National Aeronautics and Space Administration

Chesapeake Bay
Agriculture

Applying NASA Earth Observations to Monitor Marsh Migration in Maryland's Coastal Croplands

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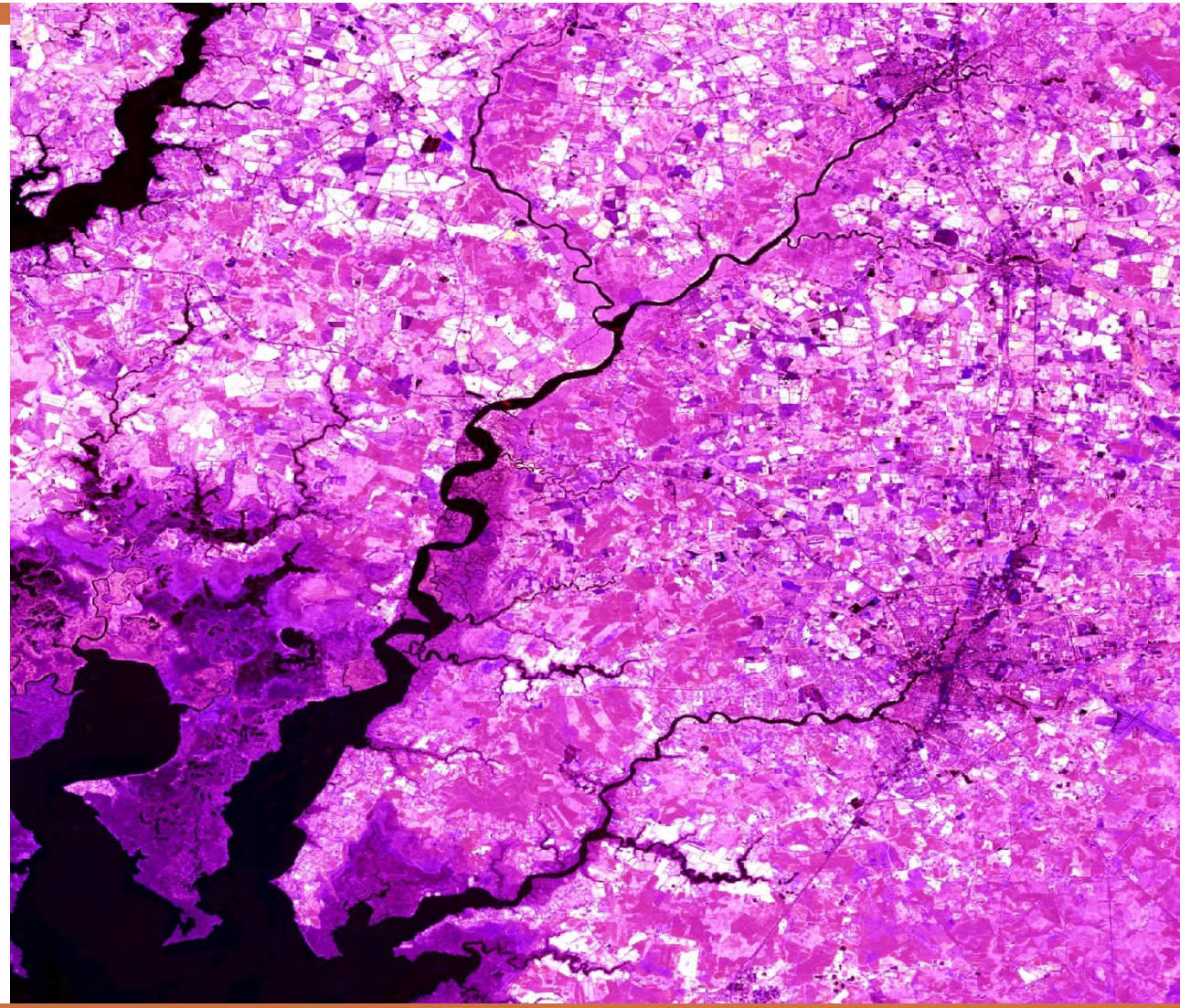


