INFO 247: Final Project Write Up
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Submitted May 11, 2022

I. Project Title: California's Largest Lake: From Environmental Disaster to Green Powerhouse?

II. Project mission, goals, and key narrative points

The mission of this interactive data storytelling project is to inform a primarily California audience of what's happening in the Salton Sea and its potential benefits and risks for the state, the market, and communities nearby.

The story of the Salton Sea is endlessly fascinating, but complex. It has a tragic past and a potentially transformational future as one of the world's largest lithium production sites. The high-level goal of our project is to tell the 'future' part of that story, clarifying the key technical details of how lithium extraction works, the Salton Sea's lithium capacity, and the economic impacts of a ramp-up in lithium production for the region and global markets. A secondary goal is to to contextualize this story within the Salton Sea's bizarre history, contrasting its ugly past with the possibility of a brighter future.

This interactive story will aim to communicate the following eight key narrative points, weaving together a combination of text, photos, and data visualizations:

1. Introduce the Salton Sea, its location, size, and origin story.
2. Guide the viewer through key highs and lows of the Salton Sea's history as a tourist location turned environmental waste site.
3. Explain most recent developments in the state leaders' plans to transform the Salton Sea into a lithium production center.
4. Briefly introduce the viewer to lithium, explain its centrality to energy storage technology, and highlight which countries are leading current global supply.
5. Detail the estimated annual lithium production capacity of the Salton Sea region, and contrast it with current and projected lithium demand.
6. Show where the lithium under the Salton Sea is located and how safe, clean extraction could work.
7. Highlight the potential economic benefits of lithium extraction to the surrounding communities.
8. Update viewers on the latest plans on the part of state and corporate leaders to begin extraction, while raising questions about prioritizing community and environmental wellness.

III. Tasks the project interface is targeted towards

Our interactive piece is based on a scrolly-telling format, which is meant to simply and seamlessly enable the user to guide themselves through each stage of the story in a linear way. As such, scrolling and pausing to read, observe, and interpret content are the core tasks that the interface presents. We intentionally break the text of the story up into small 1-2 sentence chunks that can be absorbed gradually alongside an accompanying visual, whether a photo, traditional data visualization, or other form of information visualization like a diagram.

Since the end goal of our visualization is to inform our audience, we would consider our mission fulfilled if an audience member reaches the end of the article having read and absorbed the information. While we don't tell the reader what to do with the information (this is a piece of journalism, not advocacy), we do aim to raise awareness of high-importance concerns for readers. It's our hope that, equipped with this information, our audience will be better positioned to engage with the issue as they wish.

IV. Discussion of related work and design inspiration

We reviewed several pieces of related work for this project. These pieces broadly can be categorized into two buckets: 1) Articles and other journalistic work on the Salton Sea or California lithium production topic and 2) Interactive, scroll-based stories that covered different topics but provided stylistic inspiration. We introduce three of each and discuss their relevance to the project below:

Related Work on the Salton Sea and Lithium Production in California

'The Fight for California's Great Lake', published by *ViewPoints* at Riverside City College

This piece was important to the development of our story because it represents another student-led effort to highlight the Salton Sea's history and potential, as well as the history of how marginalized communities surrounding it have been excluded from decision making in the past. We discovered this piece later in our story development phase, but felt that our goals differed from those of this story sufficiently so that we would not feel as though we were "re-inventing the wheel." This piece focuses more on the health of the Salton Sea itself and community interests, and pays only marginal attention to the role of lithium.

While the story does not provide a publication date, it appears that it was written at least a year or two ago, which might explain why the very recent lithium development was left out. Still, this article offered stellar in-depth, on the ground reporting that helped us better understand the ecological dilemma facing the Salton Sea and its impacts on surrounding communities, as well as the history of how those communities have been left out of previous decisions. Lastly, from a design strategy perspective, this story leaned almost entirely on text and photos, providing very little data visualization. In contrast, our piece would be designed to provide a much higher-level view of the Salton Sea, with a deeper, data-driven dive into the role of lithium extraction.

