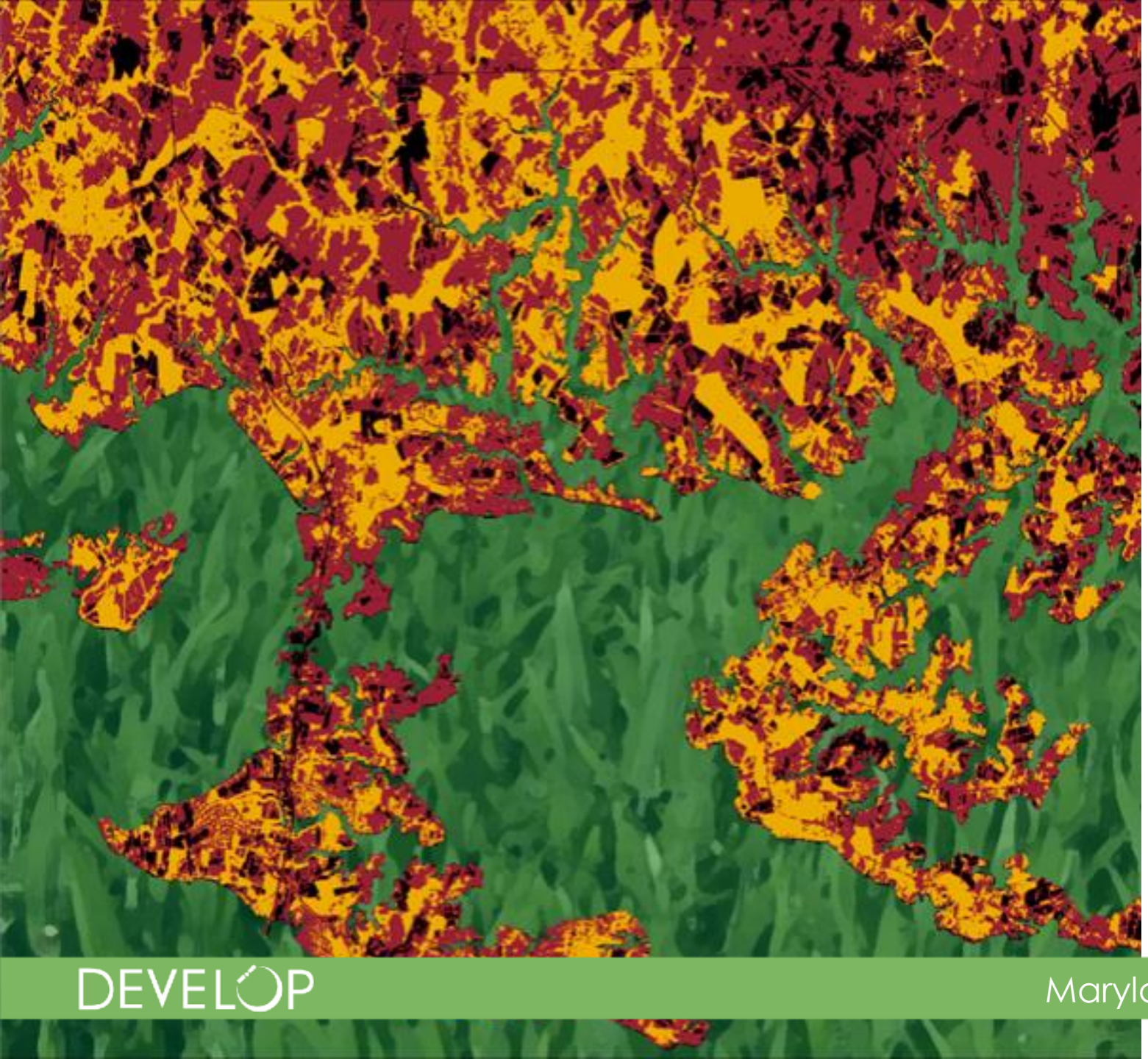


National Aeronautics and Space Administration

Chesapeake Bay Agriculture and Food Security III

Quantifying Wintertime Agricultural Land Use and Springtime Management of Winter Cover Crops using Landsat and Sentinel to Support Environmental Conservation in Maryland

Julio Peredo

Dean Hively

Cover Crops

- Planted during **autumn** in between regular crop growing seasons
- Protect against **erosion and nutrient runoff**
- Primary cover crops for nutrient control are **wheat, rye, barley, and triticale**
  - Other options: brassica, radish, legumes
- Effectiveness depends upon **management practices**

