Aqua·litative

Acoustic & Kinetic Translations of California Water Data

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ABSTRACT

Aqua•litative is a kinetic installation that renders multiple data sets related to California's water history into a sensory experience. The work transforms climatological data into acoustic sounds (ringing of clock chimes) and kinetic movement (motors moving arms of balsa wood). The installation maps twenty-six Californian weather station's data across twenty-six modules, slowly unfolding forty years worth of climate activity (1975-2015). By using climate to drive a human-made machine we resound the tale of nature as cultural construct. This paper will address conceptual framework, creative process, and technical details of an environmental art installation.

Keywords

Data, data-driven art, installation, physical computing, environmental art, sustainability, sound art

1. INTRODUCTION

California has been reeling from several years of drought, and state officials have begun to roll out another set of water rationing regulations throughout the state.[10] In addition, drought has negatively impacted the Colorado River and Lake Mead, which is used to generate electricity for an average 1.3 million people across three Western states.[7] California is the 8th largest economy in the world, and water is a human managed resource. As the World Bank currently reports, by 2025, "nearly two-thirds of countries will be water-stressed and 2.4 billion people will face absolute water scarcity."[18] If we view California's water-stressed situation under the lens of William Cronon's cultural constructions of nature, California's water has become "commodity", "moral imperative", and "contested terrain." [4] These spaces help form a point of departure for Aqua•liative.

The environment has been a rich source of artistic endeavor. Adams [1] and Rose [14] each created site-specific weather installations to directly tie the local, physical landscape to sound. Traubeck [16] plays a tree's history by mapping the tree's rings to piano notes. Similarly, Gordon Mumma [5] translated seismographic data to piano scores in his 1960s Mographs. Aqua•litative attempts to provide an entry point for different audiences to understand complex data in an inviting and approachable format. Aqua•litative transforms California water data into acoustic sounds and physical movement shown in a gallery space. California climate data moves motors and rings clock chimes that represents an aural/visual history weighing water supply with water policy.

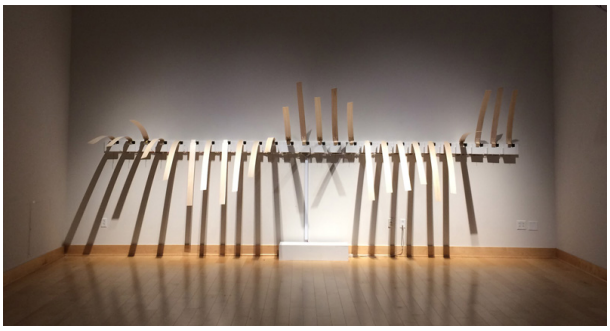

Figure 1: Aqua•litative in the gallery

2. DATA SETS

Throughout the project, we investigated and prototyped with several data sets including product information from the Nielsen Retail Scanner Data Set (2006-2013) [17], The North American Drought Atlas (835 Tree Ring Chronologies, 0-2005) [6], National Oceanic and Atmospheric Association (NOAA) weather data [11], Western Regional Climate Center (WRCC) weather station data [3], and the National Agricultural Statistic Service (NASS) data on California-grown produce [15].

Most data sets fed early prototypes, some of which became part of the gallery exhibition. For example, NOAA weather data became visualizations hung in the gallery space [Figure 2] and Nielsen scanner data generated info-graphics on human related data, specifically the sales of Californian bottled water across the US. While not implemented, the North American Drought Atlas fueled early sound-design prototypes, and one interesting sound example mapped rainfall to note density.[2]

Due to the comprehensiveness of the WRCC's data loca-

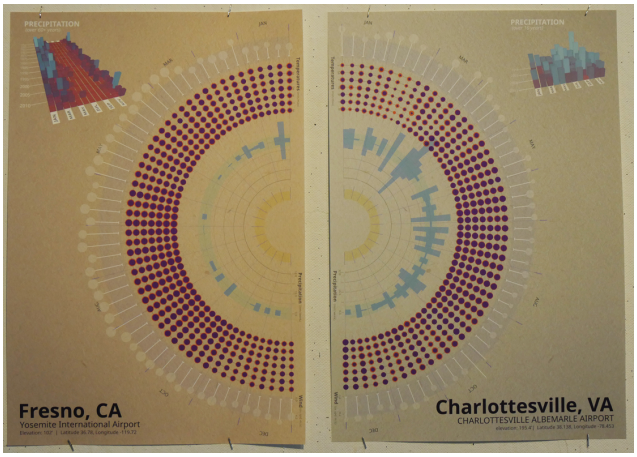

Figure 2: NOAA weather data (2015) compares locations in California to Virginia. The exhibition took place in Virginia, so that visuals provided a local comparison for audience members.

tions and climate-related statistics, we chose the WRCC data set to drive the installation. In addition, early designs [Figure 3] complemented ideas of time and location that WRCC data afforded. Aqua•litative uses climate data from twenty-six weather stations from the WRCC (1975-2015) that actively represent California's different climate regions. Monthly time points proved best for framing the installation narrative; we generated monthly averages based upon the daily values, removed excess data columns, and then compiled individual station files. We were able to reduce file size, in some cases by a magnitude of one-hundred (e.g. 262 MB sized files became 2.6 MB).