The Chesapeake Bay

Video Credit: Google Earth Studio, ESLC

Project Partners

Image Credit: DEVELOP Team

Community Concerns

Rising Sea Levels Induce Saltwater Intrusion

Seawater enters the soil, increasing the salinity content of the land used for farming

Increased Salinization Leads to Inhospitable Farming

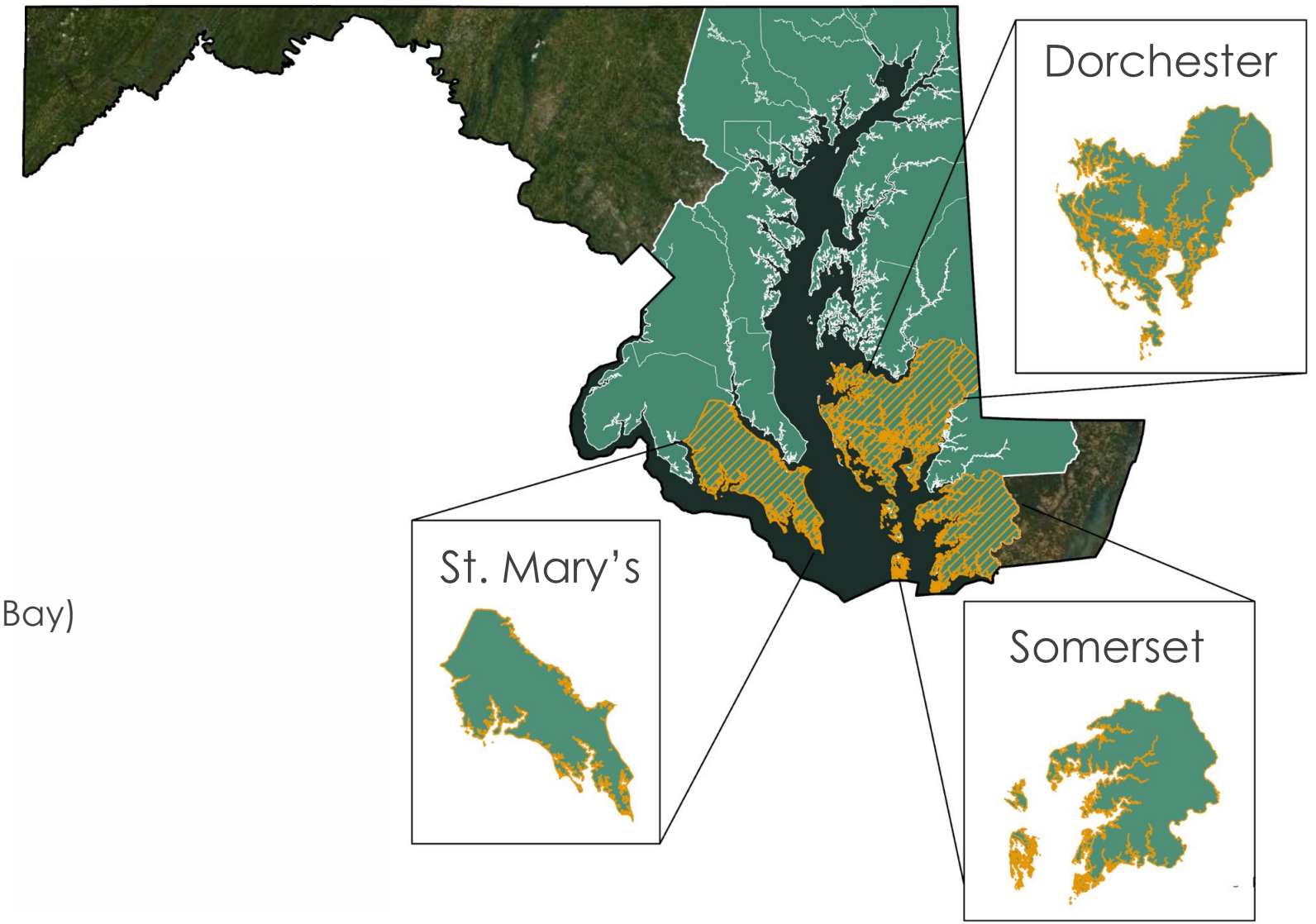
Changes in soil geochemistry damages crops and creates patches of unusable soil

