Using remote sensing to improve efficiency of water pollution monitoring

Useful links

Prior LSE work

Capstone project 2022 "Forecasting Seawater Transparency", https://drive.google.com/file/d/1YL8GlBQvNsuXxw0hDd4duGBi01dqLxa_/view. Their colab notebook https://colab.research.google.com/drive/1eXfMOtbUWwbbbBl_dEaPGMuJKaGYKRrm?usp=sharing

Datasets

[Satellites] You can find satellite datasets for marine research from the Copernicus website: https://resources.marine.copernicus.eu/products. You need to register in the system. Then you will be able to download historic data. There are multiple datasets you can use, for instance: https://data.marine.copernicus.eu/product/OCEANCOLOUR_GLO_BGC_L3_MY_009_103/description. Check out previous year students' material for examples on how to work with this data.

[Pollution data] The data behind https://www.sas.org.uk/map/ is to my understanding comes from several sources, one being from the Environmental Agency https://environment.data.gov.uk/bwq/profiles/.
TBD: check if the data granularity is sufficient and if EU data is also available

Learning materials

[Whitepaper] Satellite-assisted monitoring of water quality to support the implementation of the Water Framework Directive https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5cc8cbc7d&appId=PPGMS. Very interesting document composed by the top researchers in the field with some background on the problem, motivation and references to prior studies.

[MOOCs] on AI for Earth Observation https://marine.copernicus.eu/news/ai-earth-monitoring-mooc and Monitoring the Oceans from Space https://www.futurelearn.com/courses/oceans-from-space. Very useful to watch as they talk about using Copernicus satellite data with some concrete examples for ocean monitoring.

[ClimateChange.AI] More generally, a very interesting initiative with relevant events, blog posts, publications, etc. https://www.climatechange.ai/

Proposal

Sewage pollution of the rivers and the ocean is a tremendous problem in the UK.

Storm overflows are used to spill excess wastewater and rainwater into inland waters and the sea. They are "safety valves" used in combined sewer systems to protect properties from overloaded sewers causing flooding and sewage backing up into streets and homes during heavy storm events. In 2020, there were over 400,000 sewage discharges in England, totalling over 3 million hours [1].

Monitoring of sewage spills from storm overflows and wastewater treatment plants has improved in recent years as event duration monitors (EDMs) have been rolled out across 80% of outflows on the network since 2015 [2]. The readings from EDM data are available for public use. Based on this and other data, the sewage pollution watchdogs - such as Environment Agency or Surfers Against Sewage charity - developed tools for realtime sewage spills monitoring and alerting [3, 4].

The data from in situ measurements such as EDMs or manual observation has certain limitations. The former is expensive and is only available within the locations the equipment is installed at. The latter has limitations in both geographic and temporal scope as it requires human observers to conduct the measurements.

An alternative solution for monitoring sewage pollution lies in using remote sensing from satellites. The open source data available from Europe's Copernicus Earth monitoring system provides optical measurements of the seas on a daily basis with a spatial resolution of up to 300m x 300m [5]. Leveraging this data to assess ocean water quality can help to fill in the temporal and spatial gaps of existing in situ measurements with minimal extra costs.

The idea behind this project is thus to assess the feasibility of using satellite remote sensing datasets in order to complement existing methods for monitoring and modeling sewage pollution spills in the UK. The project will require working with a mixture of satellite datasets available from The European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the sewage pollution reports from the Environment Agency and other related datasets (meteorological forecasts, bathymetry, etc.). The research methodology can range from correlation analysis and mutli-variate time series analysis to more advanced machine learning methods for spatio-temporal modeling.

This project can help to measure and understand the scale of a very important ecological problem in the UK as well as to attest the feasibility of using cheaper and scalable approaches to monitor it in real-time.

References

1. https://lordslibrary.parliament.uk/sewage-pollution-in-englands-waters/
2. https://consult.defra.gov.uk/water-industry/storm-overflows-discharge-reduction-plan/supporting_documents/Final%20Consultation%20Document%20PDF.pdf
3. https://www.sas.org.uk/map/
4. https://environment.data.gov.uk/bwq/profiles/
5. https://www.eumetsat.int/our-satellites/sentinel-series
6. https://committees.parliament.uk/publications/8460/documents/88412/default/