three development strategies: browser-based, which should reach all mobile platforms; native-based, which has apps that must be downloaded to the user's device; and hybrid-based, which is a combination of these two. Fu then discusses the advantages and disadvantages of each. Browser-based apps work for multiple platforms, and are quicker and cheaper to develop, but the user experience is not as good. Native-based apps have better performance but are more expensive and have low portability. The exercises here start with the creation of a web map for use in the following sections. Then the reader is taught how to collect points, lines, and polygons using Collector for ArcGIS, followed by a quick sampling of the JavaScript API, and finishing with the installation and running of the ArcGIS for Android plug-in.

The last chapter is the shortest in the book, although it could be longer. In just four pages, Fu quickly outlines the creation and publishing of 3D models to ArcGIS Online, plus how to use CityEngine web viewer.

Overall, Fu has put together a very good book on learning about web GIS in the Esri universe. That said, in this reviewer's opinion, this book should not be sold as a printed work; rather, it should be sold by Esri Press as an e-book for two reasons. First, its many online sources would be more easily accessible from an e-book; and second, since it has so many corrections and changes (see **downloads2.esri.com/ESRIPress/bookResources/WebGIS/WebGIS/Supplement_final.pdf**), registered purchasers of the work could download free updates to the book. I was not pleased with how much I needed to mark up the book to prevent frustration with the out-of-date instructions.

ABSTRACT MACHINE: HUMANITIES GIS



By Charles B. Travis.

Esri Press, 2015.

136 pages, maps, diagrams. $52.99, softcover

ISBN: 978-1-58948-368-2

Review by: Ann M. Hanlon, University of Wisconsin–Milwaukee

With the digital revolution has come the ability, at one's desktop, to access tools and methodologies that were previously the domain of specialists. Cartography and mapping are perhaps among the most tempting and intuitive of those methodologies. And scholars of the humanities, especially in fields such as history and geography, but also in literature and the fine arts, are keen to adopt the language and metaphors of the map to analyze, visualize, and interpret their traditional materials. Likewise, librarians and others working in the fields of digital humanities have recently begun to learn to use GIS as a tool to access and understand library collections and to interpret and visualize what some have begun to call humanities data. Charles Travis's book, *Abstract Machine: Humanities GIS*, provides a compelling model for how humanities professionals can use and understand GIS technology to reconstruct, interpret, represent, model, and otherwise critically engage literary texts and historical narratives in order to rediscover and more deeply explore those materials.

Travis writes from the perspective of a scholar immersed in the intersections of the science of cartography, the history of geography, and the language and meaning of literature. And he proves capable of communicating the breadth of opportunities that GIS and visualization techniques can bring to the humanities. Drawing on a depth of knowledge that might be intimidating to the uninitiated, he nevertheless provides in this book a definition and critical history of what has become known as the spatial humanities, and provides a less well-developed but still useful how-to guide to using GIS and its attendant tools to reconceptualize historical events and literary landscapes. He draws heavily on literary theory, viewing GIS, geography, and cartography through multiple theoretical lenses, particularly poststructuralist ones.

The organization of the chapters nicely illustrates the layering of skills necessary to conceptualize, source, and construct the maps and visualizations discussed in the book. Beginning with a historical overview of the field of geography, he provides a backdrop for the development of the more scientifically-oriented field of cartography, which he contrasts to a geographical approach more aligned with the arts and humanities. That duality is also apparent in the methodologies of the digital humanities versus the content and questions those tools are meant to illuminate. If nothing else (and there is plenty else), the first two chapters articulate not only a history of the spatial turn in the humanities, but describe an ongoing and productive relationship between the sciences and the humanities that is only more apparent today thanks to the ubiquity of digital tools. Employing GIS to explore questions in the humanities provides a particularly convincing use-case to explore.