'Turning the Tides: The Story of the Salton Sea', published by USC Annenberg's School of Journalism

Another student-led piece, this video/virtual reality YouTube series published by a student team at USC Annenberg's School of Journalism also offers a deep dive into the Salton Sea's history, key environmental challenges, and the communities that rely on the Salton Sea, such as a local native American tribe that has lived in the region for thousands of years. This piece relies on multimedia entirely and incorporates some impressive virtual reality features. It was particularly relevant to the development process for our project by providing more helpful background information and highlighting the aesthetic richness of the Salton Sea region. It influenced our decision to choose a full-screen format that incorporated a diversity of photos of the Salton Sea and surrounding areas. Like the previous piece, this one also mostly neglected the lithium component of the story, which strengthened our resolve to make that the central theme of our story.

Quantifying California's Lithium Valley: Can It Power Our EV Revolution?

This recent piece published by friends of Orions at the Berkeley Lab offered a detailed overview of the potential of the Salton Sea to become a center for green energy through lithium extraction. The piece interviews experts at both U.C. Berkeley and U.C. Riverside, who are currently working together to better understand the size and concentration of the lithium reserves that lie below the Salton Sea region. This piece highlighted the reality that the exact amount of lithium in the reserves remains unknown, though experts at Universities and working for the state have produced estimates. This article also details the extraction process and explains why it could make the Salton Sea one of the cleanest lithium extraction operations in the world. This information all directly informed our own explanation of the extraction process and the accompanying diagram that we developed for our story.

Related Work for Stylistic Inspiration

[In Certain Science and Engineering Fields, Sex Diversity Among Graduate Students is Stagnating. In Others, It's Getting Worse.]

By far the most influential work on our project was Jason Kao's piece for the Columbia Spectator. The influence of Kao's work is most visible in the presence of white scrolling text boxes linked to D3 charts. He inspired our text-on-left figure-on-right approach that we used for all of our visualizations. Most importantly, Kao is the literal creator of React-Scrollama. Without his work, our project would have been much more difficult. He also posted source code of the aforementioned article online, providing key scaffolding for our piece. We directly adopted some of his code for our text-over-image visualizations at the start and end of the piece. Somehow, Kao did all this while an undergraduate student at Columbia. Incredibly talented guy.

It was a Night Like Any Other

The New York Times is heavily influential in the graphics community and scrollytelling is no exception. Articles like the one above helped to inspire the text-over-image style that we use at the opening and closing of our piece. We found many excellent images for this article and the NYT approach helped us find a way to put the images and text on nearly equal footing. We particularly liked that this article opened with a very strong full screen image with text scrolling over it. Because we couldn't find an appropriate video, we instead used the scrolling text to drive image transitions.

The Scramble to Secure America's Voting Machines

This article offered several good practices that we adopted. We particularly liked the presence of a non-square figure on a white background that would change as text scrolled. We adopted this approach for viz 2, where we layer additional information onto the figure that corresponds to the text. We also liked the size and spacing of the white text boxes. We used a similar padding and a similar font, trying to recreate the same feel. We also adopted the practice of spacing our text boxes with about 80vh between them, so that a new box enters right as the old one exits.

V. Description of the Visualization with Video Recording

Our interactive data story brings together user-friendly, scrolly-telling capability through Scrollama, high quality images (purchased for unattributed use through Adobe Stock or through attributed government sources), and bite-size chunks of text, to guide our viewer through the key story points outlined above. In terms of data visualization, our story utilizes a few approaches, including interactive bar graphs designed using D3, isotype visuals created from scratch in Adobe Illustrator, and hand-drawn diagrams, also created in Adobe Illustrator.

The following video capture documents all key moments in the story and all data visualizations and photos used:

https://drive.google.com/file/d/1yFFLG8I0gJJipQ7PkICEJvIx7u0Y5Dqh/view?usp=sharing

VI. Key data Sources Used in the Story's Data Visualizations

This story drew upon a large number of data sources for both the data visualizations as well as the written text. In the two tables below, we detail and provide links to all data sources for any facts stated in the story text or for any data visualized.

