FIRST PLACE

Team Members: Caden Povolish, Iyare Oseghae, Savannah Heath, Tom Varner

Project Title: The Spatial and Temporal Algorithms for Predictive Learning (STAPLE) Program

Abstract: Utilizing a cloud-hosted application to track areas where pipe infrastructure may need special attention, predict the lifespan of individual water main pipes, and forecast the financial impact of future pipe failures would be an endeavor worthy of any water utility company. The solution for that endeavor is the Spatial and Temporal Algorithms for Predictive Learning Estimation (STAPLE). Thanks to data provided by the San Antonio Water System (SAWS), over 300,000 records of pipe infrastructure in San Antonio, and over 25,000 records of SAWS pipe failure work orders were collected. Using this data in conjunction with daily San Antonio weather data available online from the National Centers for Environmental Information, and spatial soil data for Bexar County, our team was able to find underlying relationships that built the foundation for STAPLE. Those methods will be demonstrated and expanded upon in this proposal.

The implementation of STAPLE would benefit San Antonio significantly. Approximately 17% of San Antonio's water demand as of June 2021 was made up of non-revenue water, which is water lost due to pipe failures, leaks, and inaccurate customer metering [18]. Water main pipe failures within the city's distribution network are the predominant form of non-revenue water in San Antonio, equating to 14.4 billion gallons in 2020. Not only does this water loss endanger the productivity of the heavily protected Edwards Aquifer, it also costs the city's taxpayers an approximate $35 million/year, which is about $54 per taxpayer [6]. In light of these issues, reducing pipe leakage is essential for the conservation of the city's water resources.

Previous efforts to predict pipe failures have generally only utilized a water distribution's network data (i.e. pipe diameter, material, length, location,) to predict if a pipe is susceptible to failure. To date, most municipalities rely solely on internal network data to predict pipe failures, despite evidence that environmental and soil conditions can greatly exacerbate pipe failures. For example, numerous studies note that certain climate and soil conditions contribute to significantly higher failure rates and greatly reduce the operational lifetime of the pipe [7, 12, 17]. STAPLE will take these factors into account in its modeling, which will assist in improving its predictive accuracy.

With the development of STAPLE, SAWS and potentially other water utilities would have software to improve their operational efficiency, save taxpayer dollars, and ultimately assist with preventing significant water loss. If STAPLE can accurately predict even just 10% of pipe failures, and take preventative action, our team determined that the estimated total savings is $3.5 million, of which $780,225 would be conserved water.

SECOND PLACE

Team Members: Pratheek Gopalakrishnan, Mansi Joshi, Hebin Cherian, Veena Prasad, China Whitby

Project Title: A method to improve water quality using graphitic structures

Abstract: Water covers around 71% of the Earth's surface, which is 1.2 billion trillion liters. We could potentially have 170 billion liters of drinking water per person living on Earth right now. However, we have one in nine people lacking access to safe drinking water. The future accessibility of freshwater sources is becoming extremely uncertain due to pollution, unpredictable flooding, increased droughts, and shrinking glaciers. The melting of polar glaciers is one of the most prominent threats which causes sea levels to rise, leading to a phenomenon called saltwater intrusion, where seawater contaminates our fresh groundwater making it salty to drink. Groundwater pumping also reduces the flow of fresh water in the coastal areas, which in turn causes the seawater to be drawn towards the freshwater zones. Furthermore, pathogens that have been frozen in glaciers for thousands of years are making their way into these waters. Our literature survey indicates that the coastal area of the USA is vulnerable to saltwater intrusion. To produce clean drinking water, we need to remove all the contaminants that are contained within it.

With our team consisting of science, engineering, and art history majors, we introduce a filtering method to address this issue, while keeping our focus on low power and cost. Membrane filtration is a water purification method, and unlike reverse osmosis or membrane distillation, it does not need boiling temperatures or high pressure and has no energy demands. Membrane filtration separates pure water from contaminated water naturally using a hydrophilic membrane. As carbon dioxide emissions in desalination are expected to rise to 400 million tons of carbon equivalents by 2050, we believe it is critical not to use any energy source for this process. Additionally, the choice of a hydrophilic membrane is critical for the performance of the filter. We believe graphene oxide, of micrometer thickness, is a suitable candidate as a filter membrane when water flows along the in-plane direction.

Hence, we propose a filter based on graphene oxide that could filter water. Our system can help filter out most contaminants such as salt, biocontaminants, sediments, and chemicals and help solve issues related to the state-of-the-art reverse osmosis system like high energy consumption and high cost.

THIRD PLACE

Team Members: Luis Escalante, Tomas Soriano, Karla Ruiz, Dennis Fichman

Project Title: San Antonio's Water Quality Awareness

Abstract: Clean water is a vital resource for healthy and flourishing ecosystems on which all living things depend, not excluding humans. Mainly by burning fossil fuels and using chemicals, humans have drastically altered the global climate system and living conditions on Earth. The availability of water is becoming alarmingly scarce for all, and due to human activity, some water sources are reaching insalubrious rates of hazardous chemicals. This proposal is designed to move the public conversation forward and inform, engage, and empower us to think globally and act locally. The San Antonio Water System (SAWS) services San Antonio, acquiring water from the Edwards, Carrizo, and Trinity Aquifers.

In the U.S. 99% of Americans have some level of 'forever chemicals' - chemicals whose molecular make-up is unable to break down naturally in the environment - that contaminate the soil and leech into the water table. They stay in the body and accumulate over time as a person is exposed. Forever chemicals have pernicious effects on the human body, causing cancer and disrupting the human endocrine system. In 2019, the Department of Defense (DOD) released a report identifying contaminated military installations in the U.S. It determined the extent of groundwater contamination. Several of San Antonio's military installations were noted on the DOD's report.

Our proposal focuses on engaging San Antonio residents about their water quality through a multi-media campaign of semi-permanent interactive kiosks powered by solar panels, using touch screens and informational technology.

The kiosk structure will be architecturally designed to capture water. The touch screens will display water contamination issues, statistics, and graphics about San Antonio's water quality. We will also offer potential possible ways forward towards equitable potable water for all. Kiosks will be placed in high-traffic locations across the city. We plan to involve local universities, municipal authorities, and civic organizations for permission to mount these kiosks on their sites. We want to ignite the process of self-discovery, informing and recognizing their own biases, in turn developing empathy and becoming better prepared for responsive and active empowerment.

Clean water is a fundamental human right, and it is an essential step towards improving the living standards of people. Water-poor communities are usually economically poor in San Antonio, leaving their residents trapped in an ongoing cycle of poverty. Also, their education suffers when sick children miss school; economic opportunities are routinely lost to the impacts of illness. When the water is not clean, it breeds disease and can rob people of their basic human dignity. We are confident that this engagement with San Antonio residents about their water quality initiates public action. Awareness is one thing, but without actions, it evaporates, just like water.