Travis's first use-case involves historical events: namely, the seventeenth-century conquest of Ireland by Oliver Cromwell, and the consequent Irish Rebellion. In many ways this is the most straightforward use of GIS, with data derived from primary sources and then categorized and plotted on a map. The lessons here are of a piece with most historiography and he appropriately opens by citing John Lewis Gaddis's *The Landscape of History*, and Gaddis's comparison of history to cartography—both "practices that manage infinitely complex subjects by imposing abstract grids over them" (23). Chapter four explores Bakhtin's notion of the chronotope, or how we experience time and place as a value-laden construct, by using GIS to imagine and contrast the rural and urban patterns of Irish poet Patrick Kavanagh's "lifepaths." Chapter five is perhaps the most satisfying in terms of demonstrating how humanists might extend the metaphors of cartography and the science of GIS to interpret and explore a text. Taking on James Joyce's *Ulysses*, he uses GIS as a "tool that collates, juxtaposes, and explores the relationship between a writer's text and various source materials" (76). *Ulysses* makes for a particularly good data source as Joyce himself drew not only on literary sources such as Homer's *Iliad* and Dante's *Inferno* to guide his writing, but also on a specific 1904 map of Dublin. Travis's visualization of, as poet Ezra Pound described the novel, "Ulysses as a magnificent new Inferno in full sail" (77) succeeds because the source material itself is spatial—the levels of Hell, the journeys of Homer's Ulysses—and because those spaces are imaginary. Visualizing those imaginary spaces on the real space of Dublin (though necessarily represented metaphorically, as a map) opens up new ways to imagine this text. The ArcScene visualization itself is not a work of art—certainly no match for Botticelli's depiction of Dante's levels of Hell, which Travis depicts on the preceding page—but it does suggest that there is more we can do to understand and play with the texts we may have, up to now, only read.

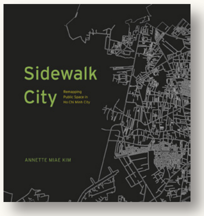
The book is at its best when Travis articulates the mutually informing theoretical potential of GIS and the humanities. He convincingly conveys the creative and scholarly prospects for expanding the role of GIS beyond straightforward mapping and employing it as a tool to variously interrogate source materials, plot and visualize the influence of geography on language and poetry, or reconstruct historical place and circumstance. Where the book is almost inevitably disappointing is in the illustrated examples of each GIS-based mapping project. Strangely, given the medium, there are almost no links to an online, non-static version of any of the maps he has created, except in chapter seven, which references the *Digital Literary Atlas of Ireland*. The maps themselves vary in how effective they are in conveying the complex and often subtle arguments Travis wants to make in each case. The best examples are the maps that chart Kavanagh's lifepaths—helping the reader to see the contrast between the centrifugal patterns of the poet's rural life and the centripetal patterns of the urban—and the maps created to visualize, in layers, the interplay between Joyce's source materials for *Ulysses*. Both sets of examples—the visualizal metaphors of route and line in the former case, and of ascending levels and corresponding paths/episodes in the latter—directly express the notions of chronotope and deformative interpretive reading practices that Travis states he hopes to convey.

More practically, Travis is careful to outline the broad steps he took and tools employed to create each visualization pictured in the book. Each project description has a recipe-like list of tools and methods that nevertheless functions more as a broad overview of his project design than as a step-by-step guide to recreating his efforts. For those already well-versed in using GIS and visualization tools such as ArcGIS—and the tools are largely from the ArcGIS family, with almost no use of open source tools such as QGIS or CARTO—these steps might provide enough information to approximate or extend the project. For those newer to the GIS scene, they may provide a helpful guide to the kinds of tools, skills, and sources used to create similar projects.

The final chapters emphasize a critical approach to GIS and visualization tools. For scholars eager to undertake such projects, Travis correctly stresses the importance of understanding the capacity and limitations of GIS and the tools used to create maps and visualize data. He stresses a critical engagement with the software rather than a passive approach to these tools as "black boxes." Importantly, he also emphasizes the iterative nature of GIS Humanities projects: the maps that one might create shouldn't be seen as a final argument or finished product, but rather as something that can continue to be refined, added to or subtracted from, and revised.

The argument that GIS is a tool to "creatively engage with one's sources" (124), and the author's central argument, that while "GIS serves fundamentally as a cartographic tool, the potential of the technology extends far beyond the cartographic pale" (123), is amply demonstrated and clearly articulated. This is not a how-to book; those looking for guidance in building humanities projects using GIS should look elsewhere. But it does provide a compelling scholarly argument for applying digital tools to humanities research. This is a valuable book for GIS specialists beginning to work with scholars and students in the humanities. And it is a welcome foundation for humanists looking to articulate and understand the language of GIS and cartography and its potential to augment traditional humanities methods, arguments, and narratives.

SIDEWALK CITY: REMAPPING PUBLIC SPACE IN HO CHI MINH CITY



By Anette Miae Kim.

