Aliso Creek Smart Watershed Network: A High-Resolution Data Acquisition and Analysis Platform to Support Urban Runoff Management and Water Recovery

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Highlights

- Orange County Public Works and Moulton Niguel Water District partnered to evaluate the sustainable use of urban runoff and stormwater as a potential water supply within the Aliso Creek Watershed.
- The project deployed a network of 60 water level sensors and 20 conductivity sensors that transmit data over MWND's Advanced Metering Infrastructure network.
- The Smart Watershed Network dashboard provides access to the latest monitoring and watershed data, allows visualization and analysis of data, and enables modeling of water recovery scenarios (e.g., capture and diversion) based on actual monitored flows.

Introduction

Dry weather irrigation runoff from urban areas has been identified as a significant source of water quality impairment in the Aliso Creek Watershed (SOC WMA, 2018). Additionally, there is interest in harvesting dry and wet weather runoff to augment non-potable water supplies. However, urban runoff needs to be better characterized in terms of quantity and quality at an outfall level to support decision making. The large scale of the watershed (35 sq-miles) and complexity of the drainage network (more than 80 storm drain outfalls) necessitated an innovative approach to improve data availability and support efficient data analysis while controlling costs.

The Smart Watershed Network was developed through funding from the Metropolitan Water District of Southern California Future Supply Action Planning program. The aim of the project is to (1) develop a flow and conductivity monitoring network within stream channels and storm drains in the Aliso Creek Watershed, (2) pilot a system to transmit these data over Moulton Niguel Water District's (MNWD) Advanced Metering Infrastructure (AMI) network (currently used for water metering), and (3) develop a new open-source cloud-based data management, integration, and analytics space to provide comprehensive watershed information and scenario results to support planning and decision making at multiple scales.

This presentation will provide an overview of how this system was developed, with a specific focus on the open-source data management, analytics, and scenario modeling features that are being used to evaluate the sustainable use of urban runoff and stormwater as a potential water supply within the Aliso Creek Watershed.

Methodology

Monitoring System Deployment

The project team used locally available GIS data (storm drains, watershed delineations) to identify 60 sites for flow monitoring and 20 sites for conductivity monitoring. We tested water level and conductivity sensors to confirm compatibility with the AMI gateways that are used for data transmission. After testing, we procured and deployed the sensors, including development of rating tables for each site.

Data Transmittal and Federation Pipeline

Raw data from the sensors is transmitted over the AMI network to MNWD's central data repository. The project team created a data pipeline to clean, process, and make these data available for analytics and scenario analysis. This pipeline runs automatically when new data are posted. It makes use of the OCPW Hydstra database and API as the master system of record for data storage and rating table management. Additionally, water usage data are aggregated at the subwatershed scale to produce timeseries of estimated outdoor water usage for the drainage areas tributary to each monitoring station. These data are processed on MNWD's system, aggregated, and anonymized to protect privacy, and posted to a secure ftp on a monthly cycle corresponding to water billing cycle.