Cropland Loss Diminishes Agricultural Productivity

Disrupts the livelihoods of farmers who rely on the land for their income and personal wellbeing

Image Credit: DEVELOP Team, ESLC

Study Area and Study Period



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Study Period: 2001–2021
Forecasting to 2040

Study Area (Chesapeake Bay)

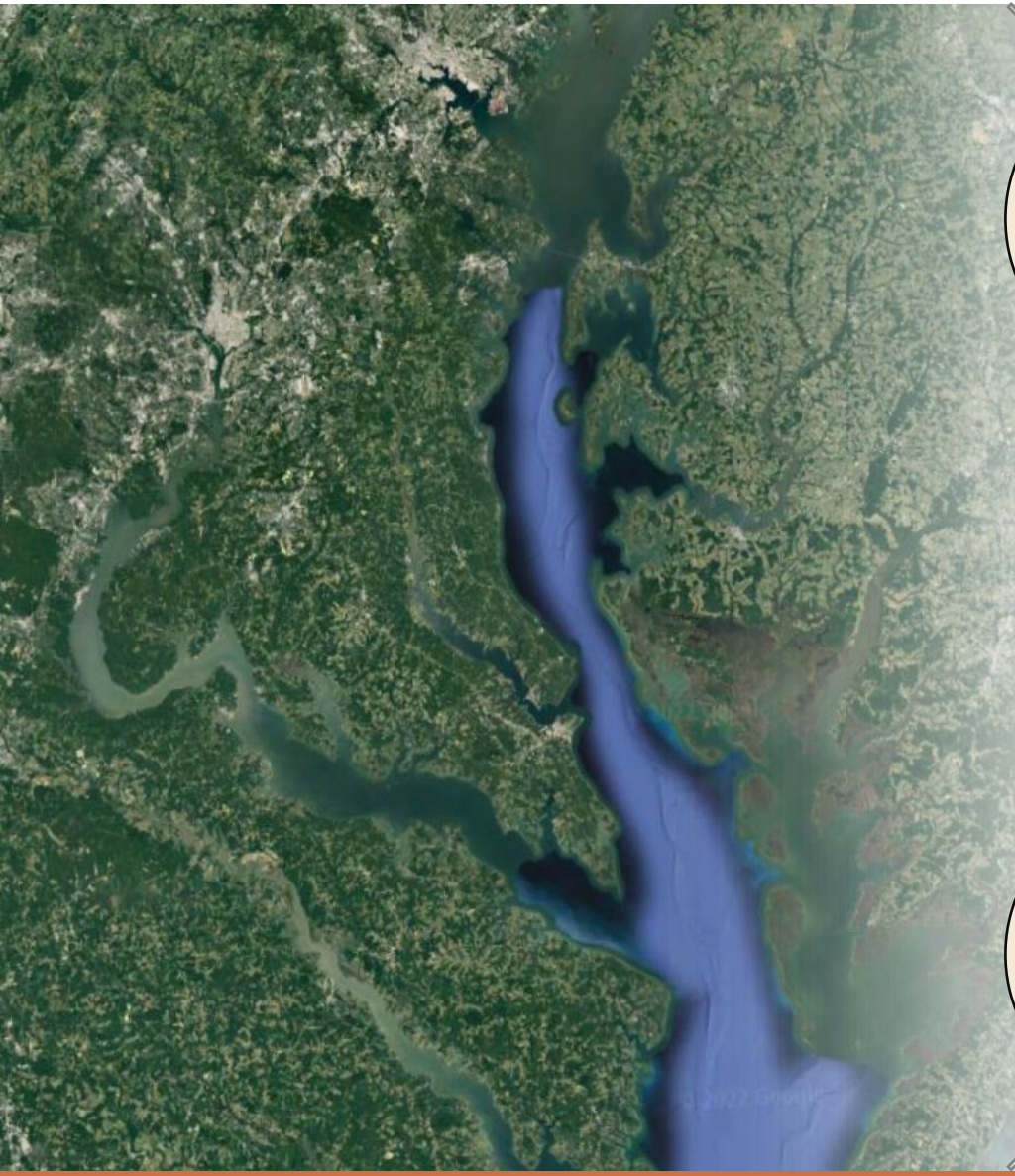
Counties of Interest

0 25 50 100 Miles

0 25 50 100 Kilometers

Image Credit: World Imagery Basemap

Project Objectives



Create

- Create Land Use Land Cover (LULC) Maps from 2001–2021

Demonstrate

- Demonstrate the Inland Extent of Marsh Migration

Forecast

- Forecast LULC Maps to 2040

Image Credit: Google Earth

Earth Observations