The University of Chicago Press, 2015

264 pages, 52 images. $45.00, hardcover.

ISBN: 978-0-226-11922-9

Review by: Fábio Gil Rodrigues, University of Lisbon

Anette Kim's *Sidewalk City: Remapping Public Space in Ho Chi Minh City* presents narrative research on sidewalk life in that Vietnamese city. Dr. Kim is the Director of the Spatial Analysis Lab (SLAB) at the Sol Price School of Public Policy of the University of Southern California and an Associate Professor at the same University, as well as a researcher at Peking University. She holds a Ph.D. in City and Regional Planning from the University of California, with several published papers and books about public spaces uses, regulation and urban planning practices, spatial ethnography and critical cartography, with a focus on emergent Asia.

Sidewalk City takes the reader on a journey throughout the author's framework analysis of public spaces—namely the sidewalk—from a historical and geopolitical contextualization, to a critical analysis of the results, to visual narratives and further applications. It is important to bear in mind the differences between West and South East Asia when it comes to spatial planning and urban design.

In her first chapter, "Seen and Unseen: Ho Chi Minh City's Sidewalk Life," the author writes about her return to Ho Chi Minh City and frames for the reader the reality of the city and the importance of the life on the sidewalks, taking them to the origin of the book's theme and forming a solid theoretical background. The author clarifies her definition of public spaces and compares several authors'—however, those definitions neglect the importance of sidewalks.

As she compares analytic reviews of public spaces, such as Kevin Lynch's cognitive map or William Whyte's Street Life Project, Kim's major critique becomes apparent: public place analysis consists of spatial ethnography, property rights of public space, and critical cartography—but these have never been used together, creating a gap between social sciences and urban design.

Spatial ethnography conceptualizes the everyday challenges of people within the "spaces" that urban designers have created. Likewise, the importance of examining property rights on sidewalks is clear, including the usage of sidewalks and shared space, and issues of ownership and negotiation. These two concepts lead to the final important subject listed by the author: critical cartography and the creation of "lines of power and sovereignty." Maps empower ownership and create a narrative upon the land, bringing comprehension, awareness, and spatial relationships upon mapped elements or objects.

In the second chapter, "Tropical Paris and Chinatown: The History and Resilience of Ho Chi Minh City's Sidewalk," Kim provides the reader with a historical background, covering the transformation of the region during recent centuries and the social, cultural, and psychological heritages coming from those transformations. She writes that "sidewalks are physical and cultural legacies that we live with today" (28).

Kim takes the reader through Ho Chi Minh City's origins as the two physically separated cities of Saigon and Cholon, and continues with the growth of the kingdom and the differences in both cities up until colonialism. She then covers the predictable human behavior of Saigon under French regulation and the "vibrant sidewalk life" (30) of Cholon under Chinese regulation, followed by war and later independence. Each of these heritages have contributed to the city's design and the changing uses of the sidewalk, due to economic, political and social factors which have influenced society and people.

The third chapter, titled "Looking Again: Power and Critical Cartography," covers the importance of maps and mapping. The author defines critical cartography as "the subset of mapmaking that aims to bring to the fore issues of power" (56), claiming that maps are both a result and an origin of power. Representing more than a point of view, maps play a major role in knowledge, place identification, and shaping and sharpening regions and societies.

The author reviews the cartographic history of the development of Ho Chi Minh City, while also discussing and criticizing current views on critical cartography. She divides the history of critical cartography into two generations. The first focused on how colonial and imperial mapmaking evoked power and privilege; maps' economic purposes and roles in legal and property disputes; and their role in solidifying a society's concept of its empire and colonies. Kim describes the second generation as understanding the role of the map in society. New mapping software offers tools and techniques that allow the critical deconstruction and reconstruction of the map through the re-arrangements of visual elements. The role of maps in society keeps changing, shaping and sharpening it.

Throughout the text, the contemporary evolution and development of mapmaking in Ho Chi Minh City is also seen, as the author illustrates many points with concrete examples.

The fourth chapter, "Mapping the Unmapped: Mixed-Use Sidewalk Spaces" is divided into two parts: (1) a description of the methodology used for gathering data for the project, and (2) the creation of maps that empower the sidewalk—unveiling its life, and revealing a new paradigm from the study's findings: the mixed-use spaces of the "sidewalk life" (147).

