Land Characterization and Monitoring in the Chesapeake Bay Watershed

Long-term Strategy: 2024 – 2034

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Background: Characterization and monitoring of land cover (e.g., impervious surfaces, tree canopy) and land use (roads, structures, cropland, open space) conditions in the Chesapeake Bay watershed are critical for monitoring and achieving multiple outcomes set forth in the 2014 Chesapeake Bay Watershed Agreement including those related to water quality, wildlife habitat, climate resiliency, watershed health, and land conservation. These data are also essential to support development of the Phase 7 watershed model. To support the Agreement and model, current, high-resolution land use and land cover (LULC) data need to be produced over the next decade. To ensure consistency, continuity, and flexibility in data production, a long-term strategy and investment is required. Producing such data at high spatial, temporal, and categorical resolution has already begun to change the way restoration and conservation actions are planned and monitored and has the potential to target where Best Management Practices (BMPs) for pollutant load reduction are most effective.

Current LULC Data Production: The Cooperative Agreement between the US EPA-Chesapeake Bay Program Office and the Chesapeake Conservancy will conclude in June 2024. This Agreement is producing a series of consistent and comparable 1-meter resolution, 60+ class, LULC datasets for all counties within and adjacent to the Chesapeake Bay Watershed (~99,000 square mile region) for the years 2013/14, 2017/18, and 2021/22. The Agreement is also producing 1-meter resolution hydrography dataset (e.g., streams, gullies, ditches), and supporting state-of-the-art targeting and pollution reduction estimates for BMPs informed by remotely sensed data. The LULC change products (differences between 2013/14 and 2017/18 LULC) is also being used to inform the Land Use Methods and Metrics Outcomes, including metrics on impervious surface change, and the conversion of forests, cropland and pasture, and wetlands to development.

Uses of Current LULC Data: Because these data are high-resolution, categorically rich, and consistent across municipal, county, and state boundaries, they have proved useful for informing local TMDL development, county hazard mitigation plans, greenway and open space development strategies, forest conservation assessments, habitat hub and corridor networks, vacant lot inventories, monitoring easements, riparian reforestation inventories, and stormwater assessments. These local applications of the data are not all focused on environmental restoration and conservation but nonetheless help to achieve Chesapeake Bay Program (CBP) goals and objectives by ensuring that the landscape changes in ways that benefit local communities while minimizing or mitigating environmental damages.

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Limitations of Current LULC Data: While impactful, the current LULC data only cover an 8-year time span and have a coarse temporal resolution (4–5-year monitoring interval). This relatively short span and long interval constrain our understanding of the relationship between changes in LULC and changes in water quality, stream flow, watershed health, and communities. It limits our ability to assess progress for multiple outcomes including tree canopy, forest buffers, wetlands, black ducks, healthy watersheds, climate resiliency, land use methods and metrics, and land use options evaluation. Additionally, the short monitoring span limits the applicability of the data to inform long-term LULC change forecasts needed to assess the impacts of Land Policy BMPs and land management scenarios. Finally, the short span and long interval limit our understanding of the drivers of change and delay management responses to observations of change.

Future LULC Data: Restoration and conservation efforts in the Bay watershed will continue through the 2020's as will the diverse array of LULC applications implemented by counties, municipalities, and other organizations that have become reliant on high-resolution LULC data. A continuous, longer-term, and near real-time land data record is required to understand factors affecting land use and the relationships between land use, water quality, and climate change. At a minimum, the record of consistent and detailed LULC data needs to be continued through the year 2033 to: 1) ensure the production of LULC data based on 2025/26 and 2029/30 aerial imagery, 2) ensure that the products continue to meet and adapt to the diverse and evolving needs of the CBP Partnership, and 3) leverage new sources of imagery, computational capacities, and scientific techniques. To prepare for remapping the watershed with 2025/26 imagery, interpret and evaluate our current LULC data to inform multiple CBP outcomes, and to support the evaluation of new land uses and metrics through CalCAST for the Phase 7 model, **a 5-year Cooperative Agreement with a projected cost of $7.25 million** needs to be awarded in time for work to begin by October 1, 2024. Another 5-year Cooperative Agreement will be needed to cover the year 2029 – 2034 timeframe.

Core Elements of a Long-term Land Change Monitoring Strategy:

1. Production of 1-meter resolution LULC data for the years 2025/26 and 2029/30. ($1 million per year)
    - Developing data access, visualization, and analyses to inform multiple outcomes and applications (e.g., State of the Forests 2.0, Chesapeake Healthy Watersheds Assessment, Phase 7 model).
    - Establishing formal feedback loops between on-the-ground restoration and conservation efforts, county and municipal use of the data for planning purposes, and the identification and mapping of landscape features to continually adapt the data to CBP Partner needs.
    - Developing new land use classes as needed to address the evolving needs of the CBP Partnership and retrospectively updating earlier LULC datasets to ensure consistency through time and meaningful change products.
    - Exploring the application of artificial intelligence (AI) and machine learning methods to generate land cover and land cover change data informing the land use classification (e.g., solar panel arrays, timber harvests, animal operations).

2. Monitoring seasonal changes in vegetation condition to enhance climate resiliency. ($250,000 per year)
    - Tracking vegetation condition monthly or seasonally at 10-meter resolution throughout the Bay watershed to identify signs of marsh migration and dissolution, vegetation stress (affecting nutrient processing), and land cover change (e.g., clearing trees for development, planting cover crops).
    - Leveraging the information content of multiple years of LiDAR imagery to assess and monitor changes in vegetation structure for forest health and carbon accounting applications.

3. Improving BMP verification
   ($100,000 per year over five years)
    - Evaluating use of aerial and satellite imagery to verify the presence/absence of BMPs resulting in a change in land use or condition (e.g., tree planting, grass buffers, wetland creation).
    - Coupling the power and efficiency of machine learning with the intelligence and accuracy of manual classification to identify and map select structural BMPs.

4. Enhancing the utility of hyper-resolution hydrography data
   ($100,000 per year over five years)
    - Updating the hyper-res hydrography data locally in areas with more recent LiDAR imagery.
    - Attributing the hyper-resolution hydrography data with probabilistic flow measures sensitive to changes in climate.
    - Developing community-based data collection protocols and tools to interpret LULC change and identify the presence/absence of stream flow and wetlands.