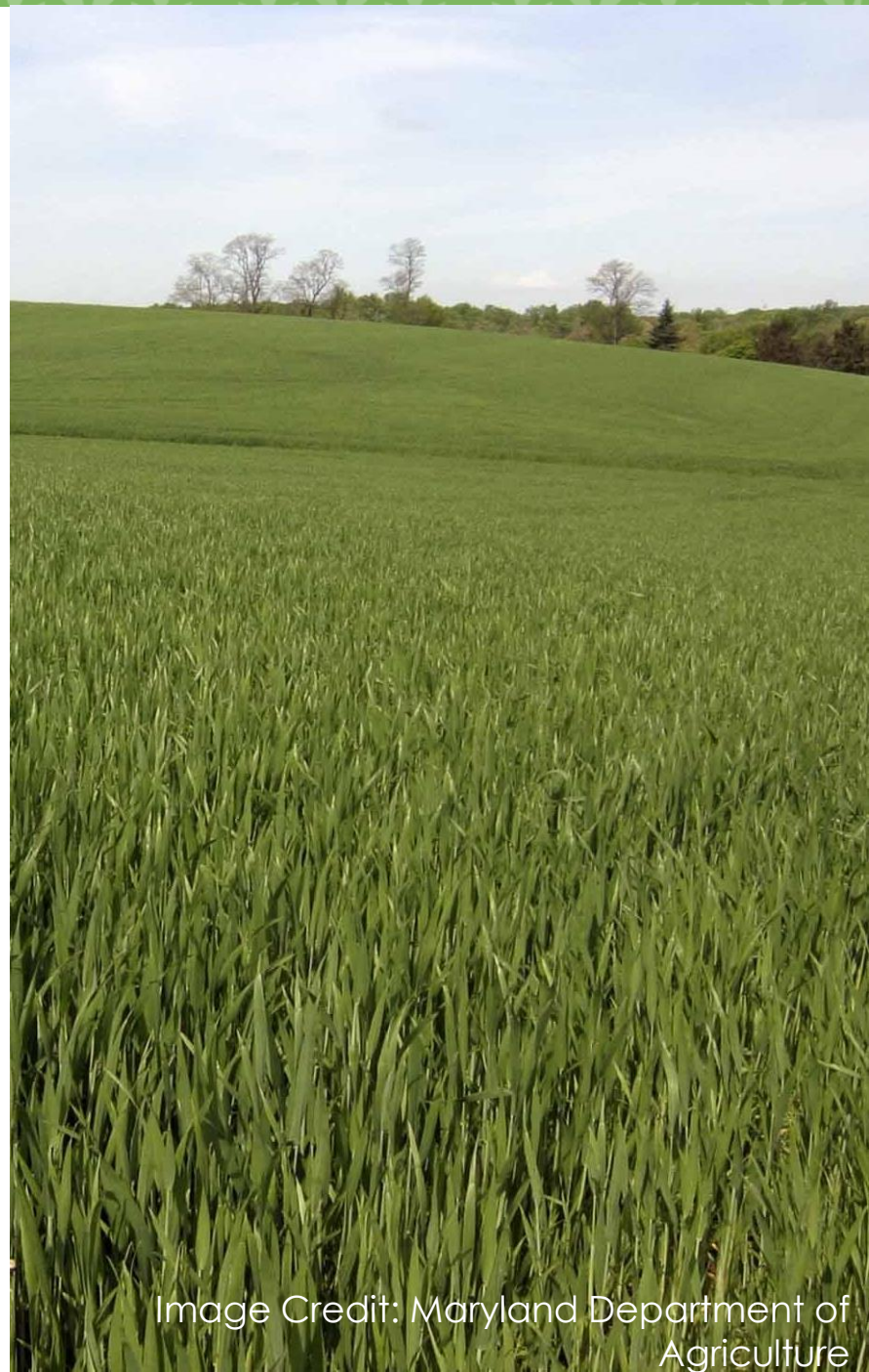


Image Credit: Maryland Department of Agriculture

Partners

Maryland Department of Agriculture, Office of Resource Conservation

USDA, Agricultural Research Service

USGS, Lower Mississippi Gulf Water Science Center

USEPA, Chesapeake Bay Program

Image Source: Hans on Pixabay

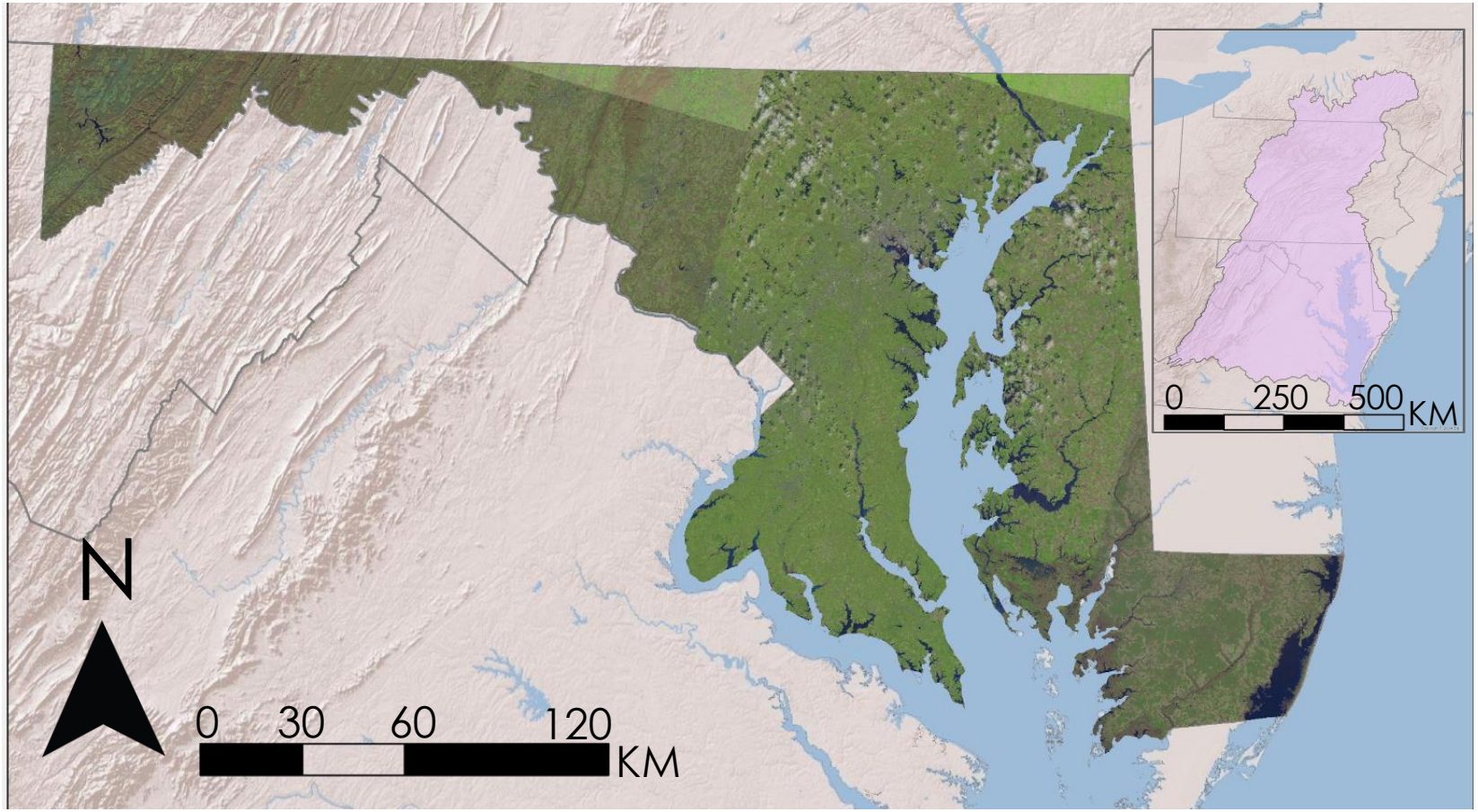
Objectives

- **Analyze** cover crop vegetation density (biomass, % ground cover, NDVI)
- **Develop** a graphical user interface (GUI) to support user time series analysis
- **Provide** an interactive tool which bolsters conservation efforts for the Chesapeake Bay via remote sensing technology