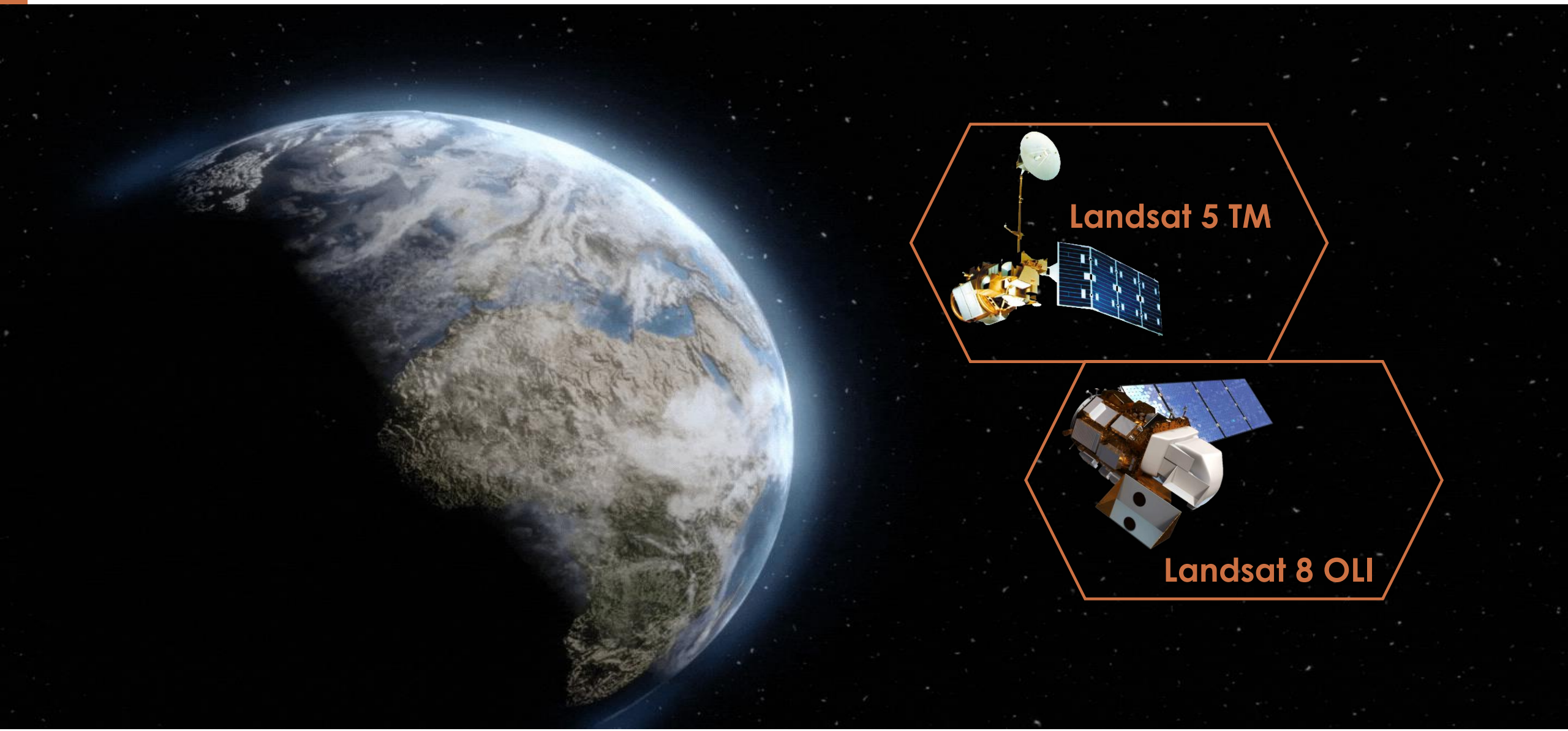


Image Credit: NASA, Pexels

Google Earth Engine LULC Methodology

Image preprocessing

Landsat 5 TM and 8 OLI Collections

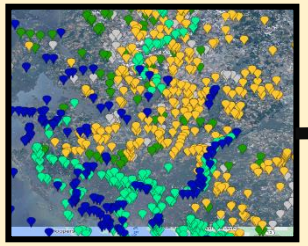
Filter for year, season and area

Add vegetation indices

Mask out cloudy pixels

Create training data

Training Points

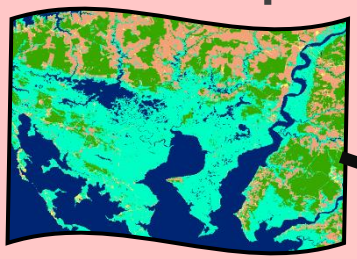