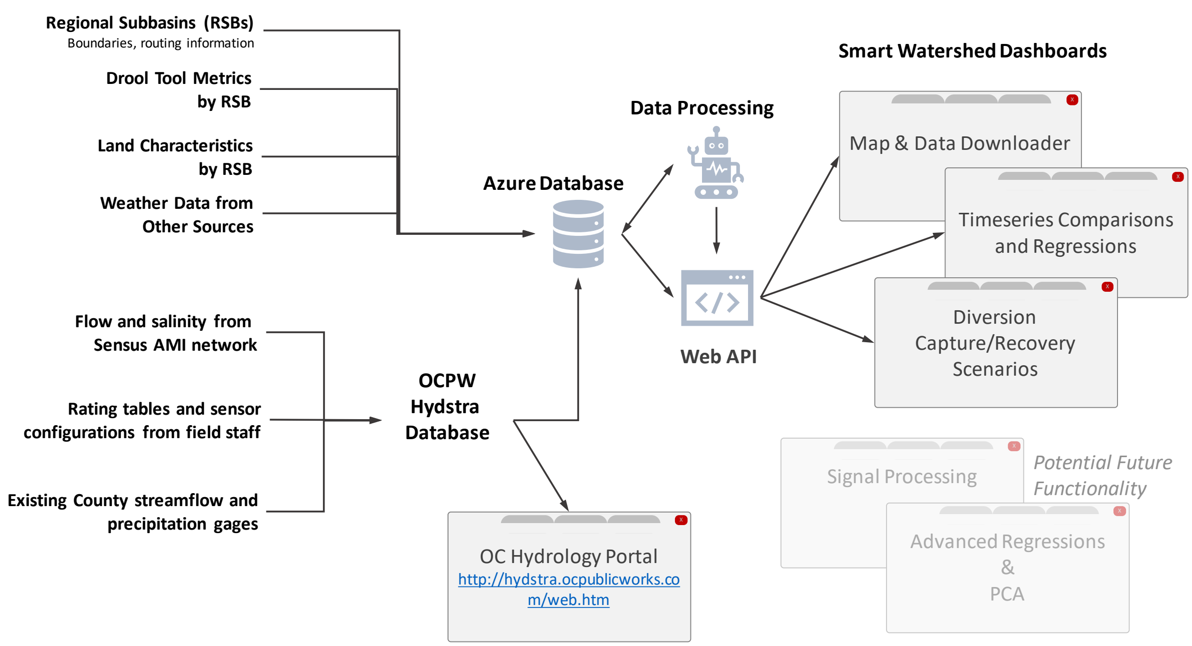

Figure 1. Architecture Schematic of Data Pipeline and Federation System

Data Analytics and Scenario Analysis

The team developed a custom open-source engine in Python to collate various data sources and perform analyses based on user inputs. The analysis engine is accompanied by a database and hosted in Azure. The system queries the Hydstra API and other data from the Azure database. The datasets are separated into wet and dry weather based on nearby precipitation data. To evaluate runoff capture and diversion scenarios, the Python engine performs timeseries analysis with level pool routing to determine the performance of a capture and diversion system over a user specified time period. The system then uses VegaLite to produce interactive data visualizations based on user inputs.

Users interact with the analysis features via a password protected dashboard. This dashboard supports efficient workflows to select stations and populate the parameters to define the requested visualizations or scenarios. Analyses are performed in the Azure space and returned to the dashboard as an interactive graph. This architecture allows for permalinks to be created by users for sharing with other managers and researchers.

Results and discussion

The project has successful leveraged the AMI network to provide data transmission from field sensors to centralized databases. This is an important advancement for OCPW as it provides a lower cost and lower-power consumption method for transmission than cellular modems. We expect that maintaining the rating tables for this network of sensors will require significant effort over time, however we envision that lower data transmission costs and lower power consumption will help offset this cost.

Development of the data pipeline from sensors to the analysis space leverages existing tools used by both MNWD and OCPW and involves several intermediate products. While simpler methods may have been possible, the system is designed for long-term stability and expandability. The resulting system operates without supervision.

Data analysis using the Smart Watershed Network dashboards shows major spatial variability of urban runoff. While it may be possible to characterize correlations that predict runoff flowrates, some factors will ultimately be site-specific. This indicates that a dense monitoring network of gage data will be critical to support analysis of runoff capture and reuse scenarios.

Water quality, specifically dissolved solids, is a key factor influencing how valuable water is for recovery. The system will allow managers to evaluate how conductivity (and associated dissolved solids concentrations) vary over time and in response to rainfall.

Conclusions and future work

The Smart Watershed Network project has successfully linked a high-resolution watershed monitoring program with other online datasets to provide a rich decision support space that is tailored to specific questions about urban runoff management and water recover. The use of the AMI network for hydrologic data transmission is the first of its kind in the region and demonstrated the potential for this type of solution in future applications. The Smart Watershed Network dashboard and analysis engine is an example of a service-oriented architecture where computationally intensive analysis is performed on cloud infrastructure in response to queries from a relatively “light” front end dashboard. The software is open source and can be used as a reference for other agencies considering a similar system.

References

South Orange County Watershed Management Area (2018). South Orange County Watershed Management Area Water Quality Improvement Plan. https://ocgov.app.box.com/v/SDR-WQIP-Clearinghouse/folder/130865514724