The author's study was conducted in two neighborhoods of Ho Chi Minh City: District 1 in the former Saigon portion, and District 5 in the former Cholon portion. Those neighborhoods were later delimited at the ward level, starting in January 2010, comprising 165.141 square meters of analyzed sidewalk space, and 6490 counted people.

The author began by observing the surrounding space in order to understand the spatial ethnography of the sidewalks in her study. Then, she carried out a physical survey, geolocating 3876 observations of vendors on the sidewalks, organized by category and gender. 270 vendors were interviewed and more than 3000 photographs were taken.

The resulting visualizations provided qualitative information about the vendors, commuting and living in the city, as well as ten beautiful and well-conceived maps and map metaphors about life on the sidewalks. Additionally, as a result of interpreting this study, the author stumbled upon the paradigm of mixed-use sidewalk vendors.

Chapter 5, "Drawing New Lines on the Pavement: Street Vendors and Property Rights in Public Space," reveals the importance of understanding the background of street policies in Ho Chi Minh City; the protection and regulation of street vendors plays a role in safety, public health, and discrimination. However, creating such regulations can be a very arduous matter, a process made difficult mainly because, as the author writes, local authorities and society have drifted apart; Kim appeals for discussion.

The final analytic chapter, Chapter 6 — "The Tourist Map: Altering Visions of What Sidewalks Are and Could Be" — features the author's proposal for a visual representation of their collected data that might interest both local authorities and sidewalk vendors. Kim advocates for a discussion among several institutions for effective policies on sidewalk life, guided by visual information which helps illustrate theories that might, on the one hand, improve sidewalk vendor legislation and, on the other hand, boost the growth of tourists that influence the local and regional economy. By creating adequate measures and strategies for valuing the opportunities of the city's life, the use of the sidewalk is legitimated and becomes part of a multi-level social consideration.

The final chapter, "Reconsidering Sidewalks as Public Space," is presented as a reflection. Here, the reader is invited to ponder the importance of the shape of the space itself, the methodology used, the data collected, and the issues that arose while understanding local policies and property rights. It summarizes the entire text in a succinct format, while highlighting every important aspect of the author's theoretical framework, as well as her praxis.

ANALYSIS & VERDICT:

Prior to the text, the chapter index would be better off including a listing of subchapters. Additionally, the length and verbal complexity of the chapter titles might end up confusing readers or lead them to misinterpretation.

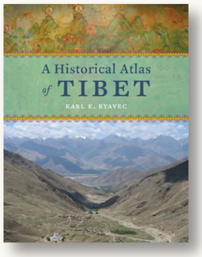
The journey of the initial chapters, in which the author led us throughout the history of Ho Chi Minh City and the theoretical concepts of spatial ethnography, legislation and policy of property rights, and critical cartography, provided a solid framework for understanding the issues found later in the book; it made possible an easy reading of her logic. Kim's combination of various social science and urban design methodologies reveals her broad knowledge, and also offers evidence that these fields are not isolated from one another.

Her usage of several data collection methods, such as surveys, interviews, and physical observations, as well as employment of a multi-cultural team, are revealed to be effective yet time consuming. However, overcoming a reliance on GPS data extraction by using a paper map and pen could enhance error propagation.

The author makes understandable and coherent the dilemma of how to classify and measure mixed-use spaces, as well as how she overcame it. She also discusses the biases in measuring both the surface area occupied per vendor and the number of entrepreneurs, due to the over- and undercounting of both variables. Her explanations further clarify analysis of the results and strengthen the argument for her choices.

As a final verdict, this book may become an essential reading when analyzing public spaces. Every chapter of the book introduces an important step for their analysis, whether the subject is sidewalk living areas or public spaces at another scale. It is important to understand the connection people have to the space and place itself, in order to create bottom-up policies and regulations that fulfill the population's needs. Mitigating gaps among social groups requires creating links between policy makers, authorities, and these social groups.

