SEWAGE PLUME DETECTION IN SOLENT, UK

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Background

Deimos Space UK is researching the detection of wastewater discharges as part of **ARIA3 - Atlantic Regional Initiative - Topic A3 - Atlantic Cities and Ports** project because:

- Untreated discharges have harmful effects on coastal ecosystems and human health.
- In situ monitoring is **temporally and spatially limited**, so remote sensing data could be the bridge to fill the gap.
- Near real time alerts about the extent of coastal pollution would be beneficial for regional tourism and environmental agencies.

Proposal

Research commenced to create a model that alerts the user when **water quality indices (WQI) exceed a certain threshold**, indicative of sewage discharges. It will either function on pixel level or as an average for a selected area of interest. For this, **cloud-free satellite images** taken on days with known sewage spills are needed for the Solent region. A suitable algorithm or software is required to calculate WQI for the available images.

Method

An initial literature review revealed that the most common method for classifying wastewater plumes was to calculate the **inherent optical properties of coastal waters**, such as chlorophyll-a (Chl-a), suspended matter concentrations (SPM) or turbidity. Often, sea surface roughness from (Synthetic Aperture Radar) **SAR imagery** would be used to **complement their research**.

Reported wastewater discharges in 2017-2019 were used to select satellite images with **high areal coverage and little cloud cover** over the Solent region. Sentinel 2 imagery was analysed for cloud cover using the EuroDataCube services. Chl-a, SPM and turbidity pixel values were calculated with an open source software called **ACOLITE** using regional/global algorithms. For validation, in situ measurements were obtained from the Environment Agency's Water Quality Archive (Beta).