Table 1: Data Sources for All Data Visualizations		
Lines from story with key fact or data point	**Accompanying data visualization**	**Information Source**
More than 80% of the world's raw lithium is mined in Australia, Chile, and China. And China controls more than half of the world's lithium processing and refining.	Interactive bar graph on current and future lithium supply	World Mining Data
More than a mile below the Salton Sea and surrounding area lie geothermal reservoirs full of superheated saltwater brine that contains lithium.	Diagram of lithium extraction process	California State Lands Commission
Geothermal plants are already pumping the 600 degree water up from underground to generate geothermal energy before sending it back down. Lithium extraction would add just one more step to that process.	Diagram of lithium extraction process	Berkeley Lab
According to estimates, the Salton Sea reservoir contains more than 1 million metric tons of lithium—enough to meet current global demand for a decade.	Visualization of 1 million metric tons of lithium powder.	Berkeley Lab
That's enough energy to build 100 billion smartphones.	Smartphone isotype visualization	Deloitte
With the energy from one million tons of lithium, you could drive a Tesla Model 3 to Pluto…and back.	Solar system and electric car visualization	Our team's calculations based on estimated full-charge

		range of Tesla Model 3
But global demand for lithium is expected to grow nearly 20-fold by 2050.	Interactive bar chart with current and expected lithium demand	International Energy Agency

Table 2: Data Sources for all Facts and Data Points in Story Text	
Lines from story with key fact or datapoint	**Information Source**
The Salton Sea, created by accident when an irrigation canal flooded in 1905, is a 343-square-mile lake in the middle of Southern California's barren Colorado Desert.	The Salton Sea Authority
From the 1960s-1970s, the lake's warm, sandy beaches drew throngs of tourists, at one point even more than Yosemite. But that all changed when pesticide runoff from nearby farms started leaching into the lake.	The California Legislative Analyst's Office
Earlier this year, California Governor Gavin Newsom announced plans to transform the Salton Sea into a center of lithium production, calling it the "Saudi Arabia of Lithium."	California Governor's Office
Lithium extraction could transform the high-poverty communities surrounding the Sea, which have some of the highest unemployment rates in the state.	State of California Employment Development Department
Some experts say the California "white gold rush" is already on. Companies like General Motors and Berkshire Hathaway have already announced investments in closed-loop, geothermal lithium extraction operations.	General Motors and Berkshire Hathaway Energy

VII. Tools Used to Accomplish Project Goals

Our team employed a broad range of tools, including some we were more familiar with and others that included a steep learning curve. We detail each tool and its role in the project below:

React: React is an industry standard frontend framework. Our project was written entirely inside React, making handling the DOM and interactivity much easier. We leveraged functional components along with the useState, useEffect, and useRef hooks to construct a highly responsive interface.

Scrollama / React-Scrollama: Scrollama provides an extremely convenient API for linking IntersectionObserver events to Javascript variables. React-Scrollama wraps Scrollama inside a React Component, making an easy-to-use interface. We used it to link transitions in our backgrounds, figures, and charts to the movement of div elements. In particular, Scrollama components expose `onStepEnter` and `onStepExit` callbacks that fire when entering and exiting steps, respectively. We created callbacks that called the useState hook to adjust the state of the React component. We could then pass the state to child elements and use it to dynamically calculate element opacity. That approach formed the core of our interactivity.

D3: D3 was used to create dynamic interactive plots for visualizations one and four. We borrowed much of the D3 code from a public Observable notebook and then heavily supplemented the code to allow it to interact with React-Scrollama. In particular, we used the useRef hook to allow D3 to build a chart around an element present in the React DOM. We then linked the data to a useState hook and the charts update functions to a useEffect hook, creating a responsive D3 chart.

Netlify: Netlify is a website hosting service that we used to communicate on draft progress and ultimately to host our final project.