Denotes GEE Script

Run the classifier

Random forest classifier

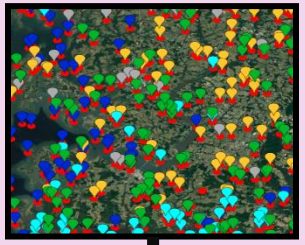
LULC Maps



Validate results

NAIP Imagery

Random Test Points



Accuracy Statistics

Image Credit: Landsat Basemaps

Forecasted LULC Methodology

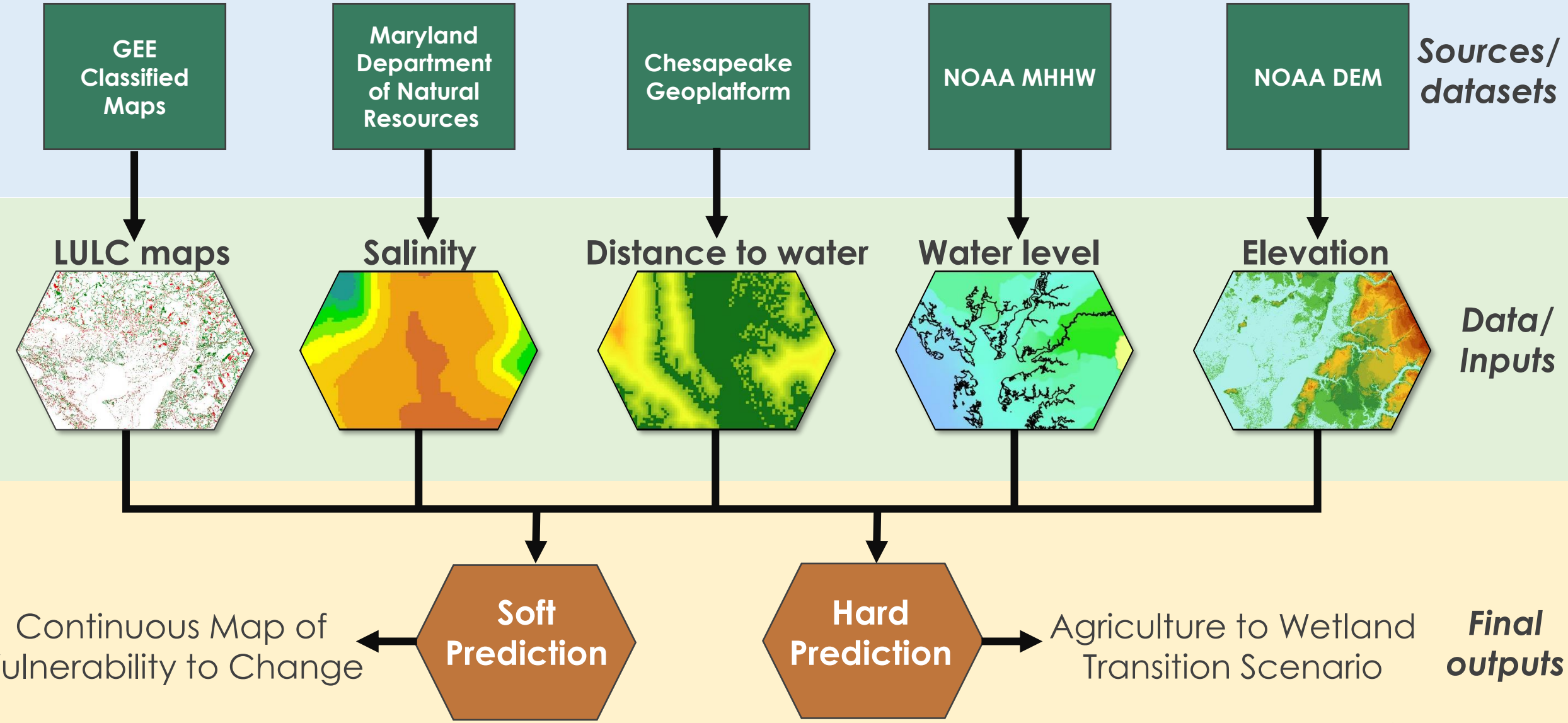
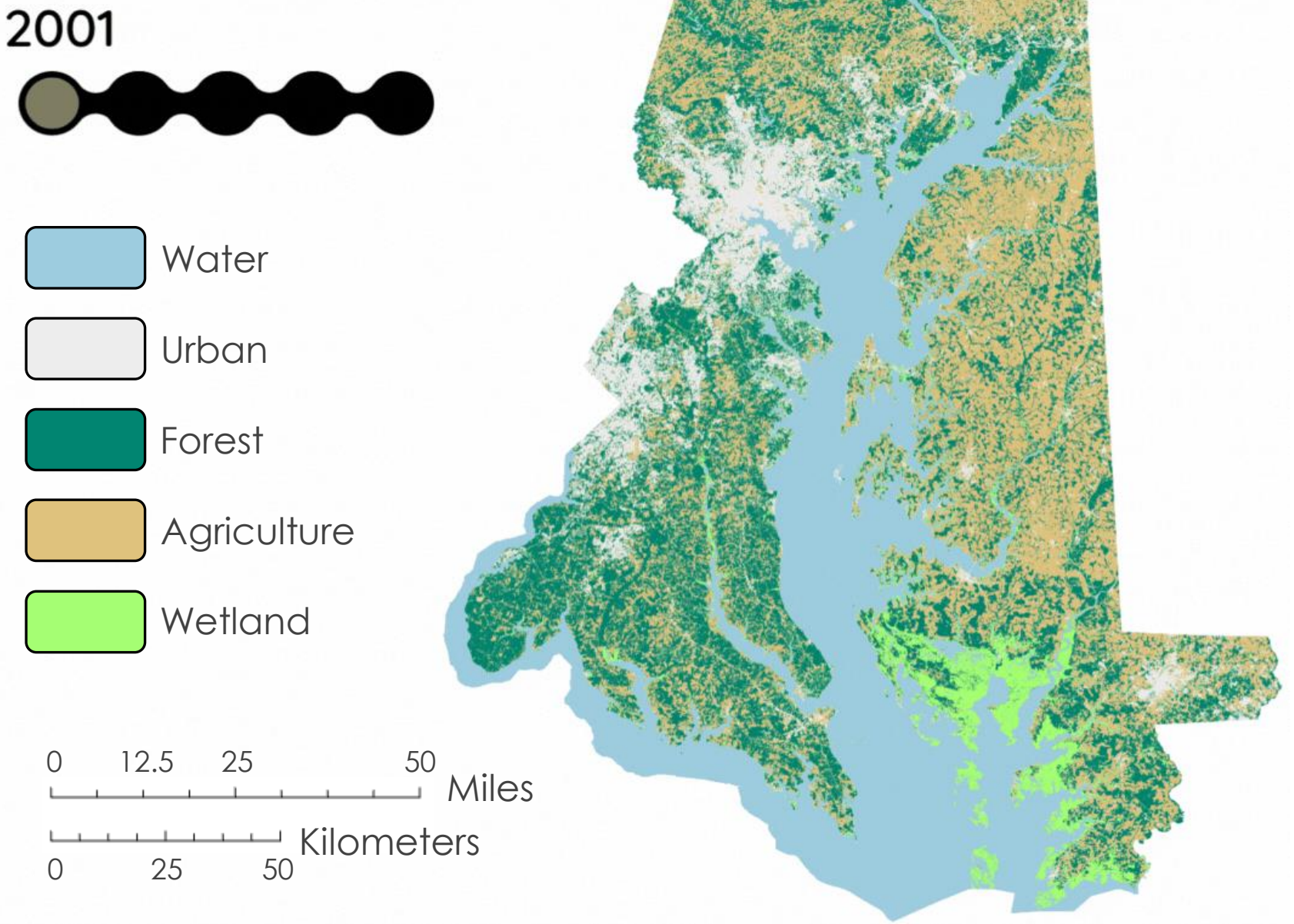


