Integrated Trends Analysis Team (ITAT)
Meeting

Wednesday, January 24, 2024
10:00 AM – 12:00 PM

Meeting Materials: Link

This meeting was recorded for internal use only to assure the accuracy of meeting notes.

Action Items

- **Efeturi Oghenekaro will share the results of the DC team's discussion of ideal timelines for data analysis of the tidal trends.**
- **Mike Lane and Renee Karrh will complete trends for water temperature data that align temporally with the Dissolved Oxygen trends. Rebecca Murphy will create a corresponding map in the usual suite of maps produced.**
- **Roger Stewart will explore the turbidity data in the CIMS database and Jessie Turner's work (sent by Carl Friedrichs) to examine how feasible producing trends for this parameter may be.**
- **When Renee Karrh has time, she will explore the Total Organic Carbon, Particulate Organic Carbon, and Dissolved Organic Carbon data for MD. There is no expectation of running trends on this data this year, or ever, depending on what data and time is available.**
- **Alex Gunnerson will share Jessie Turner's work that Carl Friedrichs showed during the meeting with the meeting minutes.**

Meeting Minutes

10:00 – 10:10 **Welcome – Breck Sullivan** (USGS)

Announcements –

- Sarah Betts, an intern from Franklin and Marshall College who will be supporting ITAT this spring semester, introduced herself. Sarah will be updating the tributary summaries and creating corresponding story maps, following the template Anoosh Tauqir created over the summer.
- Abstracts are due February 1, 2024, for the Chesapeake Community Research Symposium. ITAT members have multiple sessions for this conference. See below for more information.
- Ken Hyer has been selected as the new USGS Chesapeake Coordinator. USGS has posted an internal opening for the acting Chesapeake Associate Coordinator but will be sharing a public opening for the position later.

Upcoming Conferences, Meetings, Workshops and Webinars

- Environment Virginia Symposium – April 9-11, 2024, Lexington, Virginia. Presentation Proposals were due August 31, 2023.

- National Conference on Ecosystem Restoration – April 14-19, 2024, Albuquerque, New Mexico. Abstracts were due September 1, 2023.
- Choose Clean Water Coalition – May 20-22, 2024, Ellicott City, MD. Session proposals were due January 19, 2024.
- Chesapeake Community Research Symposium – June 10-12, 2024, Annapolis, Maryland. Abstracts are due February 1, 2024.

10:10 – 10:25 **Fiscal Year 2024 Plan for RIM and NTN Loads and Trends – Jimmy Webber** (USGS)

Jimmy Webber provided an update on the 2024 plans for the River Input Monitoring (RIM) stations and the Non-Tidal Network (NTN) loads and trends.

Summary

Jimmy Webber began with a review of the previous timeline for NTN and RIM data products. Jimmy then discussed ongoing efforts to build a dataset of historical water quality results, which is being pursued to create a verifiable dataset of all NTN sample values. This new dataset:

1. Will be used to compute all future NTN updates, with additional years of data appended to the dataset.

2. Will ensure that consistent, reproducible, and verifiable data are used for all NTN updates.

3. Will be described by a new USGS report that describes the methods used to assemble the dataset.

The USGS is currently comparing how the new dataset compares to data used previously to compute NTN loads and trends. The USGS expects this dataset to be available for NTN use in FY24.

Jimmy concluded with an overview of the upcoming NTN and RIM product timeline (slide 3). Water Year 2023 RIM data will be published in May 2024 and Water Years 2022 and 2023 NTN data will be published in September 2024.

Discussion

Breck asked if going forward NTN will continue to be updated every two years. Jimmy said the USGS plans to continue this pattern of updates but is open to discussion if there is strong interest in annually published NTN results.

Roger Stewart asked if the water quality data are being pulled from the Chesapeake Information Management System (CIMS). Jimmy said currently USGS collects all the data from the Chesapeake Bay data hub, which includes the information uploaded to the CBP Data Upload and Evaluation Tool (DUET) by jurisdictions and the historical data from the water quality portal. Jimmy said USGS is working to ensure no data is omitted during the compilation of this historical data project. Roger said Virginia DEQ found out they are missing some nitrogen data going to the water quality portal. Roger said the CIMS is the best place to go for the data and is more complete than the water quality portal.

Tom Parham asked if this new project could impact the historic Bay hypoxia forecasts. Jimmy said he does not expect the historical data to change the hypoxia forecast database since in principle it is the same data, just being consolidated.

Breck asked what the difference is between this new historical database and what currently exists. Jimmy said there should be no difference in the data because it is a compilation of all the different data sources into one USGS data release. It will also help standardize nutrient speciation reporting, so any aggregation steps will be already completed as part of the new workflow.

Breck asked if this historical database will be updated every two years? Jimmy said USGS, led by James Coglin on this project, is still thinking through the workflow for these updates and is considering how to best update the consolidated data release.

Jimmy shared the NTN load and trend website, which contains recent results.