A HISTORICAL ATLAS OF TIBET



by Karl E. Ryavec

University of Chicago Press, 2015

216 pages, 121 color plates. $45.00, hardcover

ISBN: 978-0-226-73244-2

Review by: Mark Denil

Tibet is one of those places that conjures visions of the sublime; the so-called "roof of the world": remote, insular, hermetic, forbidding (and forbidden), mystic, magical, and far, far away. For many, it is the land of the Lost Horizon of *Shangri-la* (that Hugh Conway first fled, then sought to re-find), or of *Khor-Biyong* (where Tintin found refuge), while for others it may be the terrestrial kingdom of the exiled Dalai Lama, or perhaps the locale of the northern half of that peak in the Mahalangur mountain range known as Chomolungma, where, in 1924, George Mallory and Andrew Irvine disappeared into the clouds. Whatever else it is, it is an area that has seen tens of thousands of years of human habitation; an area that has nurtured native cultures, and has absorbed and changed invasive ones. It has been a crossroads of trade and a wellspring of spirituality, and it has been both the seat of some empires and the back-country hinterland of others.

Two things, however, that Tibet has hitherto lacked have been a seacoast and a historical atlas. While there seems little prospect for the former, Karel R. Ryavec, of the University of California, Merced, has toiled for twenty years to supply us with the latter. Thus, in 2015, the University of Chicago Press presented us with the fruit of that labor: Ryavec's *A Historical Atlas of Tibet*.

The volume itself is a typical University of Chicago Press product: smooth, high-quality pages firmly bound between solid boards covered with green cloth, and sporting a matte-finish dust cover. Internally, it is organized around its 49 constituent maps, grouped into six sets or parts, and each map is supported by an expository chapter.

The *Introduction* contains eight maps that focus on general cultural, geographic, and other overview topics.

Part 1: *The prehistorical and ancient periods, circa 30,000 BCE to 600 CE*, is concerned with the earliest and least well-known time periods. It has only two maps.

Part 2: *The Imperial Period, circa 600–900* represents the first records of Tibetan governance events. Four maps cover this period.

The largest group of maps is found in Part 3: *The Period of Disunion, circa 900–1642*; here the turmoils and travails of over 700 years fill 18 maps.

Part 4, which follows, is also a sizable block: this time of 13 maps. These cover what is called *The Ganden Podrang Period* (*Kingdom of the Dalai Lamas*), some (but not all) maps of which bring us up to about 1959.

The four maps of the *Conclusion* wrap up with Tibet's resources, land cover, population and the current administrative situation as of the year 2000.

The atlas opens with a brief *Preface*, some *Notes on* [the] *Gazetteer: Phonetic and Literary Romanization*, and *A Note on Sources*, and then closes with some *Acknowledgments*, a list of *Historical Photograph Sources*, and an *Index*.

The Preface is especially interesting, in that it sets the stage for understanding how this atlas came to be, and why it likely is the way it is. Rayvec gives a nod to a small troop of predecessors who, over the years, have included Tibet in their own atlases; usually as "merely peripheral to Asia's large sedentary agricultural civilizations" (xiii), but he then goes on to tell us how the "spontaneous" idea of this atlas came to him at a scholarly meeting in 2005. His timeline is a tad obscure, but I make it out that he counts his "twelve years of research and eight years of mapmaking" from 1993, when he first began building the databases that eventually became the source for his 49 maps. It was that decision in 2005, however, and "the feeling that there was no time to waste, [that] partly explains why this historical atlas of Tibet is an independent work of one scholar and not a large project with an editorial board and armies of cartographers" (xiii) In fact, except for Nicolas Tournadre, who is listed as a (lead?) collaborator on Map 7 *The Tibetic languages*, there is no other name associated with this atlas: no editor, no photo editor, no assistant cartographer; no one. That happenstance, coupled with the casual remarks in the Preface, might give one pause, and raise some nagging questions about the author and his spare-time atlas project.

It turns out, though, that the breezy narration in the Preface is not a red flag. A read through the *Acknowledgments*, which in this instance is not the usual banal blather one tends find under that heading, but a tremendously detailed account of the author / cartographer's path to placing this volume in your hands, will put those qualms to rest.

This is a serious work, albeit a very personal and idiosyncratic one, and the reader comes gradually to the realization that while its strengths are bound up with, and may in many instances be identical with, its weaknesses, these selfsame strengths and weaknesses form a dynamic and forceful whole that stands on its own and commands our respect.

GENERAL REMARKS

Much of the attention given *A Historical Atlas of Tibet* focuses on its pioneering position, as it brings together, for the first time in a geographic context, the historical and cultural transformations of Tibet since the Paleolithic period; but its "first effort" status is hardly the end of the story. The breadth of this atlas' appeal, and its utility to readers ranging from neophyte to student to expert, is not solely grounded on a dearth of competitors. *A Historical Atlas of Tibet* establishes an overarching four-dimensional framework into which the oftentimes fragmentary, disjointed, and sketchy facts and evidence that makes up so much of Tibetan history can be fitted and understood. It is sure to have a long-term importance and influence, and it is quite sufficiently solidly founded to support that task.

