Study to Determine the Potential for Digital Tools to Contribute to Chesapeake Bay Restoration

The following report is in fulfillment of the requirements set forth in SB 348/Ch.237(4) and HB653/Ch238(4) for the 2022 session.

In consultation with the BayStat Subcabinet agencies and appropriate experts and using funding received through state or federal grant programs, the Department of Natural Resources shall study and assess the potential for digital tools and platforms to contribute to Chesapeake Bay restoration and climate solutions, including:
(i) artificial intelligence and machine learning;
(ii) blockchain technologies and distributed ledgers;
(iii) crowdsourcing platforms;
(iv) smart sensors;
(v) the Internet of Things; and
(vi) software and systems.

(2) The study shall include:
(i) as practicable, an inventory and assessment of digital tools and platforms based on the Digital Climate Solutions Report required under § 40433 of the federal Infrastructure Investment and Jobs Act;
(ii) an analysis of the likely applications of the digital tools and platforms assessed under item (i) of this paragraph for drinking water management;
(iii) the potential cost savings associated with the adoption of any digital tools or platforms; and
(iv) a summary of opportunities for the state to incentivize the deployment of promising technologies by the private sector in the state in ways that support state programs and services.

(b) On or before December 1, 2023, the Department of Natural Resources shall report the findings of the study required under subsection (a) of this section to the General Assembly, in accordance with § 2–1257 of the State Government Article.

Introduction:

The enactment of the Conservation Finance Act in 2022 (CFA) expanded the state's ability to accelerate ecological restoration through a series of landmark improvements to existing programs. The CFA broadened and helped define both blue and green infrastructure, allowing for a larger range of restoration initiatives eligible for traditional infrastructure funding. The CFA also encourages private investment in restoration efforts through a pay-for-success model that mitigates the financial risk for the state and eliminates potential disincentives for private landowners to participate in carbon markets. These components, among others, will collectively contribute to accelerating the pace and scale of ecological restoration efforts within the state.

To assist in this advancement of ecological restoration, the legislation called for a digital tools study - analogous to the one done under § 40433 of the federal Infrastructure Investment and Jobs Act 2021 - to "assess the potential for digital tools and platforms to contribute to Chesapeake Bay restoration and climate solutions." This report will summarize the potential benefits of different types of digital tools for this purpose.

Digital Tools Summary

Technology can play a crucial role in monitoring, analyzing, and managing the environment. The potential for digital tools and platforms to contribute to Chesapeake Bay restoration and climate solutions is substantial; however, understanding how these technologies can be applied to ecosystem restoration is still evolving. The following is an inventory of digital tools and how they might be applied in the state's restoration effort.

1) Artificial Intelligence (AI) and Machine Learning (ML)[1]:

An AI tool refers to a software application using algorithms to execute specific tasks. These tools find applications across diverse industries and facilitate task automation, data analysis, and enhanced decision-making.

Machine Learning is a subset of artificial intelligence and computer science and concentrates on leveraging data and algorithms to mirror human learning processes, progressively enhancing accuracy over time.

The two are sometimes used interchangeably; however, they are different. AI encompasses a broad spectrum, ranging from smart assistants like Alexa to robotic vacuum cleaners and self-driving cars. Meanwhile, Machine Learning is one of several branches within the domain of AI, dedicated to creating algorithms and statistical models enabling computer systems to perform intricate tasks without explicit instructions.

AI and ML can be instrumental in analyzing large datasets related to water quality, ecosystem health, and climate patterns. They can help in predicting changes, identifying trends, and optimizing resource allocation for restoration efforts. Machine learning algorithms can process complex environmental data to provide insights for more effective decision-making, including storm tracking and climate vulnerability.,

2) Blockchain Technologies and Distributed Ledgers[2]:

Distributed ledger technology (DLT) is a platform that utilizes ledgers stored across interconnected devices in a network to guarantee data accuracy and security. Blockchain represents a specific type of distributed ledger. Instead of centralizing data, distributed ledgers use independent computers (nodes) to record, share, and synchronize transactions in their electronic ledgers. In the case of blockchain, data is organized into blocks that are linked together.

Blockchain and DLT form the foundational components of the "internet of value," which is the recording and peer-to-peer transfer of "value" without the need for a centrally coordinating entity. Here, "value" encompasses records of asset ownership, such as money, securities, and land titles, as well as ownership of specific information like identity and health data.

Blockchain and distributed ledger technologies can enhance transparency and tracking in environmental efforts. They can be applied to ensure the integrity of data related to restoration projects, creating a secure and unalterable record of actions taken. This can be particularly useful for measuring the impact of various ecological practices and ensuring accountability.

3) Crowdsourcing Platforms[3]:

Crowdsourcing platforms gather information from large numbers of people who contribute their data through the Internet, social media, and smartphone applications.

Crowdsourcing platforms can engage the community and stakeholders in collecting valuable data, sharing insights, and participating in restoration efforts. Citizens can contribute observations, data, and local knowledge, providing a broader and more detailed understanding of the Chesapeake Bay ecosystem. These platforms can foster a sense of community involvement and ownership in restoration projects.

An example of crowdsourcing technology recently initiated by the state is MyCoast, a portal to collect and analyze photos which are linked to precipitation, riverine, and tidal data to create reports that help government agencies, business owners, and residents understand impacts in local communities and encourage action to reduce localized flooding.

4) Smart Sensors[4]:

A smart sensor is a device that takes input from the physical environment and uses built-in compute resources to perform predefined functions upon detection of specific input and then process data before passing it on. A smart sensor is a device designed to receive input from the physical environment, utilizing internal computing resources to execute predetermined functions upon detecting specific input, processing the data then transmitting it forward.