A model would use WQI to characterize sewage plumes and alert the user if one was detected in the Solent region.
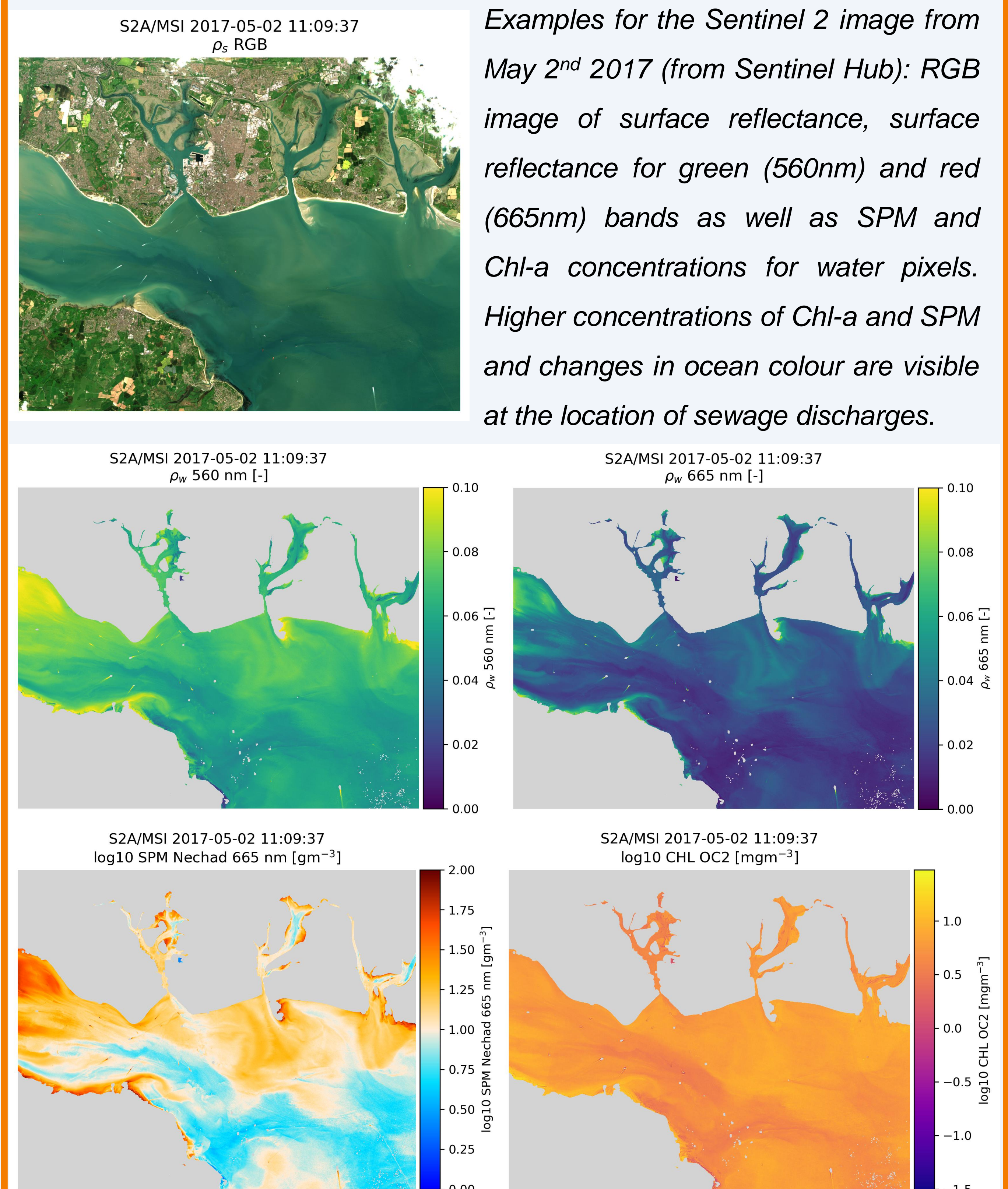
Results
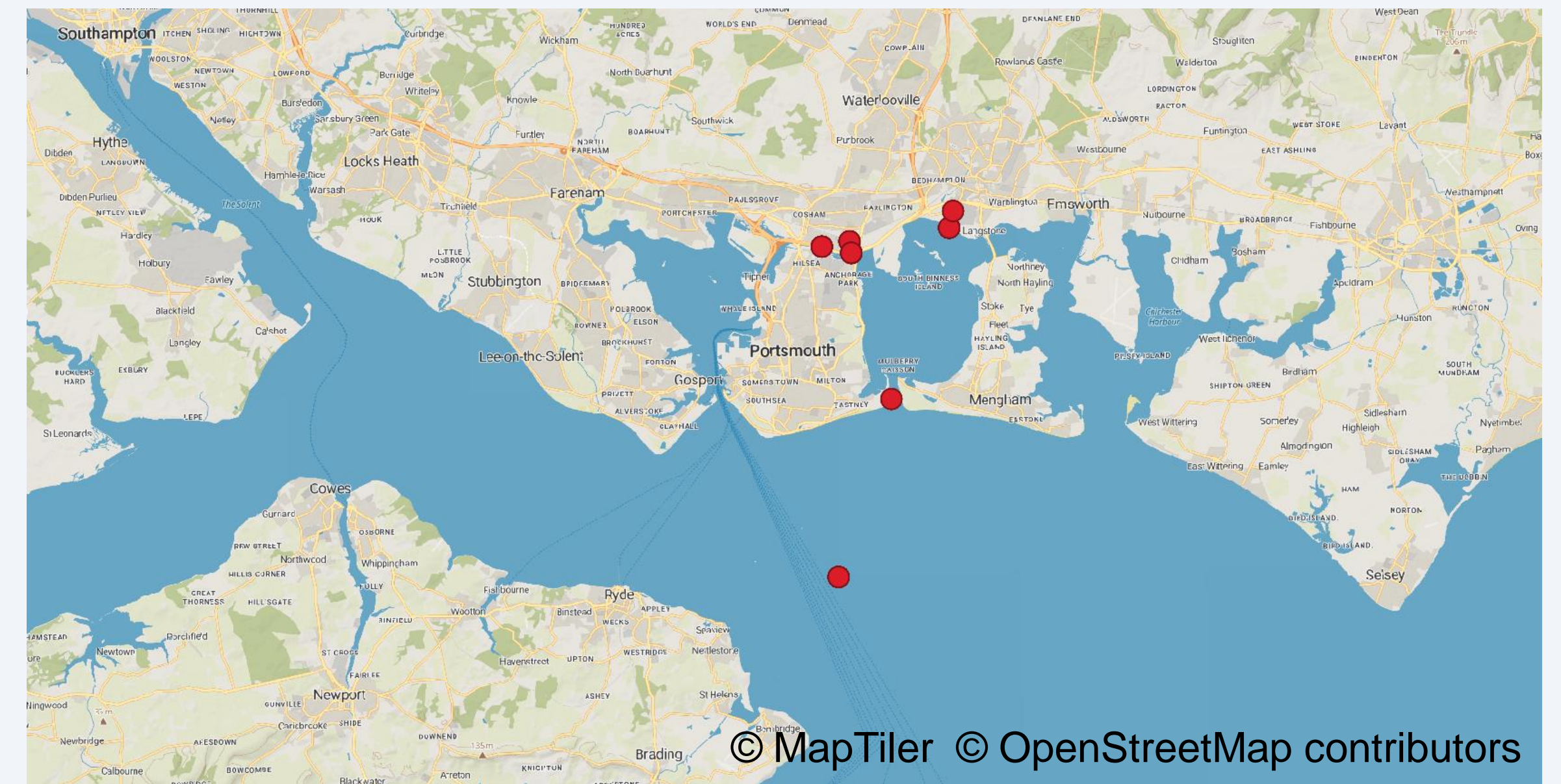
Locations of reported sewage discharges in the Solent region

Wastewater discharge exceeded 10 hours on 67 of 448 days in the sewage spill data provided. 34 days had no Sentinel 2 imagery available for the area of interest, 19 had too little coverage, 10 were too cloudy, so **only 4 images were of acceptable quality**.

ACOLITE was used to calculate the SPM, Chl-a, tubidity and surface reflectances for all water pixels in the images.

Examples for the Sentinel 2 image from May 2nd 2017 (from Sentinel Hub): RGB image of surface reflectance, surface reflectance for green (560nm) and red (665nm) bands as well as SPM and Chl-a concentrations for water pixels. Higher concentrations of Chl-a and SPM and changes in ocean colour are visible at the location of sewage discharges.

Future Work

Cloud cover proved to be an issue with obtaining useful Sentinel 2 data for dates with known sewage discharges. Additional discharge data would be difficult to obtain. Therefore, the next step in the project will be to calculate WQI using **PlanetScope imagery from Planet** due to its higher spatial and temporal resolution. ACOLITE's algorithms need to be **validated with Environment Agency water quality data** from the Water Quality Archive (Beta) for the Solent region. **Sea surface roughness, temperature and salinity** were shown to be indicative of wastewater plumes in existing literature, so thermal and SAR imagery could also be retrieved to improve the model. If enough images are available, WQI thresholds can be set for the model.

Acknowledgements