Leveraging Artificial Intelligence and Machine Learning to Advance Chesapeake Bay Research and Management: A review of status, challenges, and opportunities

February 24-25, 2025
SERC, Edgewater, MD

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UMCES / CBP
STAC Topical Meeting
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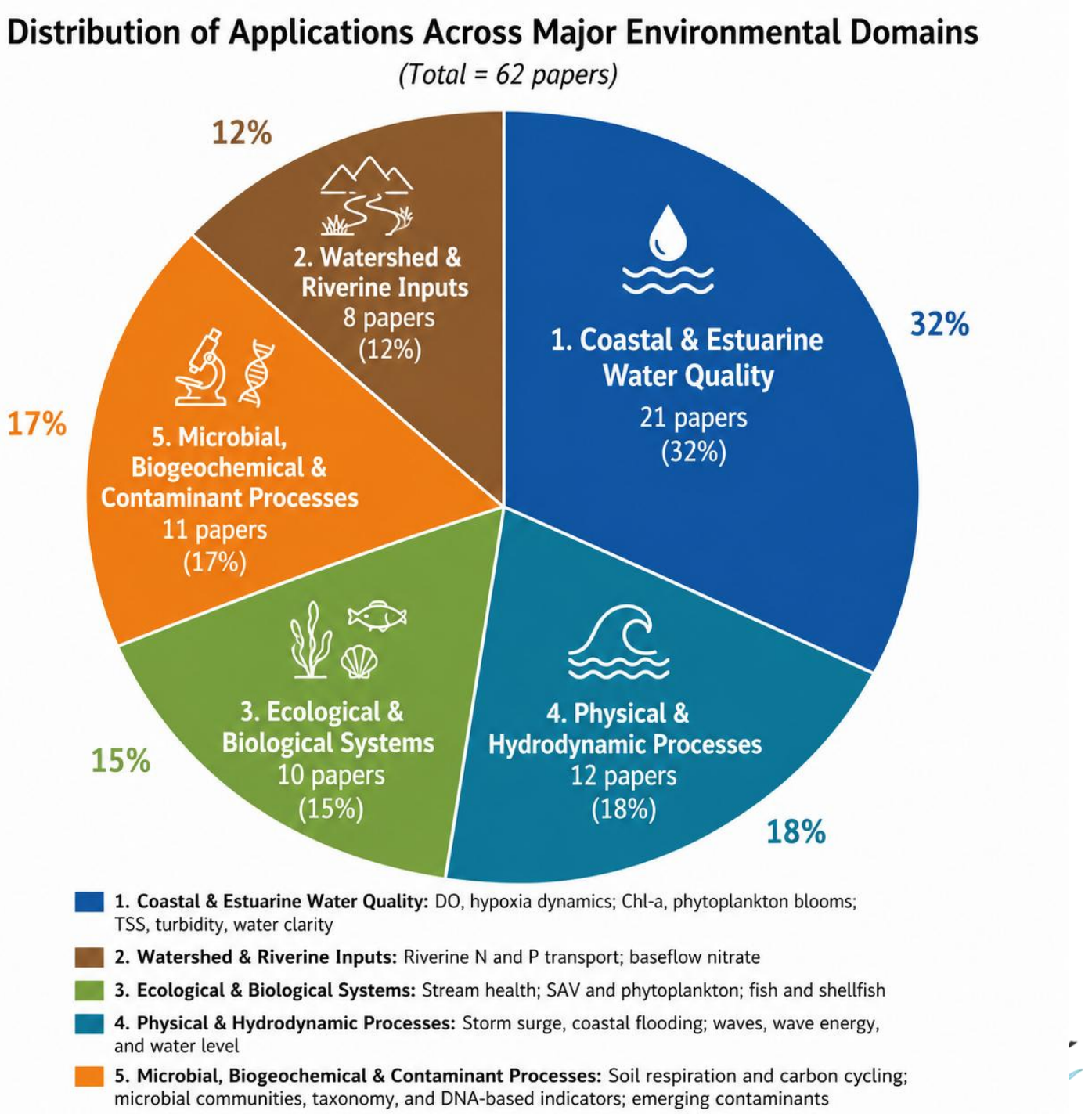
Workshop Objectives

This workshop gathered federal, state, and academic partners to synthesize the **state of the science on AI/ML** approaches, identify research needs, and improve science coordination.