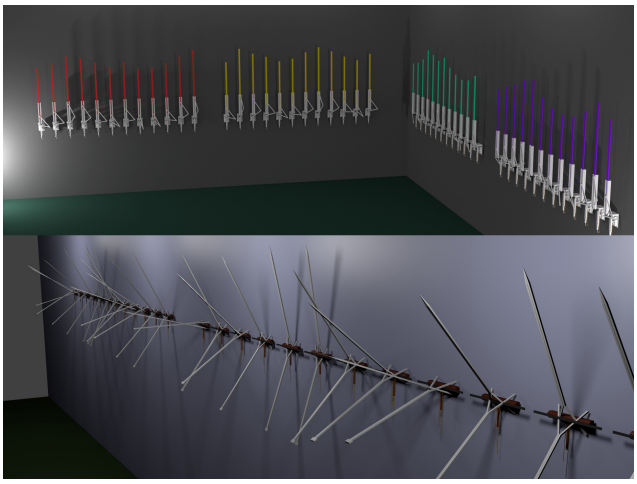

Figure 3: Early prototype designs.

3. TECHNICAL DESIGN

The physical installation is nineteen feet in length and composed of twenty-six individual modules. Each module contains a servo motor that moves a three foot piece of balsa wood, and a solenoid (activated by an external relay), which pings a unique clock chime pitch [Figure 4]. The clarity of sound from chimes evokes the clear substance of water, and twenty-six individual notes, when played contemporaneously, evoke the texture of rainfall. The sound and movement modules run independently on two Arduino boards, allowing up to fifty-two individual points of simultaneous data translation.

Figure 4: Twenty-six modules depicting electronics: servo-motors move balsa wood (kinetics) and solenoids ping clock chimes (acoustics).

All twenty-six servo motors are attached to two PCA9685 Adafruit PWM driver boards and the 5V solenoids run to four JBtek 8 Channel DC 5V relay modules [Figure 5]. In order to keep timing loops separate, one Arduino board controls the servo motors, while a second Arduino board controls electrical relays that trigger the solenoids. Loop separation of the two concurrently running processes enables more timing accuracy for the pinging of clock chimes. Our project website, http://aqualitative.org, includes a short process blog that documents early prototypes as well as houses documentation video of the installation.[12][13].

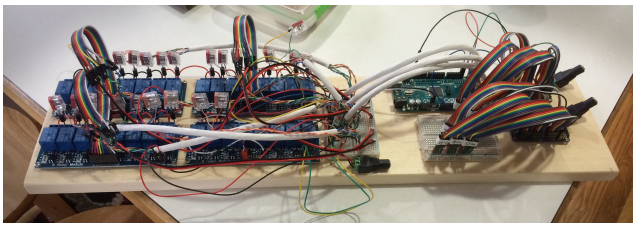

Figure 5: Aqua•litative electronics including relay and PWM servo driver boards.

3.1 Installation Modes

During the initial exhibition, Aqua•litative mapped temperature to movement and rainfall to sound. The installation actively ran two different modes: one to highlight differences in locations across the state and the second to highlight differences of a single station across a larger span of time.

In mode 1 (red LED indicator on the electronics housing), the installation maps twenty-six weather stations from across the state of California, representative of the state's different climate regions, onto the twenty-six modules. That is, one module is equivalent to one Californian weather station. Every six seconds, the installation depicts another month's worth of climate activity, incrementing across a forty year span. (1975 - 2015). During each month, balsa wood height displays station temperatures, and acoustic sounds report

precipitation levels, based upon an average precipitation threshold. In mode 1, the absence of sound is the absence of rain. The running time for this mode is approximately 48 minutes.

In mode 2 (blue LED indicator on the electronics housing), the installation maps one Californian weather station's data across the twenty-six modules, depicting over two years worth of climate activity at once (one month per module). Roughly every three seconds, a new month in introduced on the left, shifting the two-year data span to the right, similar to a push-pop array. With mode 2, a module that crosses a precipitation threshold actively pings its chime. The two-year span of data helps trigger multiple chimes that create sonic patterns, analogous to rain droplets, in a continuously evolving play between density and rhythm. The running time for mode 2 is approximately 17.5 minutes.