Image Credit: TheDigitalArtist on Pixabay

Study Area/Study Period

State of Maryland with Landsat 8 OLI Composite Image Overlaid



Study period (2014 – present):

Winter (Dec 15 – Jan 31) Spring (March 1 – April 15)*

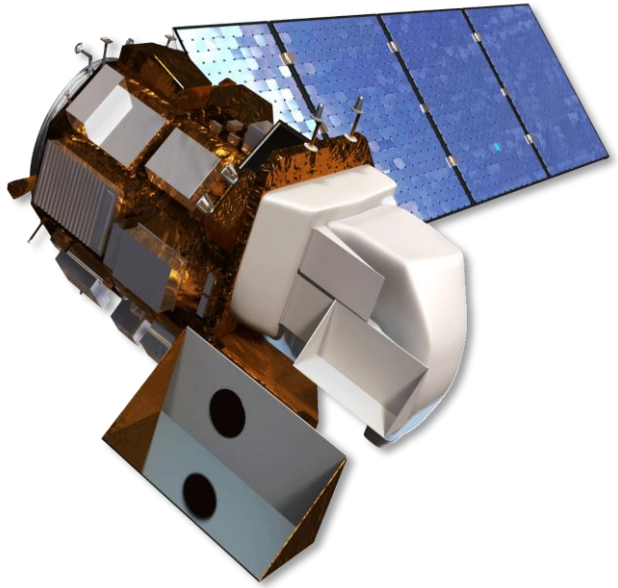
*Spring extended to May 31 for MDA biomass program

Calibration data collected from 2006 – 2012

Image Credit: NASA DEVELOP, World Shaded Relief (Esri), Landsat 8 OLI (NASA)

Earth Observations

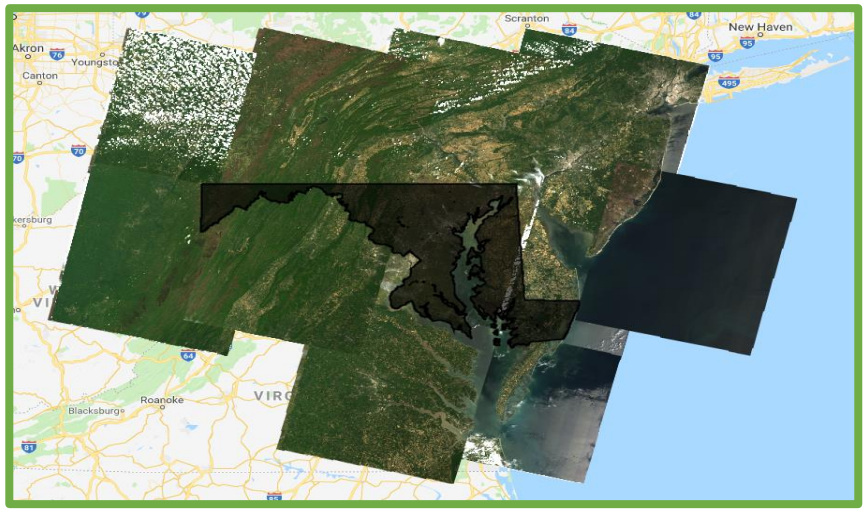
Landsat 5
Thematic Mapper
Resolution: 30m
Frequency: 16 days