1. Summarize recent AI/ML applications to the Chesapeake Bay ecosystem and lessons learned
2. Identify the challenges and gaps in applying AI/ML approaches to Chesapeake Bay data
3. Develop recommendations and identify opportunities for harnessing the power of AI/ML approaches to address Chesapeake Bay issues

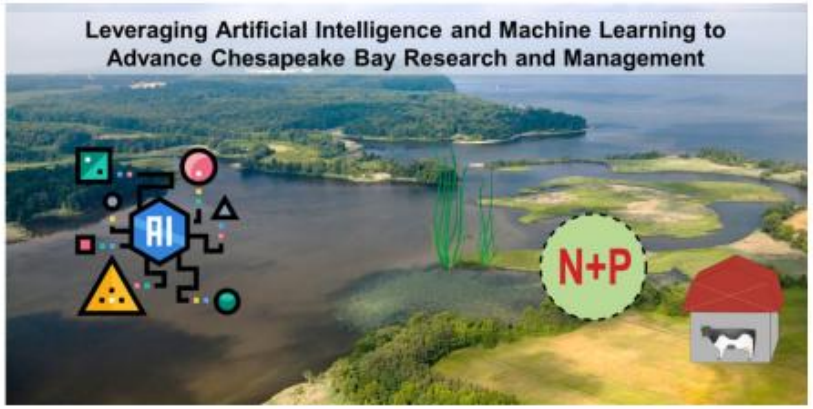
Applications of AI/ML

- Prediction & Forecasting
- Gap Filling & Data Reconstruction
- Pattern Recognition & Classification
- Process Inference & Driver Attribution
- Scenario Analysis & Decision Support
- And more!



Workshop Report

Leveraging Artificial Intelligence and Machine learning to Advance Chesapeake Bay Research and Management: A Review of Status, Challenges, and Opportunities



STAC Workshop Review
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https://www.chesapeake.org/stac/wp-content/uploads/2025/11/FINAL_Leveraging-AI-and-ML_25-005-1.pdf