Smart sensors play a critical role in real-time monitoring of environmental parameters. Deploying sensors in the Chesapeake Bay can provide continuous data on water quality, temperature, and other relevant factors. This data can be used to detect changes, assess the impact of restoration efforts, and respond promptly to emerging environmental issues.

The state has invested in the use of smart sensor technology in stormwater management ponds, creating “smart ponds” with the company Opti. Opti’s smart pond technology improves stormwater pond operations using sensors and software to monitor real-time conditions such as water level and storage volume.

5) Internet of Things (IoT)[5]:

The term IoT, or Internet of Things, refers to the collective network of connected devices and the technology that facilitates communication between devices and the cloud, as well as between the devices themselves.

IoT devices can be integrated into the Chesapeake Bay ecosystem to create a network of interconnected sensors and devices. This interconnected system can provide a comprehensive view of environmental conditions, enabling more effective management strategies. IoT can help automate processes, such as adjusting water flow or activating nutrient removal systems based on real-time data.

6) Software and Systems:

Specific software solutions can facilitate data management, analysis, and collaboration. Geographic Information System (GIS) software, for example, can help visualize and analyze spatial data relevant to restoration efforts. Integrated software and systems can streamline communication, project planning, and decision-making processes.

The integration of digital tools and platforms, including AI, blockchain, crowdsourcing, smart sensors, IoT, and specialized software, holds great potential for advancing Chesapeake Bay restoration and climate solutions. These technologies can enhance the efficiency, accuracy, and inclusivity of environmental initiatives, fostering a more sustainable and resilient ecosystem. However, it's crucial to ensure that these technologies are applied responsibly, with attention to ethical considerations, data privacy, and community engagement.

<u>Potential Digital Tools Applications to Enhance the Restoration Effort</u>

Water Quality Monitoring

Deploying smart sensors in the Chesapeake Bay and its tributaries can provide real-time data on water quality parameters such as temperature, pH, dissolved oxygen, nutrient levels, and pollutants. Continuous monitoring allows for quick detection of pollution events, enabling rapid response and targeted interventions.

Smart Agriculture

Digital tools can be used in precision agriculture practices, helping farmers in the Chesapeake Bay watershed optimize fertilizer and pesticide usage. Smart sensors can provide data on soil moisture, nutrient levels, and weather conditions, allowing farmers to make informed decisions that minimize agricultural runoff into the bay.

Weather and Climate Monitoring
IoT devices can enhance weather and climate monitoring systems, providing more accurate and timely information about weather patterns, storms, and climate change impacts. This information can aid in predicting and mitigating the effects of extreme weather events on the Chesapeake Bay ecosystem.

Crowdsourcing applications can prove valuable for gathering localized storm and weather conditions, and documenting flooding by collecting data from areas where sensors and other tools may not be accessible or practical.

Wildlife Tracking
IoT-enabled tracking devices can be used to monitor the movements and behaviors of key species in the Chesapeake Bay, such as migratory fish and bird populations. This data can inform conservation efforts and help identify areas that require protection or restoration to support biodiversity.

Efficient Resource Management
Digital tools can be applied to manage resources more efficiently, such as optimizing water usage in agriculture, monitoring and controlling wastewater discharges, and managing energy consumption in restoration projects. Smart resource management can lead to cost savings and more sustainable practices.

Data Analytics for Decision-Making
IoT-generated data can be processed and analyzed using advanced analytics tools to derive actionable insights. Decision-makers can use this information to develop evidence-based policies, allocate resources effectively, and prioritize restoration efforts based on real-time environmental conditions.

Community Engagement
Digital tools can facilitate community engagement by providing citizens with access to real-time environmental data. Public awareness and involvement are crucial for the success of restoration projects, and IoT can empower communities to participate in monitoring and conservation efforts.

Early Warning Systems
Digital tools can contribute to the development of early warning systems for potential environmental threats, such as algal blooms or pollution events. Early detection allows for swift response measures to mitigate the impact on the ecosystem.
By integrating IoT technologies into Chesapeake Bay restoration initiatives, stakeholders can gain a more comprehensive understanding of the ecosystem, respond to challenges more effectively, and make informed decisions to promote sustainable environmental management.

Cost Analysis

There is a wide breadth of emergent tools within the digital world and countless opportunities to apply new technology to watershed efforts across sectors. For this reason, a robust cost analysis for the state's needs is reliant on numerous factors that are yet unknown - including for which issues and problems the state will be pursuing digital solutions and how to best combine available tools to meet goals. This will take a multi-agency collaborative effort to build a strategic plan and budget for digital assets development, building upon the existing technological solutions mentioned above (i.e. MyCoast and Opti).

Conclusion:

The Chesapeake Bay restoration and protection effort is of paramount importance to the state of Maryland and its residents and visitors. As the state continues to explore the most cost-efficient and effective ways to meet our myriad goals to advance water quality, climate resilience, carbon sequestration, habitat restoration and equity, digital solutions offer new ways to address pressing concerns. The state's employment of all available technologies and continual assessment of tools available in the digital world should be a priority.

Links & Resources:

[1] https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained

[2] https://www.worldbank.org/en/topic/financialsector/brief/blockchain-dlt

[3]https://www.investopedia.com/terms/c/crowdsourcing.asp#:~:text=Investopedia%20%2F%20Paige%20McLaughlin-,What%20Is%20Crowdsourcing%3F,others%20perform%20small%20tasks%20voluntarily.

[4]https://www.iotone.com/term/smart-sensors/t667#:~:text=A%20smart%20sensor%20is%20a,data%20before%20passing%20it%20on.

[5]https://www.oracle.com/internet-of-things/what-is-iot/#:~:text=What%20is%20IoT%3F,and%20systems%20over%20the%20internet.