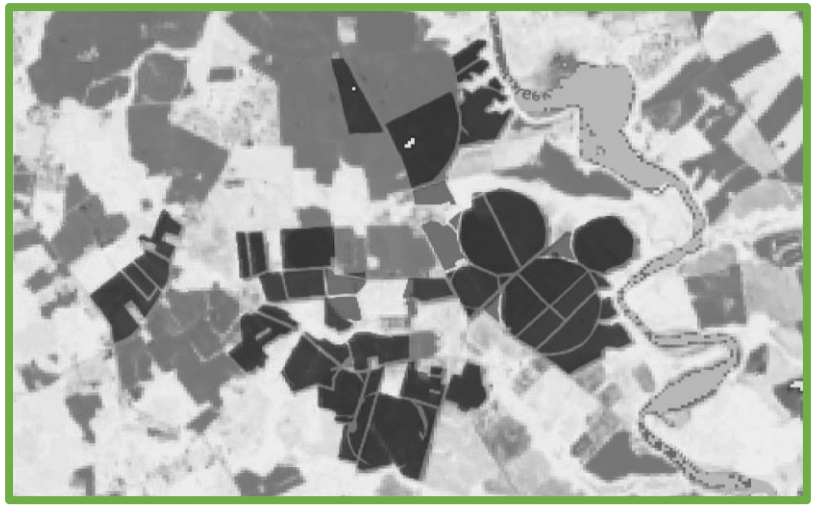
Landsat 8
Operational Land
Imager
Resolution: 30m
Frequency: 16 days

Sentinel-2
MultiSpectral
Instrument
Resolution: 10m
Frequency: 5 days

Methodology



NASA and ESA Satellite Imagery



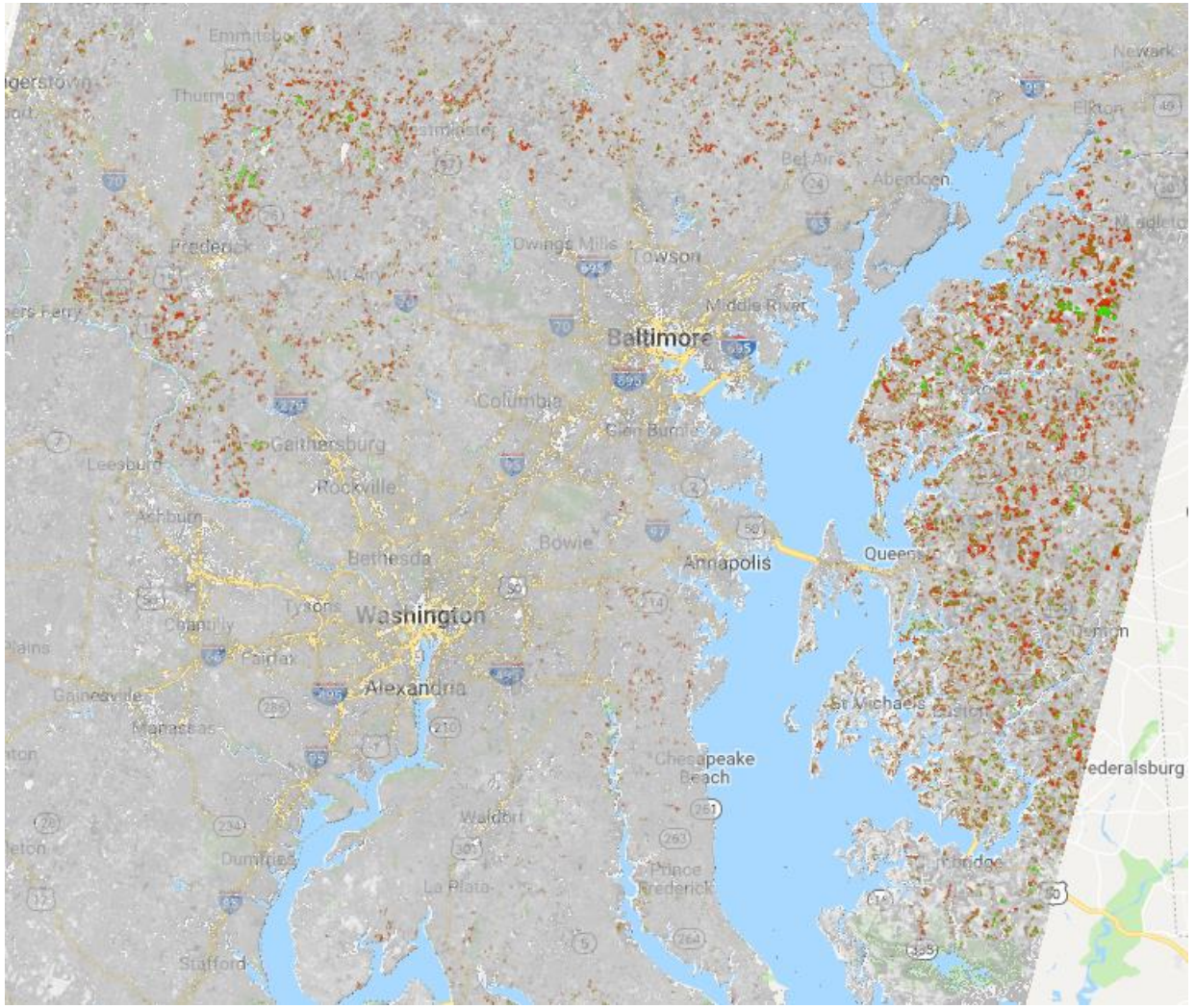
MDA Shapefiles and Agronomic Data for Fields Enrolled in Cover Crop Program

Satellite imagery used to compute winter/spring time series of NDVI for each field