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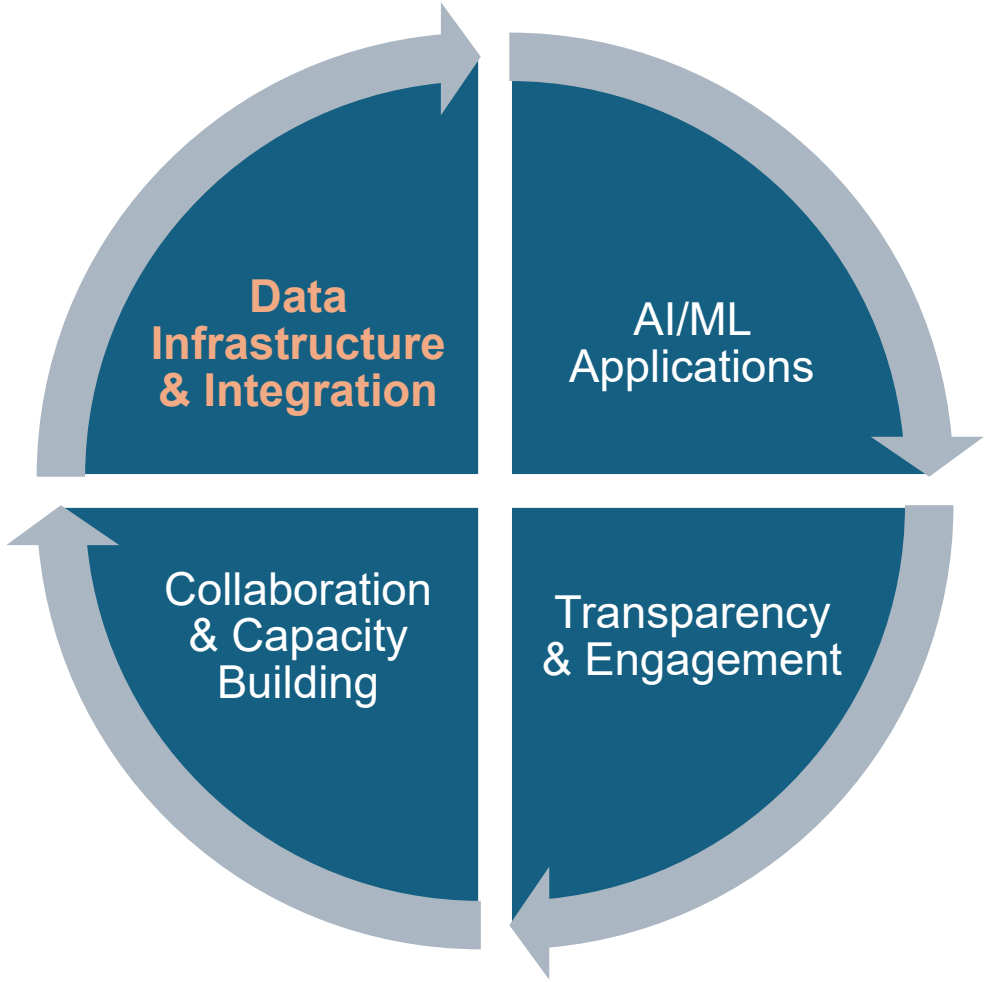
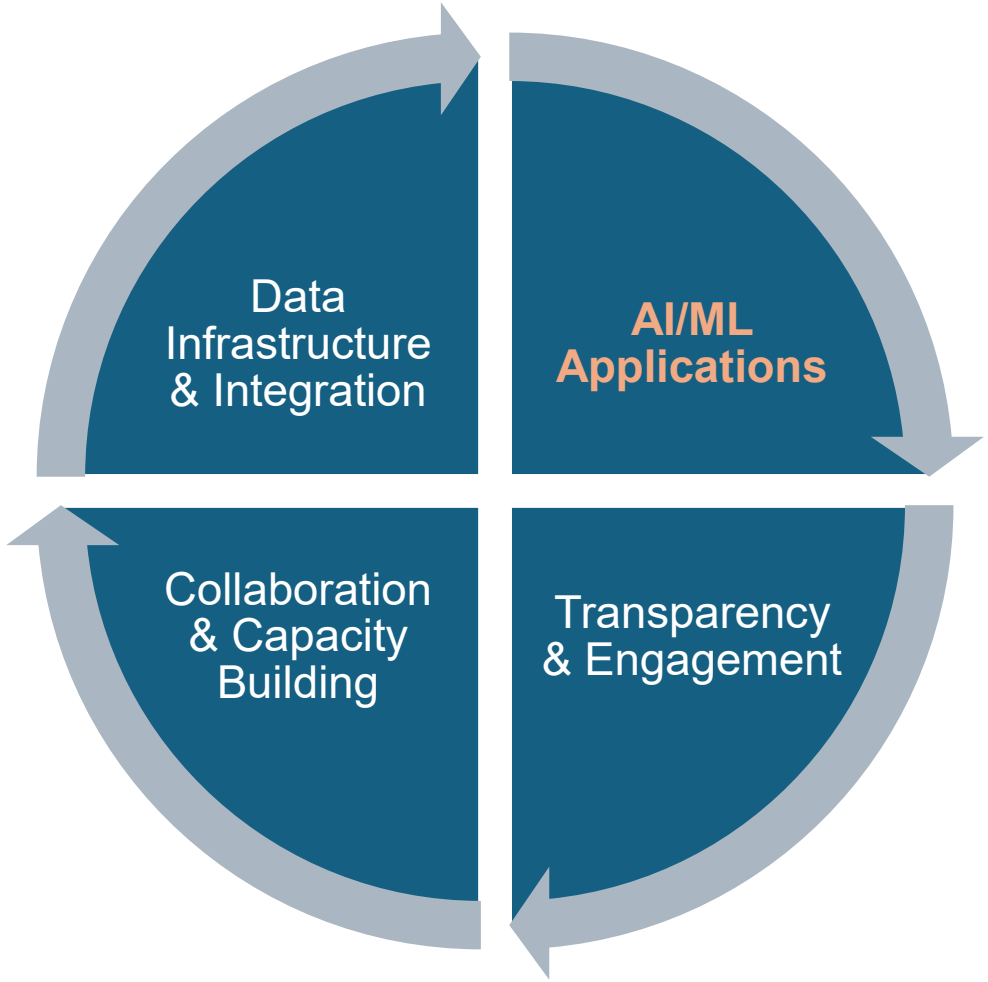


1. Strengthen data infrastructure and integration for AI/ML applications

- Harmonize spatial and temporal datasets across programs and ensure consistent metadata.
- Leverage diverse datasets, including satellite, in-situ, and high-frequency data, for modeling, monitoring, and filling water quality data gaps. (*MB1)
- Design monitoring and data processing efforts so that resulting products are problem-relevant and can be readily incorporated into AI/ML workflows.
- Build harmonized response and predictor datasets and develop exemplar use cases to guide widespread AI/ML applications. (*MB3)

