Chesapeake Bay Remote Sensing Pilot – Executive Briefing

Introduction

In his Executive Order 13506 in May 2009, President Obama stated "The Chesapeake Bay is a national treasure constituting the largest estuary in the United States and one of the largest and most biologically productive estuaries in the world." Federal, state, and non-governmental partners from New York to Virginia have made continuous efforts to improve water quality in the Chesapeake Bay Watershed (Bay) for several decades utilizing partnership agreements and jurisdictional policies. To quantify the results of these efforts and the resulting changes in sediment, nitrogen, and phosphorus loading to the Bay, the Chesapeake Bay Program adopted a mathematical modeling approach integrating several modelling methodologies generally referred to as the "Bay Model".

Many discussions on the Bay Model methodologies and data have taken place over the years. Historically, the Bay model has used data from a variety of sources. On the agriculture side, data has included agricultural census data as well as information on conservation practices applied by farmers and landowners. To date, the most readily available source of agricultural conservation practice data has been from state and Federal records of conservation practices applied with government financial and technical assistance. Additional conservation practices that farmers and landowners applied without government assistance were largely unaccounted for.

When Total Maximum Daily Loads (TMDL) for sediment, nitrogen, and phosphorus for the Chesapeake Bay were placed on the Commonwealth of Pennsylvania and other jurisdictions by the US Environmental Protection Agency, pressure to meet the TMDL increased the need for data to account for reductions in the Bay Model. In an effort to account for the additional practices not included in the past modeling efforts, jurisdictions began seeking methods to identify and receive credit for these practices. By documenting these practices, Pennsylvania's agricultural producers will receive greater credit toward the required reductions of nitrogen, phosphorus and sediments.

Purpose

In an effort to assist the Commonwealth receive additional credit for applied agricultural conservation practices, Pennsylvania Natural Resources Conservation Service (NRCS) and the Pennsylvania Department of Environmental Protection (DEP) undertook a joint proof of concept pilot project. The concept tested was to determine if remote sensing imagery could be utilized to identify and inventory conservation practices and if their associated attributes can also be collected using these methods. The secondary benefit of the pilot will be the development of a baseline inventory of conservation practices applied in the Pennsylvania portion of the Potomac River Watershed.

Location

Several characteristics were identified and discussed with the PA DEP in the selection of a location for the pilot project. It was identified that the watershed should:

- Be a sub-watershed of the Chesapeake Bay that was easily recognizable;
- Encompass several watersheds of the 12 digit hydrologic unit code (HUC-12);
- Have a manageable data collection area;
- Include diverse agricultural operations;
- Have diverse land uses; and
- Be located close to the Bay and have a higher nutrient and sediment loading value due to its proximity.

The location chosen for the pilot project was the Potomac Watershed in Pennsylvania. The Potomac Watershed is located within seven counties in South Central Pennsylvania including Perry, Cumberland, Adams, Franklin, Fulton, Bedford and Somerset counties. Because the Bay Model utilizes County Census data, it was determined that data collection would encompass entire counties. Since Cumberland and Perry Counties had such small areas in the Potomac Watershed, it was decided that the entirety of the five counties with the largest portion of the watershed, Adams, Franklin, Fulton, Bedford, and Somerset, would be utilized for the Pilot Project.

The Potomac Watershed had the desired diversity in agricultural operations such as intense dairy operations, cash grain operations, orchards, beef production. Land use was also diverse and included forests. The watershed also did not encompass a large surface area and is one of the smaller sub-watersheds with just over one million acres. The Potomac also has a higher loading value in the Bay Model due to its closer proximity to the Bay. A map of the project area is included as Appendix A.

Data Collectors

Two groups of data collectors were used for the Pilot Project. The activities of the two groups were coordinated by PA NRCS State Office GIS staff under the supervision of the State Soil Scientist. One group of data collectors were contracted to work out of the PA NRCS State Office and consisted of three former PA NRCS staff that extensive GIS and conservation practice expertise. The State Office GIS and the three PA data collectors participated in a one-week on-line GIS image interpretation refresher from the University of Michigan before beginning data collection.

In addition to the local Pennsylvania staff, another group of data collectors consisting of ten staff from the NRCS East Remote Sensing Lab (ERSL) in Greensboro, North Carolina were utilized for the project. The ERSL staff had specialized skills in photo interpretation and

knowledge of standard quality control measures that were utilized as part of their normal operating procedures.

Methodology

The methodology developed for this pilot project was established through a collaborative approach between Pennsylvania NRCS, PA DEP, the Chesapeake Bay Program, USDA NRCS East Remote Sensing Lab, and a USDA NRCS contractor located in Fort Collins. This group discussed the possible methods of data collection and established the following four project methods:

a) BMP Identification;
b) Attribute identification;
c) Geospatial Database development; and
d) Data collection;

a) BMP Identification:

PA DEP provided a list of 28 conservation best management practices that would be identified in the pilot project. The list of practices was based on BMPs that were able to be detected remotely, as well as the practices which provided the most credit in the Bay Model for achieving the goal of nitrogen, phosphorus and sediment reduction. In many cases, the Bay Model often defined BMPs differently than the NRCS conservation practice standard definition. To provide consistency in reporting, members of the team utilized the existing NRCS Conservation Practice and Bay BMP "Cross-Walk" drawing a correlation between the BMPs identified in the Bay Model and the conservation practices identified in the NRCS Electronic Field Office Technical Guide.