There is a lot to like about this atlas, though there are a few things one might wish were more likable.

THE MAPS

Two-thirds of the forty-nine maps are on the same hypsometric base, with the rest (a variety of maps that include cultivated areas, land use, travel times, and monastic establishment density) based on simple line work. The hypsometry base is divided into three elevation steps, plus a glacier/snow color within the highest elevation class, and is overlaid by a well-modulated greyscale hillshade. The hypsometric classing places both the high Himalayas and the vast Tibetan Plateau in the highest range, which, it seems to me, tends to level things out rather too much; another class break at about 6600 meters might have been useful in better characterizing the topography. That said, I also know from experience just how difficult this part of the world is to map at small scale: there is so much dramatic variation in such a complex configuration of ridges and valleys, that one is driven to extremes of generalization in an attempt to balance conveying the extremes of elevation and the nuanced ruggedness of the terrain with the need to also place coherent and readable text and thematic information on the map. Ryavec has found a balance that he has been able to stick to right through the atlas, and if his solution seems a bit over-generalized, especially in some of the larger scale maps, it would be simply ill-mannered and hubristic to fault it. I am planning to quibble with a lot of cartographic decisions in this atlas, but this big one gets a pass.

Taking Map 3: *Major regions and natural features of Tibet* as an example for general quibbling, one actually finds very little to grouse about on the map itself. There are occasional collisions between labels and the graticule (other maps in the atlas have more obvious and annoying examples of this), but the graticule itself has a well-chosen line weight and is very gracefully labeled. There is a varied and nuanced typographic hierarchy: unfortunately, it is nowhere explained (except rather incompletely and obscurely, on Map 8). In some cases the type associations seem obvious, in other instances they are less so (particularly for a non-Tibetanist like your reviewer). There is, for example, a bit of ambiguity between extra-Tibetan national and Chinese provincial names: while the (non-letterspaced) label "CHINA" is slightly larger than provincial names like "YUNNAN", the national name "BURMA" (just over an inch from "YUNNAN") is the same size, color and face as that provincial name. Mixed case for provinces may have alleviated this confusion.

It is a bit of a surprise to discover, in the upper left corner of Map 3, the label "RUSSIAN EMPIRE." Determined searching finally turns up the note at the end of the entry in a one line legend in the lowest-left corner of the map: "Major Polity Boundary/Frontier c.1900." Why is this critical bit of temporal / contextual information buried like that? Similarly, we know (admittedly, from reading this atlas) that the north-eastern Tibetan region of Amdo has only relatively recently acquired that name: why is it labeled Amdo in 1900?

The dashed line showing Major Polity Boundary/Frontiers, circa 1900, falls victim to one of the recurrent bugbears of digital cartography: there is a feature complexity threshold beyond which the dashed line symbol no longer does its job. If we look at the China / Burma border, we see the gestalt of the dashed line break down completely: near the neatline the linear dashes become just a stack of *parallel* line segments. Selective, judicious, manual feature generalization, or a different symbol, are the only solutions I know to this problem. The Afghanistan border on this map, too, by the way, clearly suffers from doubled polygon outlines.

Speaking of lines, why are there no generalized boundaries on this map for the high-level Tibetan regions on this map? Four pages further on, the small Map 4 of *Tibetan macroregions* has these lines, while Map 24, *Ngari circa 1250–1365*: *Yatse-Guntang rivalry during the Mongol Empire Period*, demonstrates an understandable manner for showing such approximate frontiers.

The most egregious atlas-wide map problem, however, concerns inset textual information and/or map furniture. GIS software is really good at making boxes around legends, scale bars, and notes; around almost anything, in fact. The author has indulged this predilection to excess. Every little thematic group of symbols has its own legend in its own tight little white box surrounded by a little black line. This practice does provide a certain flexibility: the map author can scatter or group these boxes as he pleases in places that, for a given map, are innocuous or advantageous. Sadly, the advantages of modularity do not trump the ugliness and clunkiness of the horrid little boxes themselves.