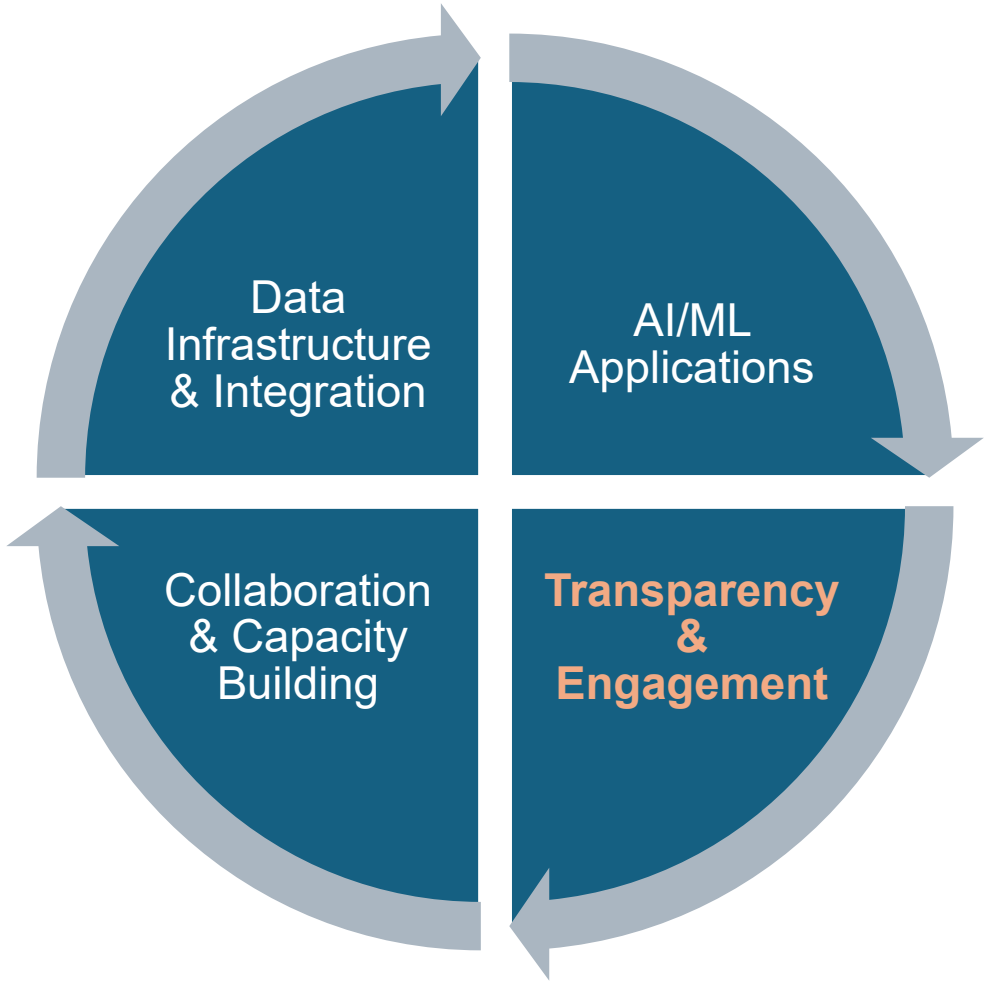
Workshop Recommendations



2. Leverage AI/ML for Chesapeake Bay tidal and non-tidal regions restoration and decision support

- Use AI/ML to assess restoration practices, evaluate progress, and identify drivers.
- Enhance Watershed and Estuarine Models by integrating AI/ML model outputs and insights. (*MB2)
- Develop accessible AI-driven tools (e.g., Chesapeake-specific LLMs) for scenario planning to help identify management priorities.