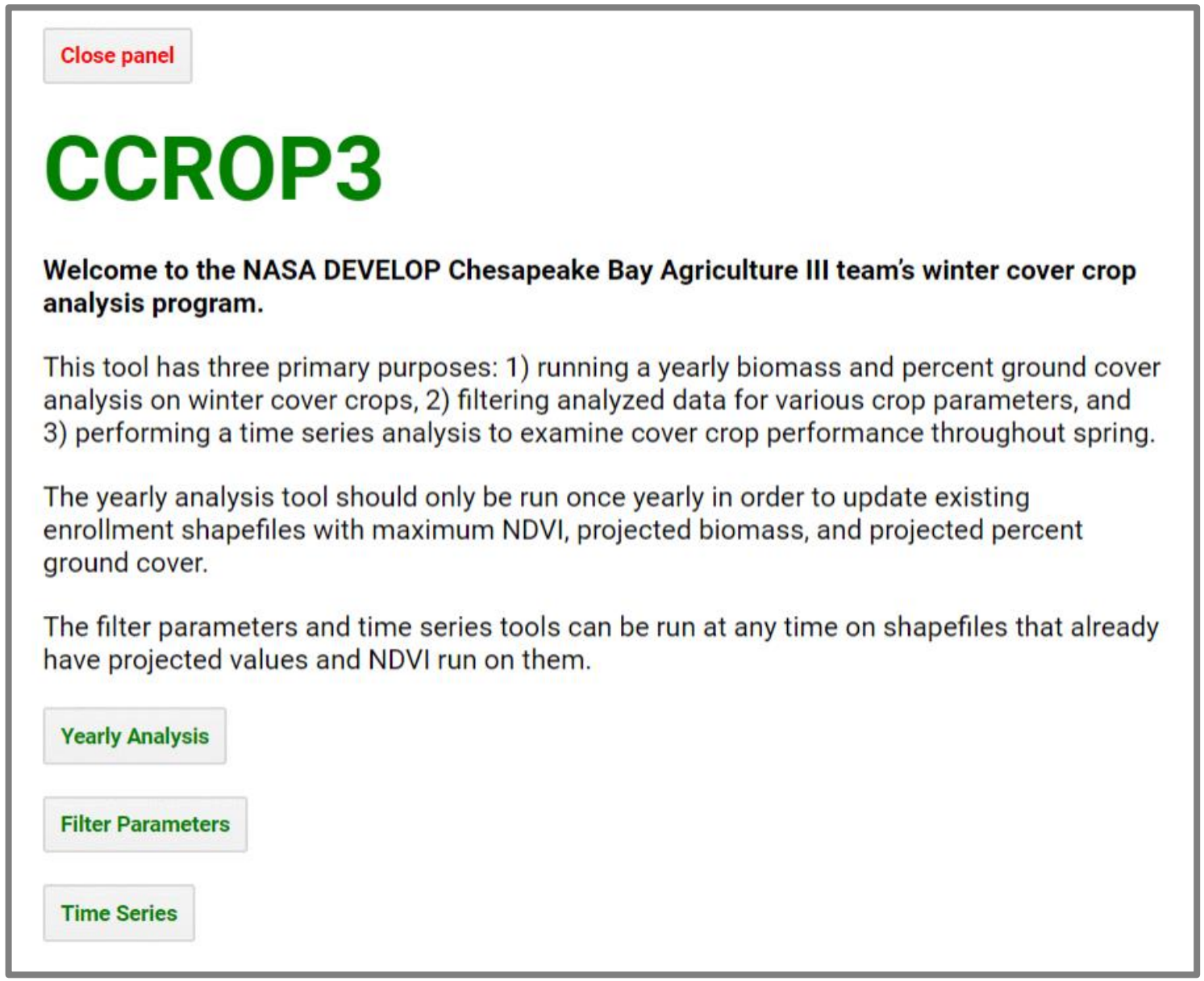
- NDVI converted to biomass and percent ground cover
- Filter data based on provided agronomic parameters
- Time series shows NDVI distribution for each overpass day

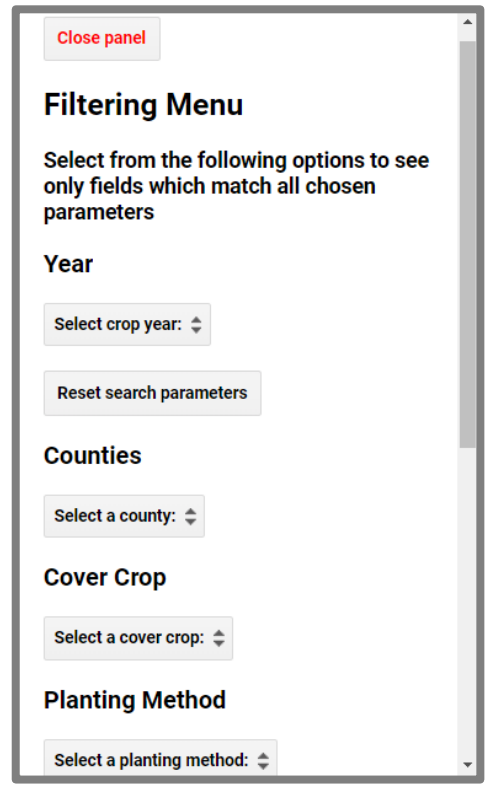
Image Credits: NASA DEVELOP

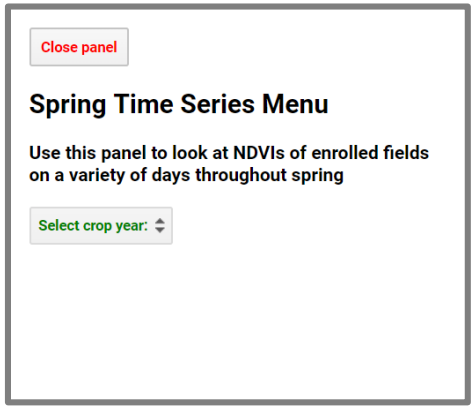
Sample NDVI Distribution



Graphical User Interface (GUI)