Adobe Illustrator: We used Adobe Illustrator to design and produce the SVG images that were used for both the isotype visualizations (illustrating the number of phones and electric cars that could be built using the estimated lithium deposit under the Salton Sea) and the Geothermal Lithium Extraction diagram and Solar System diagram. Adobe Illustrator allowed for easy hand-drawing, scaling, styling, and exporting of these visualizations.

Google Documents: A tool often taken for granted, Google Documents played a pivotal role in our project management process. We used a shared google document to draft, edit, and store the body text used for the story as well as a Google Sheets document to assign and track progress on tasks related to the project. These tools were key to allowing us to work seamlessly as a team and ensure our workload was shared as evenly as possible throughout the course of the project.

VIII. Usability Study Process and Results Obtained

The system evaluated in our usability study was an early design of the scrollytelling-style interactive data story we designed on the Salton Sea. At the stage in the development process when we conducted the usability study, we had achieved the following milestones:

- Finished drafting and editing a solid first draft of the story text.
- Adapted and deployed the React-based scrollytelling system to run our story.
- Created static mockups of all 7 key data visualizations that appear in the story.
- Selected and included other visual assets (photos and videos to include).
- Implemented all text and visual elements in the interactive scrollytelling platform.

With these tasks complete, our visualization had reached a critical point in which it was functioning at a sufficient level and all key elements were included in at least a basic form. This seemed like a fitting stage in the project's development to carry out our usability study. There were four core goals of our usability study, including:

1. To gauge the intuitiveness and user-friendliness of the platform, visualizations, and written content,
2. Identify any points of confusion or interruption in the functionality or flow of the story,
3. Test the ability of the story to successfully communicate key facts, and
4. Solicit feedback from a group of testers who represent our target audience in order to iterate on the design.

The rationale behind these goals were the essential aims of usability testing: to improve the overall user experience of our tool and to iteratively correct design flaws that hinder navigability and impact.

About Test Participants

We identified three participants who generally represent our core audience: California-based, college-educated adults who would be broadly interested in topics of energy, the environment, or public policy. They were selected on a volunteer basis through contacts within both Orion's and Derek's graduate program networks. All volunteers were California residents and students at UC Berkeley. As such, they represented a small but meaningful segment of the target audience.

Key Scenarios/Tasks

The testing sessions were conducted in-person or over Zoom video calls in which either Derek or Orion shared the link to our data story so they could view it on their own device at their leisure. The participant was encouraged to "think out loud" through their experience of the site, vocalizing any reactions, likes, or dislikes. Derek or Orion took notes on any reactions expressed by the participant while they read. Once the participant finished the story, Derek or

Orion conducted a short interview, taking thorough notes on all responses. Due to the scrollytelling format of the design, participants were asked to perform three specific tasks:

1. Read through the story from start to finish, freely and vocally expressing any positive, negative, or neutral reactions to the story itself or the user experience. Once finished, close the story.
2. Answer a set of user experience interview questions posed by Derek or Orion.
3. Answer a set of fact-based interview questions that gauge the degree to which key pieces of information were communicated (participants were not told any details about the questions posed until after they had finished reading the story and had closed it.)

Test Measures

The two sets of interview questions queried participants on their user experience and their recall of specific information in the article. Participants were given unlimited time to finish reading and were encouraged to take as long as they wanted. None took longer than 10 minutes to complete the story. After they finished either Derek or Orion queried the participant's experience and their recall of specific information in the article.

The user experience questions were framed to identify strong and weak points in the story, any points of confusion, highlight any technical issues, and solicit overall reactions and suggestions for improvement. We interpreted answers to this set of questions as qualitative data. The fact-based questions were used to test user's prior awareness about the story topic as well as the extent to which the story communicated key facts and determine if any require re-shaping. We interpreted answers to the factual questions as both quantitative and qualitative. They were quantitative in the sense that we could determine the fraction of each question answered correctly, but also qualitative because our team took notes on some nuances in participant responses which aided our interpretation of results.