b) Attribute Identification:

For each of the 28 BMPs, the attributes for each practice were identified including the Bay Model measure (acres, count, or linear foot). Many practices required additional data (i.e., such as riparian buffer width) in order to be given specific reduction credits in the Bay Model. This additional information and attributes were identified for each practice. A summary of this information is included as Appendix B.

c) Geospatial Database Development:

A USDA NRCS Contractor from the National Geospatial Center of Excellence (NGCE) was enlisted to assist with the development of the database for the Pilot Project. This Contractor specialized in geospatial database development. It was estimated that the experienced contractor saved three to four days of staff time in the database development process. The geospatial database and its design reflected the practice code, practice name, unit of measure (acres, count, or linear feet) along with approximately thirty additional fields for data entry for the associated practice attributes. In some cases this required numerous drop down menus

reflecting the criteria used to obtain credit in the Bay Model. The geospatial database captured all critical practice data and attributes requested by DEP.

d) Data Collection:

After consultation with NRCS staff, DEP, and Bay Modelers, a grid approach was adopted to collect the remote sensing data. This grid approach, which has been successfully used by NRCS for easement monitoring, divided the project area into more manageable pieces of approximately seven acres per grid. An example of this can be seen in Appendix C. The data collectors were assigned a "working area" that contained a number of grid cells. Each cell was individually reviewed and if conservation BMP's were present, they were digitized and attribute data was entered into the geospatial database. After data collectors completed the data collection in the cells, that data was "checked in" and saved to the master database. This method prevented corruption of the data and assisted with quality control and workload management. Practices observed through remote sensing technology were entered into the geospatial database through a Geographic Information System (GIS).

Other sources of geospatial data were commonly used by the data collectors to aid in the remote sensing process. These may have included one or more of the following:

- National Agriculture Imagery Program (NAIP), 1 meter resolution
- Digital Globe Imagery, 0.5 meter resolution
- Google Earth
- Google Street
- USDA-NRCS Toolkit Data
- FSA Cover Crop Reports
- Normalized Difference Vegetation Index (NDVI) on dormant LandSat Imagery

<u>Quality Control/Quality Assurance</u>

This pilot project included field verifications to confirm the accuracy of the remotely sensed data collection. The importance of a field verification process was emphasized by the Chesapeake Bay Program Agricultural Workgroup before the project began and by EPA modeling staff (Mark Dubin and Jeff Sweeny) and DEP throughout the project. It was agreed to that the standard USDA NRCS 5% quality assurance/quality control sample would be utilized for verification.

Using published statistics from the 2012 Census of Agriculture, the number of farms to be verified was determined as a percentage of the total number of farm operations. Five percent of farms were field verified for four counties (Adams, Fulton, Bedford, and Somerset). Due to the high agriculture operation density in Franklin County, a ten percent field verification was used there.

Using ArcMap software's random point generator, a random point cloud was developed for each county. If the point fell on an agricultural operation that farm was to be field verified. Field verifications were limited to farms within the pilot project counties in the Potomac Watershed boundary.

Farms that were selected for field verification received an onsite visit from a retired NRCS or Conservation District professional. The staff that conducted the field verification of the remote sensed data included two of the three former PA NRCS staff that conducted the remote sensing, one former conservation district manager, and two retired NRCS district conservationists who had extensive knowledge of conservation practices. These professionals were selected for the following reasons: knowledge of the type of conservation practices existing on the landscape; communication experience with the farm community; and knowledge of geospatial data.

Field verification procedures and protocols were developed at the NRCS state office. Each staff providing field verification received in-field training of the procedures and protocols. The field verifications consisted of a full farm inventory. The inventory process consisted of verification of remote sensed practices, identification of practices not captured via remote sensing, and reconciliation of remote sensed practices that did not exist on the ground.

Field verification information was entered into the geospatial database, and any conservation practices observed that were not in the database were geospatially identified and attribute data collected. Practices that were not found on the ground were marked as DELETE in the database.

Data Analysis and Data Release

The remote sensed pilot project data will be released to DEP in aggregate form. This legal obligation originates from three separate laws, the Privacy Act of 1974, as amended, (5 USC 552); Section 1244 of the Food Security Act of 1985, as amended (16 USC 3844); and Section 1619 of the Food, Conservation and Energy Act of 2008 (7 USC 8791).

Conservation practice data will be aggregated to the 12-digit HUC level. Each 12-digit HUC will contain a summary of the practice amount for each practice. To protect landowner privacy, if the count of any conservation practices that are reported on a numerical count, did not exceed five, then the data would not be released and would be aggregated to the county level. This was the same protocol used by USGS in their Agreement with USDA data sharing agreement for a project "to provide consistency and completeness in reporting of USDA-sponsored agricultural conservation practices among the six Chesapeake Bay watershed jurisdictions with agricultural lands." (USGS Open-File Report 2013-1287 Integrating Federal and State Data Record to Report Progress in Establishing Conservation Practices on Chesapeake Bay Farms"). PA DEP received the aggregated and summarized data on the HUC 12 and county level in April 2016.