When I was a young lad studying cartography at the College of Geographic Sciences (COGS), we were taught about Newman Bumstead of National Geographic, and about Bumstead's Laws:

- the space between the words must be visibly greater than the space between the letters.
- the space between the lines must be visibly greater than the space between the words.
- the space between a block of text and anything else must be visibly greater than the space between the lines.

These rules can be usefully violated, but there must be a good reason and it must be gracefully done.

Mr. Ryavec's little boxes are an excellent demonstration of what happens when you ignore Mr. Bumstead's advice. The Bumstead violations rampant in these little boxes render them cramped, ugly, inefficient, and an impediment to map reading. Where the boxes are grouped (sometimes more, and sometimes less, logically), the internal dividing lines create little tessellated tilings; where they are separated by space, the eye must wander about the page in hopes of hitting on one, with little indication if it is the one sought until it has been read through. Certainly, several of the atlas maps have a great deal of information (often place lists) imposed on the map face: that is all the more reason to open things up a bit. Using plain, un-outlined white patches (polygons, but not necessarily rectangles) with a bit of breathing room around the outside and some structured whitespace to organize them internally would be a step forward. It is notable that some of the larger scale maps, such as Map 32 *Amdo circa 1368–1644: Local monastic powers in relation to China's Ming Dynasty*, manage to have scale bars and some supporting text sans boxes, despite having boxes for the thematic and standard elevation legends.

Map 8: *How to use this atlas: Map coverage and cartographic conventions,* a two color map (black and blue), is the only source of extents for the various maps in the atlas, besides being a place and feature name reference unencumbered by topography. It is a very useful map. Using only two colors, however, it is less usable than it might be. The base map is admirably clear and readable, but, being overlaid with map extent rectangles also in black, and, using the same line types and weights as the base map features, the map is unnecessarily confused and confusing. The labels for the extent rectangles are not easily distinguishable from the other annotation, either. Color for the map extent information might seem a logical tactic. One also wonders why this useful map is buried on pages 30–31: this makes it hard to find when using the atlas, and, as there are no key maps anywhere else in the volume, finding this map while not losing one's reading place is not an infrequent task.

THE TEXT

The first section in any atlas is concerned largely with scene setting: naming, describing, and arraigning the stage upon which the (in this case historical) narrative will play out. Ryavec takes on a formidable task in trying to provide a physical and ethnographic description of the area while simultaneously introducing an understandable structure for Tibetan history. The result is a less-than-happy balance; one is left with a very muddled picture of the land, its people, and its history, which results in a somewhat discouraging start. Throughout the atlas, the narrative lacks continuity: often names, places, religious sects, and other things are mentioned in passing as significant, but we only learn later (sometimes much later) what that period, place, or thing actually was. For example: an Imperial Period is mentioned early on page 8, but it is not mentioned again until near the end of page 15, where we learn that it started in the seventh century and (if the Tibetan Empire that apparently fell in the ninth century is identical, as is perhaps likely but not explicitly stated) we also learn how long it lasted. This example is typical of the way the narration seems to careen about from fact to fact, an impression exacerbated by the almost random paragraphing, frequently clumsy explanations, and the occasional loose splinter of sentence fragment.

I don't doubt Ryavec's facts, and I note that he does mention in the *Acknowledgments* having circulated his text amongst his colleagues for review. Nonetheless, a copyeditor is sorely missed. It is likely that such a luxury was beyond the means the author's limited project resources, and it would be churlish to condemn the atlas for not being as highly polished as "if seven maids with seven mops / Swept it for half a year" (to borrow from Lewis Carroll's 1872 poem, *The Walrus and The Carpenter*). Contrary-wise, I would myself be remiss to review this work and take no notice of its finish.

CONCLUSION

As I remarked earlier, *A Historical Atlas of Tibet* is a serious and important work, albeit a very personal and idiosyncratic one. It is important in itself as a scholarly work, and it is important for being a pioneering effort. It is a substantial achievement in its field, and it is a tremendously impressive product for a lone researcher and cartographer. The author, who labored alone 20 years to bring us this atlas, and himself expresses the wish he had another couple decades to put into it, has presented us with a real gem. Similarly, we in our turn can hope that this jewel becomes the seed from which even more ambitious and comprehensive Tibetan atlases may grow under the hand or guidance of Karl Ryavac. Neither wish diminishes the value of this atlas. Go buy one.

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