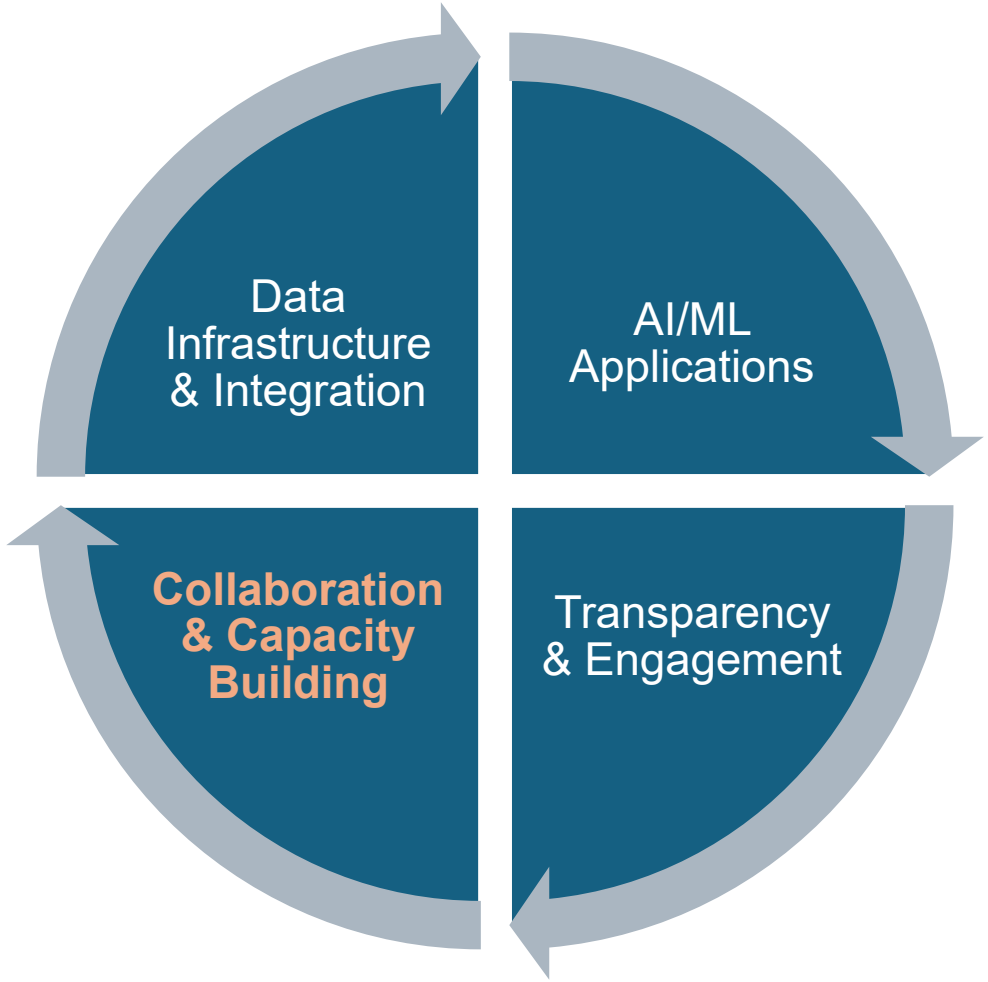
Workshop Recommendations



3. Promote transparency and engage managers and stakeholders

- Advance explainable AI and uncertainty protocols so that results are interpretable and trusted.
- Couple AI/ML with tailored data visualizations to improve interpretability and use.
- Foster close engagement of managers and decision-makers at all stages of AI/ML projects to ensure products align with management priorities and can be effectively applied.
- Use tailored communication strategies to translate AI/ML insights into actionable guidance for restoration planning.

Workshop Recommendations



4. Build collaboration and capacity

- Establish a Chesapeake Bay AI/ML network (e.g., **Ches-BRAIN**) to foster collaboration and conversations and to make it easier for managers to connect with AI/ML experts. ***(Ches-BRAIN: Chesapeake Bay Research with Artificial Intelligence and Networking)***
- Invest in training and literacy programs so that scientists, managers, and decision-makers can effectively use AI/ML tools and outputs.
- Encourage participatory events such as Hackathons to spark innovation and strengthen cross-sector collaboration.

Adopting AI/ML for Management

- **Data readiness**: Consistent monitoring, metadata, and QA/QC workflows
- **Stability & robustness**: Methods must perform consistently across time and datasets
- **Interpretability & transparency**: Outputs must be explainable and traceable
- **Defensibility**: Results must hold up under regulatory and stakeholder scrutiny
- **Integration with existing methods**: Complement trusted approaches (e.g., WRTDS, watershed models)
- **Workflow alignment**: Fit within decision cycles and reporting processes

WRTDS as a Reference

- **Handles variability explicitly**: Separates long-term trends from hydrologic fluctuations
- **Stable over time**: Results evolve gradually, not erratically
- **Interpretable by design**: Structure aligns with physical understanding
- **Transparent and traceable**: Assumptions and workflows are clear
- **Communicates uncertainty**: Provides ranges and context, not single values
- **Aligned with decision needs**: Supports trend evaluation and policy decisions