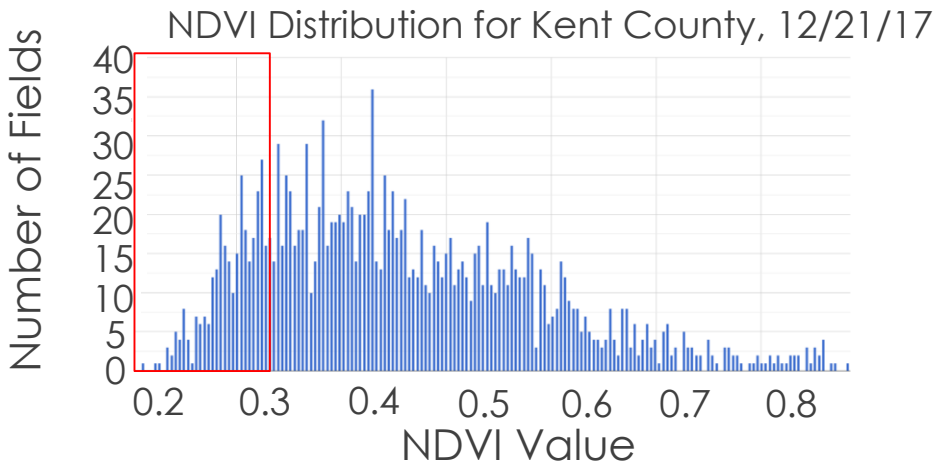


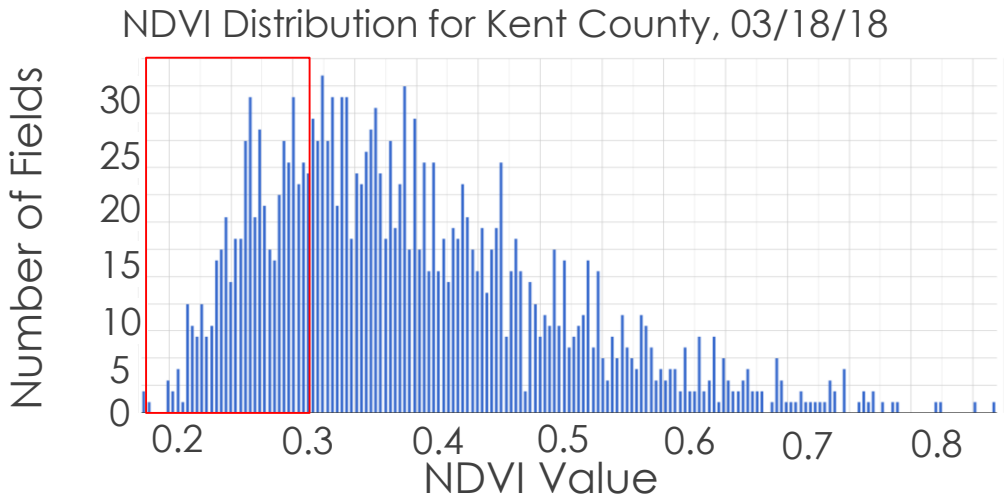
Results – Time Series Display

Subset of field NDVI Values, December 21, 2017

Subset of field NDVI Values, March 18, 2018

Results – Histogram Output





December 21: 8% low NDVI fields out of 1665 total observed fields

March 18th: 22% low NDVI fields out of 1665 total observed fields

Kent county performance winter 2017-18

Species	# Fields	NDVI	Biomass	Ground Cover
			kg/ha	%
Early Wheat (pre Oct 1)	413	0.47	550	32
Mid Wheat (Oct 1 - Oct 15)	314	0.46	506	31
Late Wheat (post Oct 15)	332	0.38	298	22
Total Wheat	1059	0.44	458	29
Early Rye (pre Oct 1)	75	0.52	791	38
Mid Rye (Oct 1 - Oct 15)	19	0.52	656	38
Late Rye (post Oct 15)	61	0.4	380	25
Total Rye	155	0.47	613	33
Early Barley (pre Oct 1)	179	0.52	784	39
Mid Barley (Oct 1 - Oct 15)	109	0.54	867	41
Late Barley (post Oct 15)	0	0	0	0
Total Barley	288	0.53	816	40
Early Triticale (pre Oct 1)	12	0.81	3048	73
Mid Triticale (Oct 1 - Oct 15)	8	0.78	2802	69
Late Triticale (post Oct 15)	9	0.52	698	39
Total Triticale	29	0.71	2251	61

