**NASA DEVELOP National Program**

****NASA Jet Propulsion Laboratory

**Spring 2016**

**Short Title: Los Angeles Oceans II**

**Subtitle:** Remote Sensing Detection of Wastewater Plumes to Assess Public Water Quality in Los Angeles County

**VPS Title:** Ground Truthing Remotely Sensed Observations of Wastewater Plumes

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

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**Partner Organizations:**

City of Los Angeles Hyperion Water Reclamation Plant (HWRP)(End-User), POC: Curtis Cash, Ashley Booth, and Mas Dojiri

**Project Details**

**Applied Sciences National Applications Addressed:** Oceans

**Study Area:** Santa Monica Bay, CA

**Study Period:** August 26 – November 30, 2015

**Earth Observations & Parameters:**

Aqua, MODIS – sea surface temperature, chlorophyll-a, remote sensing reflectance

Landsat 8, TIRS – sea surface temperature, chlorophyll-a, remote sensing reflectance

Terra, ASTER – sea surface temperature

ALOS-2, PALSAR-2 – sea surface roughness

Senitnel-1, SAR – sea surface roughness

**Ancillary Datasets Utilized:**

* Hyperion Water Reclamation Plant- *in situ* temperature, salinity, dissolved oxygen, pH, conductivity, chlorophyll-a fluorescence
* NASA/JPL, hyperspectral instrument- *in situ* atmospheric aerosols, CDOM, turbidity
* University of Southern California- phytoplankton species
* University of California Santa Barbra- HF radar for surface currents, and GPS-equipped drogue surface drifters

**Software Utilized:**

ArcGIS – Raster manipulation/analysis, image enhancement & map creation of MODIS, VIIRS, Landsat-8, ASTER, ALOS-2, and Seninel-1

SeaDAS - Data processing and manipulation of MODIS and VIIRS data

SNAP – Sentinel Applications Platform used in the processing of Sentinel-1 & ALOS-2 SAR data

ENVI – ASTER and Landsat-8 processing

Matlab – Data processing and analysis, validating satellite image data with *in situ* data

**Project Overview**

**80-100 Word Objectives Overview:**

Sewage treatment plants must periodically undergo facility maintenance or upgrades to their current infrastructure of outfall pipes that routinely carry treated effluent into deep, offshore coastal waters. During this maintenance, the outflow is typically diverted to a shorter outfall pipe, releasing effluent into shallow coastal waters. By combining NASA Earth observations and *in situ* readings taken during the outflow event at the Hyperion Water Reclamation Plant (HWRP) in the City of Los Angeles, we can determine whether the effluent is negatively impacting the marine ecosystem and washing ashore, potentially harming beachgoers.

**Abstract:**

The Hyperion Water Reclamation Plant is one of the largest wastewater treatment plants in the western United States. Treated sewage is generally released at depths of approximately 60 m through 8.05 km outfall pipes into the deep coastal waters of the Santa Monica Bay. In times of repair and maintenance, services on the main outfall pipe are temporarily suspended and require the plant to divert treated sewage to a shorter 1.6 km pipe that extends into shallow coastal zones. These shallow zones make it possible for the buoyant freshwater plumes to reach the surface, potentially contaminating the local environment. This diversion event occurred September 21 to November 2, 2015, and this project plans to integrate previously obtained satellite images and ancillary data collected by other scientists. By combining remotely-sensed observations with GPS-equipped drogue surface drifters and *in situ* readings of temperature, salinity, dissolved oxygen, pH, conductivity, transmissivity, atmospheric aerosols, colored dissolved organic matter (CDOM), and chlorophyll-a florescence, an accurate assessment of the full impact and extent at which these effluent plumes affected the Los Angeles Basin is possible. The outcome of this study can aid in developing proper methods to avoid harmful outcomes during similar diversion events in the future.

**Community Concerns:**

* Treated wastewater is diverted to shorter outfall pipes that extend into shallow coastal zones, where buoyant, freshwater plumes, containing possible containments, may reach the surface and potentially the coastline.
* Contaminants and bacteria can be harmful to humans who come in contact with the wastewater.
* Excessive nutrients near the surface may also stimulate harmful algal blooms (HABs) that are not only toxic to many marine organisms but also cause health problems to humans.

**Current Management Practices & Policies**:

The overriding concern of these agencies during required diversion events is to identify the wastewater plume, the extent of the plume, and how the plume might impact water quality and public health related to potential nutrient enrichment and beach bacterial contamination, respectively. The City of Los Angeles Hyperion Water Reclamation Plant conducts their own internal research operations, both within the plant and in the coastal waters in which they discharge the treated effluent. Extensive *in situ* sampling programs were undertaken on a daily basis during the recent diversion to determine water quality, concentration and spread of effluent-indicator components (e.g. fecal indicator bacteria and nutrients), and environmental ocean conditions. However, conducting *in situ* operations are very costly, and Hyperion officials typically partner with outside sources to bolster their near real-time observations. A project website has been set up for all science institutions working on this project, to allow for easy and fast data exchange. Satellite data provided through this web portal served as a synoptic capability for plume detection, which we used for guiding adaptive *in situ* sampling strategies. The City of Los Angeles is required to submit a final technical report on the diversion event by Spring 2016.

**Decision Support Tools & Benefits:**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Maps of Thermal Plume Signature | Landsat 8, TIRS  Terra, ASTER  Aqua, MODIS | The effluent plume has distinct temperature signatures that can be detected via satellite. This makes it easier for HWRP to track where the plume is. |
| Maps of Ocean Color Changes | Landsat 8, TIRS  Aqua, MODIS | The effluent plume carries high nutrient loads and suspended solids that can be detected via satellite. The biological response in terms of phytoplankton bloom can also be monitored via satellite. This makes it easier for HWRP to track where the plume is. |
| Maps of Sea Surface Roughness | Alos-2, PALSAR-2  Sentinel-1, SAR | The buoyant effluent plume is rich in oils and grease that forms a slick on the surface of the water as the plume rises. This can be detected using radar and makes it easier for HWRP to track where the plume is. |
| Charts and Maps Comparing *In Situ* Data to Satellite Images | Landsat 8, TIRS  Aqua, MODIS  Terra, ASTER | Water quality and biological responses from the *in situ* measurements made before, during, and after the diversion event will be used in conjunction with the satellite images to validate both space borne and i*n situ* measurements for all parties involved. |

**Project Imagery**

**IMAGE** TBD

**Caption:** TBD

**Image:** TBD

**Software Release Requirements**

What category do the tools your project is creating fall within?

Category I