Usability Study Results

Table 3: User experience questions results	
Question	**Responses**
How long did it take you to read through the piece?	6-7 mins
	4 mins
	4 mins
What were the 2-3 top takeaways that you gathered from it?	a. Large lithium reserves in Salton Sea are a game-changer for the global battery markets (smartphones, EVs) whose demand is only expected to increase later on b. Untapped potential to be one of the cleanest lithium extraction operations c. Impoverished areas around the lake - lithium extraction can have

	economic impact for both CA and Salton
	The Salton Sea used to be a big tourist attraction before runoff caused it to become a toxic cesspool. It has the potential to produce large amounts of lithium, which can be used to power many electronic devices.
	That lithium mining in CA could be a gamechanger in this salt flat that is currently a toxic lake. That the extraction process would be clean and economically transformational for the communities.
Had you heard about the Salton Sea before the piece?	No
	No
	No
On a scale of 1-10, how would you rate your level of interest in the story as you read (1 none, 10 very)?	8.5
	6
	7
Which parts of the story (text or visuals) did you like the most?	The visual showing how 1,000,000 metric tons of lithium can make a Tesla 3S drive to and back from Pluto
	I liked the pictures.
	The juxtaposition of the 1960s photo with the/pollution photo. All the photos were cool and helped visualize the area. Also liked examples of teslas and phones.
Were there any parts of the story (text or visuals) that you found confusing or unhelpful?	Maybe the visuals representing no. of smartphones/EVs manufactured? Seemed a bit repetitive having them sort of back to back. Also, not sure if this can be done, but maybe the global lithium supply estimate (with the comparison between countries - Australia, Chile, China, US, Argentina etc.) visual can have the numbers stacked above each of the bars in the chart?
	Yes, the end got a little strange and choppy. It seemed like there were missing parts of the story.
	The whole “if all the lithium was one battery” concept - Instead say something like if you lined up all the batteries end to end it could cover x number of miles. Didn’t need all 3 of them (iphones and teslas) maybe think about removing one. It was also confusing at the end: is it enough to meet demand or not? Maybe do something more creative on the production charts–kind of basic.

Did you run into any technical problems navigating the piece? Any moments when you weren't sure what to do next?	No technical problems faced
	Yes, there was no real end to it, just a lot of blank space at the end. I was unsure if I was missing visuals or if that was purposeful.
	Nope not really. There were some times when the photo transitions were a little weird or when some visuals didn't line up with the text.

Table 4: Fact-based interview questions results		
Question	**# answered fully correctly**	**Notes**
Where is the Salton Sea?	3/3	N/A
The Salton Sea drew more annual visitors than which other major natural site?	3/3	N/A
Where does the lithium in the Salton Sea region come from?	3/3	N/A
True or false: the Salton Sea's annual production amount will meet global demand in 2050?	2/3	One participant was confused about the current production vs. future demand.
What do you remember about the communities near the Salton Sea?	2/3	One participation only recalled that the communities were impoverished, but neglected to mention the health problems caused by pollution.

Discussion of Results:

Our usability study results yielded several salient takeaways:

Most people have not heard of the Salton Sea

None of our participants had heard of the Salton Sea prior to reading our article. All of our participants reside in California, so their unfamiliarity confirms that the Sea is a local geographical feature with little name recognition outside Southern California. This finding mirrors the authors' experience when discussing the project with colleagues: few people have heard of the Salton Sea despite its size. This finding was largely expected and reinforces our decision to frame the story as simultaneously a local and global narrative.

Our story effectively communicates the core message

The key takeaways shared by participants closely mirror our intended takeaways from the study. Readers picked up on both the local impact on the region as well as the global impact on the overall battery market. Interestingly, not all readers mentioned both impacts on their feedback. Readers 2 and 3 only mentioned the local impact, and reader 1 mentioned both. We intended to include both a global and local angle in the story, but it appears that based on the tendencies of the reader they can come away with either or both.