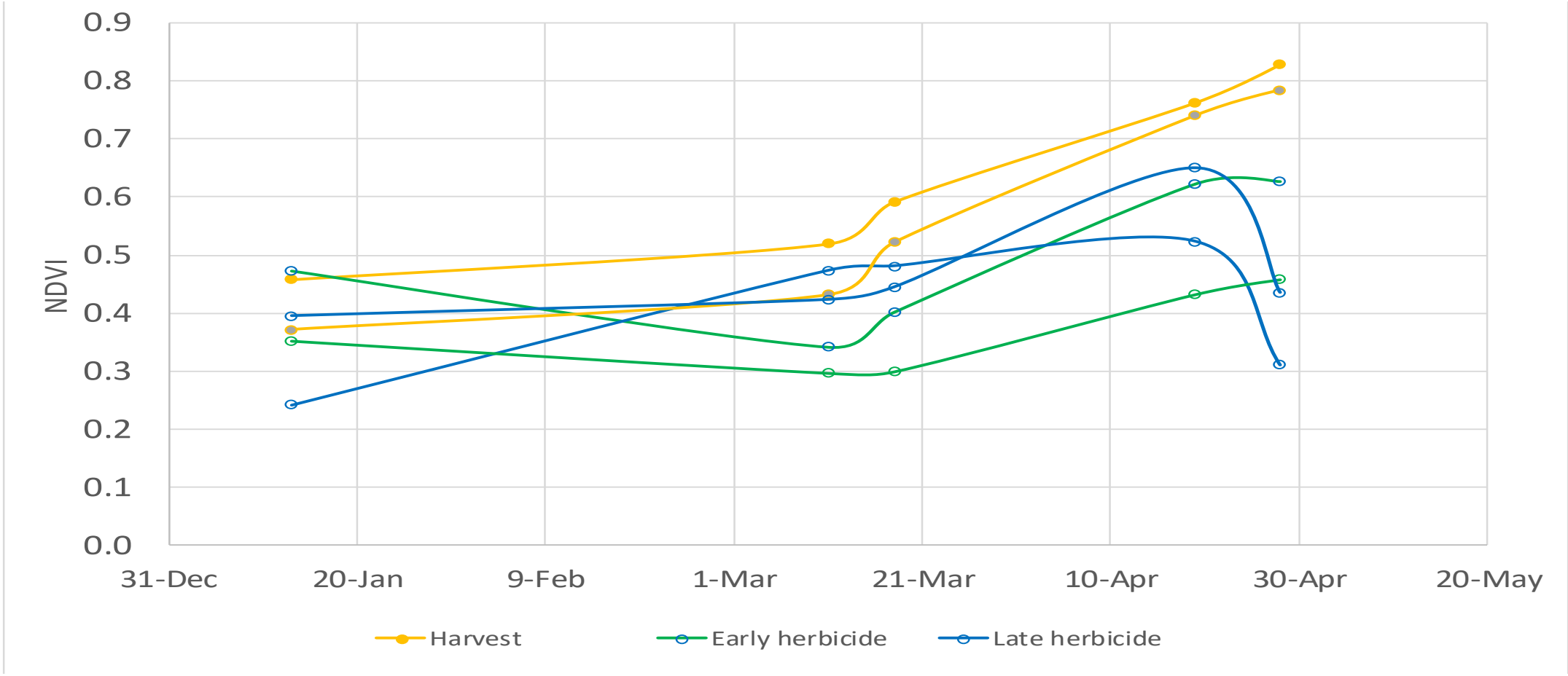
Kent county performance winter 2017-18

Previous Crop	# Fields	NDVI	Biomass	Ground Cover
			kg/ha	%
Corn	831	0.47	634	33
Soybeans	793	0.45	512	31
Vegetables	12	0.61	1332	49
Double-crop Soybeans	26	0.35	261	19
Sorghum	8	0.58	830	45
All Fields	1670	0.46	576	32

Spring time series

NDVI value for each field with every satellite overpass

- Allows determination of spring kill date
- Allows identification of fields taken to harvest



Conclusions

- CCROP can be used to visually represent cover crop enrollment and winter/spring vegetation spatially and temporally
- Tabular data produced by GUI can be used to support agronomic analysis
- Spring termination dates can be verified
- Underperforming fields can be targeted for more detailed review

Uncertainties/Limitations

- Sentinel-2 surface reflectance is not yet implemented into GEE
- Spatial/temporal satellite limitations
- Differentiating between cover crops and harvest crops/weeds
- Accuracy of biomass/percent ground cover conversions
- Update and maintain GUI