10:25 – 11:15 **Widespread Deoxygenation in Warming Rivers – Li Li** (Penn State)

Li Li presented on her team's paper "Widespread deoxygenation in warming rivers" and discussed some of the deep learning methods to explore the datasets used in the production of this paper. ITAT members may find the methods and results to be interesting and pertinent to their work. There will be time for questions following the presentation.

Summary

Li Li began with the perspective that water quality issues tend to be overlooked in climate risk assessments and stressed that forecasting capabilities will become increasingly important. The two major challenges in water quality modeling are data scarcity and process complexity. Li raised the question, "can deep learning models help address these challenges?" Deep learning applications in hydrology have been extensive since 2016, but its application for water quality is a few years behind.

For dissolved oxygen (DO), sun light, water flow, and temperature are the three main factors controlling DO levels. In general, deoxygenation is less expected in rivers than in oceans and lakes. Li said the rest of the presentation will focus on the questions raised on slide 8.

One topic discussed was using deep learning models, specifically long short-term memory (LSTM), to temporally fill a time series of water quality data. The team found DO was an ideal parameter to apply this method to because there was sufficient data. The team was then able to apply the temporal filling spatially for the continental U.S., and the results showed the model performed best in the northeastern portions of the U.S. One key question for LSTM deep learning models is "when do models do well, and does more data mean better model performance?" The results published in these papers showed that the model does better in basins with low DO variations, not necessarily when there is more data. Another result was that the model could learn the theory of DO solubility. For nitrate, results showed that results depend on land processes more than hydrometeorology, which has relevance for climate extremes.

Li then presented results from the paper on deoxygenation in warming waters. The team looked at warming and deoxygenation by land use (agriculture and urban) and by

region. Warming was happening faster in urban areas than agricultural areas, but deoxygenation was happening fastest in agricultural areas and in 70% of rivers. Overall, results showed rivers are warming up and deoxygenating faster than oceans but slower than lakes and coastal areas. Using a wide variety of climate models, this work shows the number of hypoxic days will continue to increase and that data from grab samples during daytime likely underestimates stress and the number of hypoxic days. Temperature is the primary driver of these trends.

Li then turned to questions such as "What about other solutes with less data?" and "How does climate affect other solutes?" which draw on the work of her paper with others on Climate Controls of River Chemistry in Earth's Future. Li presented a series of figures for the mean, long-term concentration of 16 solutes, including sodium and dissolved organic nitrogen, which demonstrated a universal pattern: higher concentrations in arid climates. One national conclusion of this paper was that as aridity increases, water quality will decline.

One major conclusion of the presentation was that climate is a major control on water quality, but human stressors are more influential.

Li concluded with a summary of key points (slide 27) and broad areas of future research (slide 28).

Discussion

Elgin Perry asked if when Li uses the term "Deep Learning Models", is this limited to neural networks, or does it include other methods? Li said in this case LSTM is a recursive neural network model.

Tom Parham said it is surprising that the total number of streamflow gages have declined by about 50% and asked if USGS is seeing this same trend. Li said she does not think this perceived decline exists, as it may simply represent delays in getting the data uploaded to the global stream flow indices and metadata archive portal. Delays may include quality control procedures or other data cleaning requirements.

Gary Shenk expressed his appreciation for this fantastic work. Gary commented the Chesapeake Bay Program (CBP) modeling team will need to deal with the challenges of climate change modeling that Li articulated. One example would be moving from DayMet to Empirical Climate Models (ECMs) and knowing how to manage the jump in the data. Gary also expressed his interest in learning more about the coupling of deep learning and process-based modeling.

Qian Zhang asked Li if she sees value in developing a LSTM for the Chesapeake Bay region using region specific data or if there would not be much more to learn than what is already shown by the continental-level model the team developed. Li said there is still value in pursuing regional scale models because they are more representative of the region than continental scale models. Region specific models are also likely to be more accurate.

Li asked if the CBP has high resolution temperature and DO data. Tom Parham said there is lots of high frequency water quality in the Bay region. Breck agreed and shared that the vertical profilers will soon be online for the tidal portions of the Bay and its tributaries, which have a temporal frequency of every ten minutes. Breck suggested this

information may be useful for future deep learning model approaches in the Chesapeake Bay watershed.

11:15 – 11:45 Preparing for 2023 Bay Trends – All

ITAT members discussed this year's schedule for producing the 2023 tidal trends and which results are needed. Time was set aside for other questions or comments on the 2023 trends.

Summary

Breck began by sharing she, Rebecca Murphy, and Efeturi Oghenekaro discussed the timing of data analysis for DC because spring would be a better timeframe for them. Efeturi said the DC team will be meeting next week and will share the results of their discussion with ITAT afterwards.

Breck then walked through the current parameters being collected for bay trends. Tish Robertson asked if ITAT is doing Total Suspended Solids (TSS) trends. Rebecca said because of the step trend, TSS is only computed for 1999-present.