4. CONCLUSION

Initially, the project began as a way to craft a dialogue about water-related issues. Certainly, in the presence of sustainability and resilience issues, California serves as an American case study. The state grows over 90% of US lemons, nectarines, strawberries, garlic, celery, broccoli, olives, pistachios, walnuts, almonds, and artichokes.[15] California's food has become America's food story, and we even explored water as commodity through bottled water visualizations [8] [17].

We also explored California's terrain by juxtaposing weather data of locations in California against that of locations in Virginia [Figure 2]. The locations of Virginia provided a local comparison for audience members. The two modes of the installation attempt to activate listeners ears to the sound patterns of rain, as well as its absence. The movement of motors evokes organic visual patterns (temperature cycles) against a human-made, mechanical backdrop. California's water issues are complex and its management contested. By using climate to drive a human-made machine we resound the tale of nature as cultural construct. And instead of offering an answer to California's water crisis, the work points back upon itself, revealing the ongoing, contentious relationship we have with our environment.

Aqua•litative opened in the Elmaleh Gallery in Charlottesville, VA in April, 2016 and exhibited at the Duke Gallery in Harrisonburg, VA Sept. 5 - Oct. 15, 2016 as part of Harmonic Laboratory's Recurrent Constructions show.[9] The exhibition included workshops to incoming James Madision University art students, as well as lectures to graduate courses in art, design, music and dance. The project was funded in part by the Jefferson Trust and the University of Virginia Office of Graduate and Postdoctoral Affairs.

References

[1] John Luther Adams. *The place where you go to listen: in search of an ecology of music*. Middletown, Conn: Wesleyan University Press, 2009. 160 pp. ISBN: 978-0-8195-6903-5.

[2] Jon Bellona. "Reading CSV/TSV files in Kyma: Part 2". In: *Kyma Insights Online Magazine* (Apr. 2016). URL: http://kyma.symbolicsound.com/reading-csvtsv-files-in-kyma-part-2-of-2/ (visited on 05/24/2016).

[3] Western Regional Climate Center. *Southwest Climate and Environmental Information Collaborative Data Station Lister*. URL: http://wrcc.dri.edu/csc/scenic/data/multi/lister/.

[4] William Cronon, ed. *Uncommon ground: Rethinking the Human Place in Nature*. New York, NY: Norton, 1996.

[5] *David Tudor & Gordon Mumma*. By David Tudor and Gordon Mumma. US: New World Records, 2006.

[6] National Science Foundation E.R. Cook. *North American Drought Atlas*. URL: http://iridl.ldeo.columbia.edu/SOURCES/.LDEO/.TRL/.NADA2004/.pdsi-atlas.html.

[7] U.S. Department of the Interior. *Bureau of Reclamation: Lower Colorado Region - Colorado River and Hoover Dam Facts and Figures*. Jan. 2012. URL: http://www.usbr.gov/lc/region/pao/brochures/faq.html#ppalloct (visited on 05/24/2016).

[8] John Reagan Jon Bellona John Park. *Aqua•litative*. 2016. URL: http://aqualitative.org.

[9] Harmonic Laboratory. *Recurrent Constructions*. 2016. URL: http://harmoniclab.org.

[10] Adam Nagourney. "California Releases Revised Water Consumption Rules". In: *The New York Times* (Apr. 18, 2015). URL: http://www.nytimes.com/2015/04/19/us/california-releases-revised-water-consumption-rules-for-drought.html (visited on 05/24/2016).

[11] National Oceanic and Atmospheric Association. *Climate Data Online*. URL: https://www.ncdc.noaa.gov/cdo-web/.

[12] Jon Bellona, John Park, John Reagan. *Aqua•litative: Acoustic & Kinetic Translations of California Water Data*. URL: https://vimeo.com/166018743.

[13] Jon Bellona, John Park, John Reagan. *Aqua•litative: Acoustic & Kinetic Translations of California Water Data (narration)*. URL: https://vimeo.com/167800077.

[14] Ethan Rose. *Elements*. 2015. URL: http://ethanrosemusic.com/elements.

[15] National Agricultural Statistics Service. *"Statistics by State: California*. URL: https://www.nass.usda.gov/Statistics_by_State/California/ (visited on 10/14/2015).

[16] Bartholomaus Traubeck. *Years*. 2011. URL: http://traubeck.com/years/.

[17] Kilts-Nielsen Data Center at the University of Chicago Booth School of Business. *Retail Scanner Data (2006-2013)*. URL: https://research.chicagobooth.edu/nielsen/datasets#simple2.

[18] WorldBank. *At a Glance: Water*. URL: http://water.worldbank.org/node/84122 (visited on 05/24/2016).