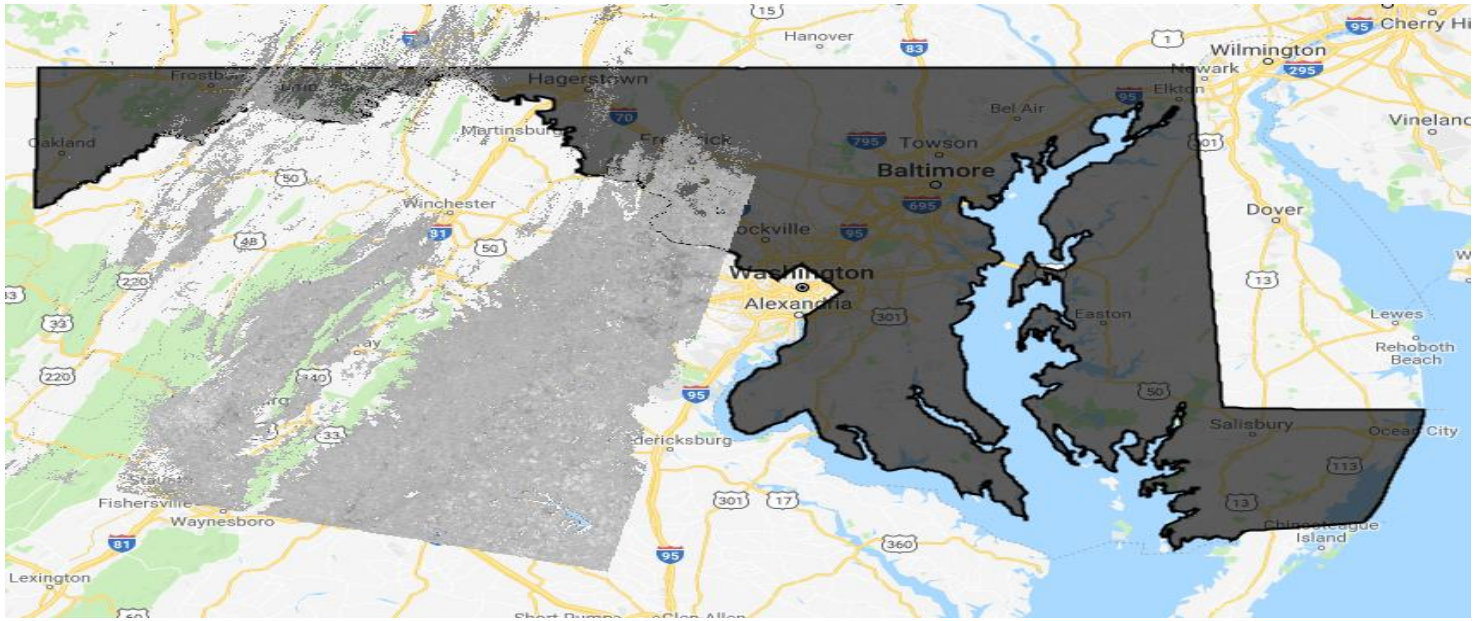
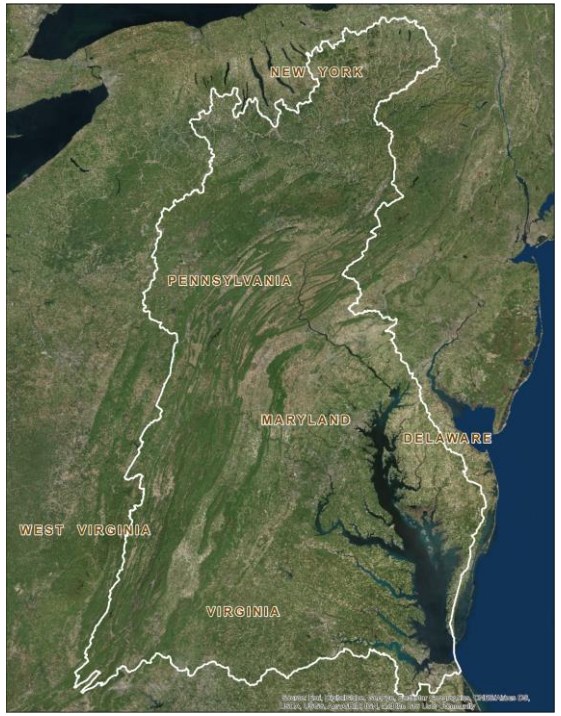


Image Credit: NASA DEVELOP

Future Possibilities

- Sentinel/Landsat integration for continuous time series
- Expand to other Chesapeake watershed states
- Alternative analysis variables (EVI, red edge, nitrogen)



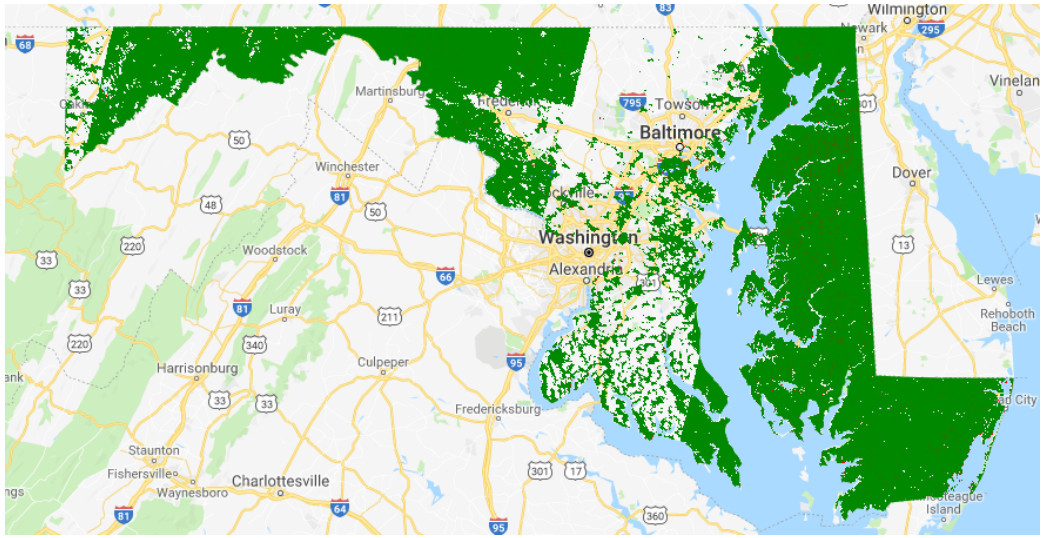


Image Credits: NASA DEVELOP

ACKNOWLEDGEMENTS

DEVELOP

Contributors

Dr. Sunita Yadav

Alison Thieme

Perry Oddo

John Fitz

Sean McCartney

Logan Kline

Diane Portillo

Bryan Eder

Callum Wayman

Benjamin Whong

End-User

Jason Keppler

Maryland Department of Agriculture

Center Lead

Victor Lenske

Advisors

Dr. W. Dean Hively

USGS Lower Mississippi Gulf Water Science Center

Dr. Greg McCarty

USDA Agricultural Research Service

Rich Batiuk

EPA Chesapeake Bay Program

Dr. John Bolten

NASA Goddard

Involvement of USGS, USDA, and MDA was supported by the National Fish and Wildlife Foundation, the USDA Conservation Effects Assessment Project, and the USGS Land Resources Mission Area

This material contains modified Copernicus Sentinel data (2017—2019), processed by ESA.

This material is based upon work supported by NASA through contract NNL16AA05C. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.