The ending needs to be clarified

Multiple readers mentioned the lack of a clear ending, partially due to a technical issue where undesired white space was displayed at the trailing end of the article. The story ends with the sentence, “even though the Salton Sea’s lithium deposits aren’t sufficient to significantly impact future global markets, it could be a game changer for the region and the state.” Nonetheless, one reader commented “confusing at the end: is it enough to meet demand or not?” and expressed during the interview that she wanted to know more about what the next steps are for the Salton Sea. Is production already happening? Is it still a long way off? This is evidence that our ending blurb did not effectively fit into the narrative, despite stating a conclusion, it does not appear to be a conclusion readers were primed for. Upon reflection, we agreed that in our effort to keep the story focused and concise, we have over-trimmed the ending piece.

Readers valued the visuals

Several readers stated that the images and graphics were their favorite part of the story. Ultimately, it was the images and not the text that anchored the story. Regrettably, only one user mentioned the data visualizations themselves as a favorite part. One reader suggested “maybe do something more creative on the production charts,” they are referring to the mockup chart that we intend to replace with an interactive visualization. These messages reinforce our takeaway to put more effort into moving the visuals from static mockups to more interactive, dynamic graphs.

Transitions need to be cleaned up

Several readers mentioned dealing with choppiness and odd transitions between images. The authors also encountered this issue when interacting with the site. Currently, the image fade is linked to progress through the text block, which only produces a good transition if the reader is scrolling slowly. It appears that slow scrolling is not consistent enough user behavior to guarantee smooth transitions.

Actionable responses:

Our team took away the following actionable next steps from the usability study data, which we implemented in the final version of our data story:

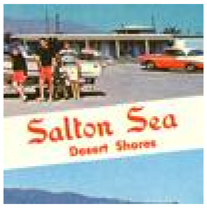
- The last chunks of text should be restructured to clarify the main takeaway.
- We should add another panel and a few sentences focused on next steps for the region to finish the story.
- Transitions should be changed to a timed transition instead of linking scroll to opacity.
- The two mock bar chart visualizations should be replaced with real interactive charts.
- The overall aesthetic of the visualizations should be revisited to clarify and simplify the design and add interactivity where possible.
- In some areas, the triggers to align text with visuals need to be adjusted to ensure the viewer has adequate time and space to absorb them together before scrolling past.
- There is a need to clarify the text and chart that compare the Salton Sea's estimated annual lithium production with projected global demand, to both highlight the immense amount of lithium the Salton Sea can produce while also showing that even this amount alone will not meet projected global demand in future decades.

IX. Team Division of Labor

Both members of our team brought a unique set of interests, background experience, and skills, which we endeavored to use in a complementary way that would allow for efficient use of time and energy while providing opportunities for both of us to learn. Overall, we both felt satisfied that the labor (measured in both hours of work and effort) was evenly distributed.

Table 5: Division of Labor by Student		
Key Project Piece	**Percent performed by Orion**	**Percent performed by Derek**
Conducting background research	50%	50%
Concept development, sketches, and mockups	50%	50%
Integration of React, Scrollama, and D3	100%	0%
Drafting story text	0%	100%
Mid-semester presentation	50%	50%
Building D3 visualizations	60%	40%
Designing SVG images	10%	90%
Web design with CSS/HTML	90%	10%
Designing, conducting, and writing usability study	50%	50%
Iterative text and design edits	50%	50%

X. Small thumbnail image (100x100 pixels) for INFO 247 Final Project Web Page:



XI. Links to Demo of the Final Data Story and the Supporting Github Repository:

Demo of the data visualization story: https://salton-sea-story.netlify.app/

Github Repository: https://github.com/orioncohen/salton-sea

Video of Site Usage Demo:
https://drive.google.com/file/d/1yFFLG8I0gJJipQ7PkICEJvIx7u0Y5Dqh/view?usp=sharing

The above github repository link contains all of the html, css, and javascript files where this project is coded, as well as all linked datasets that appear in visualizations.