Elgin Perry said he was interested in trends analysis on water temperature for the same summer period (June to September) as summer DO, considering the implications of Li Li's presentation earlier in the meeting. Mike Lane and Renee Karrh said this would be easy to do, in terms of the GAMs analysis, but would require a bit more mapping work from Rebecca. Rebecca said that this would be a reasonable request for her.

Roger Stewart asked if there is enough data to add turbidity and said he could check the CIMS for such data. Renee Karrh said this would require acquiring the data and then implementing quality assurance procedures, which are standard when starting up trends for any new parameter. Breck asked if ten years would be the minimum for the data requirements. Roger said yes, ten years would be sufficient. Carl Friedrichs said the data is not widely available across the entire Bay and is more often located in shallow waters. Carl shared some research a former student of his, Jesse Turner, did using turbidity measurements. Breck said given the CBP's increased focus on shallow water in response to the Comprehensive Evaluation of System Response (CESR) report and the Beyond 2025 Steering Committee small group, this may be an area of particular interest. Breck asked Carl if this data would help address some of the topics raised related to shallow water conversations. Carl said turbidity has always been a parameter collected at the continuous monitoring stations in shallow waters and the Chesapeake Bay National Estuarine Research Reserve. Tish said when VA DEQ gets TSS values, they also receive corresponding turbidity values, so they have a long time series in the Virginia tributaries to draw on. Carl said these are the data Jessie Turner investigated.

Elgin asked if turbidity measurements provide unique information that TSS does not. Carl said turbidity is a helpful metric because it is a more direct measure of the optical properties of the water, specifically for converting to Kd (the diffuse light attenuation coefficient), which is relevant for key management questions like Submerged Aquatic Vegetation (SAV). Turbidity is also more closely related to satellite-derived empirical measurements of reflectance and YSI turbidity sensors are very accurate, so it is easier to align with widely available data. Roger said VA DEQ finds turbidity very useful in comparing to other water clarity variables, like chlorophyll, Secchi depth, and TSS. Roger

said one comparison they have not done for turbidity values yet is contrasting them with photosynthetically active radiation (PAR). Roger said he has high confidence in turbidity values state-wide since they are calibrated by the VA DEQ lab.

Mike Lane walked through his exploration of organic carbon monitoring data. This included descriptive statistics for different stations throughout Virginia.

1. For total organic carbon (TOC), the data are not suitable for trends analysis because there is not enough data and there were methodological issues in the data collection.
2. For particulate organic carbon (POC), seasonal Mann-Kendall analysis could be started at any point on the data.
    a. Renee said for Maryland, they could use GAMs 0-4 to approximate seasonal Mann-Kendall shorter-term trends. This would require identifying where there is a gap in the data.
3. For dissolved organic carbon (DOC), GAM analysis could be run as the period of record ranges from 2007-2022.
    a. Mike said he was curious why SBE5 station had such high DOC readings. Elgin asked if this is a blackwater stream, meaning they drain swamplands and have tannins and other materials that color the water. Roger said SBE5 is influenced by tides and not blackwater in nature. Roger asked if it is influence by wastewater discharge. Tish said she can check with the Virginia Pollutant Discharge Elimination System permit staff to investigate this question.

Mike said the main conclusion of his exploration is that ITAT could run trends on DOC and POC for Virginia.

Breck asked what management insights DOC and POC might influence? Renee said DOC is part of the phytoplankton index of biotic integrity (P-IBI), so a question might be "how are DOC trends influencing the P-IBI index," which has relevance for management. Additionally, with climate change, there is more interest in carbon measurements, and this is what we have available. Breck said some of this work may be of interest to the outcome of the Beyond 2025 steering committee, depending on their conclusions. Rebecca said if the Beyond 2025 Steering Committee is interested in this work, ITAT could likely summarize the research and the work on this topic.

Renee Karrh said she could take an exploratory look at DOC or POC data for MD so it can be compared with VA, but they could not produce the trends for these parameters this year due to all the time required for running the flow models and performing quality assurance/quality control. Mike said one thing he has not yet investigated is what methodological changes have occurred and when they have occurred. Renee said this is a big challenge for trends calculations.

Carol Cain asked if the Redfield ratio is passe (C 106 : N 16 : P 1)? There was no response to this question.

11:45 Adjourn

Participants: Alex Gunnerson, Andrew Keppel, August Goldfischer, Blessing Edje, Breck Sullivan, Carl Friedrichs, Carol Cain, Cindy Johnson, Efeturi Oghenekaro, Elgin Perry, Gary Shenk, George Onyullo, Helen Golimowski, James Colgin, James Webber, Joe Morina, Jon Harcum, Li Li, Mike Lane, Mukhtar Ibrahim, Nicholas Santoro, Qian Zhang, Rebecca Murphy, Renee Karrh, Rikke Jepsen, Sarah Betts, Roger Stewart, Tish Robertson, Tom Butler, Tom Parham, Tony Timpano.