Image Credit: NAIP Basemap

LULC Maps 2001 – 2021

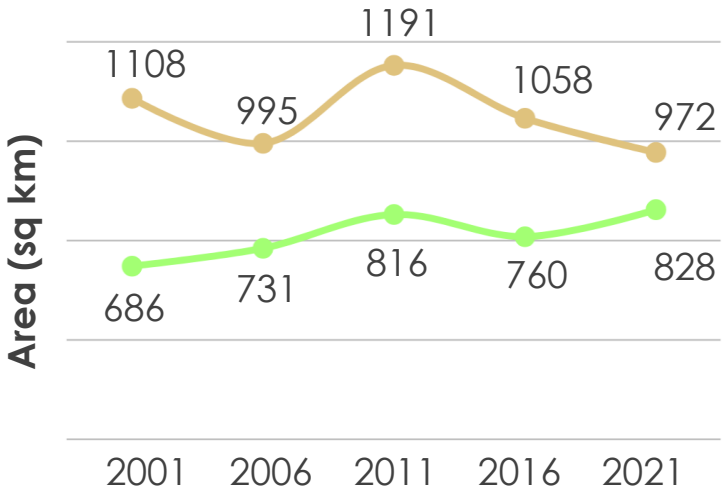
The highest overall accuracy was 87% in 2021

The lowest overall accuracy was 81% in 2007

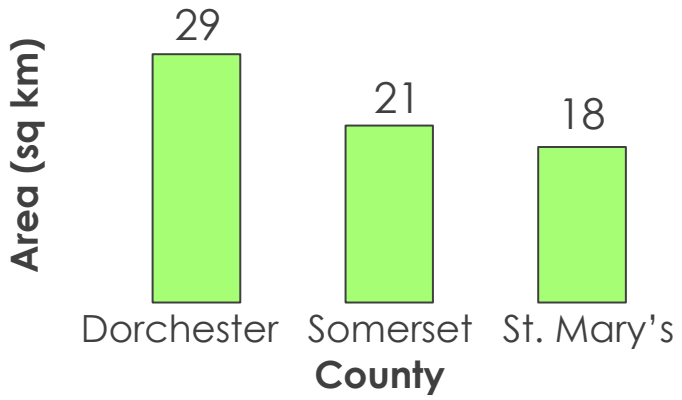


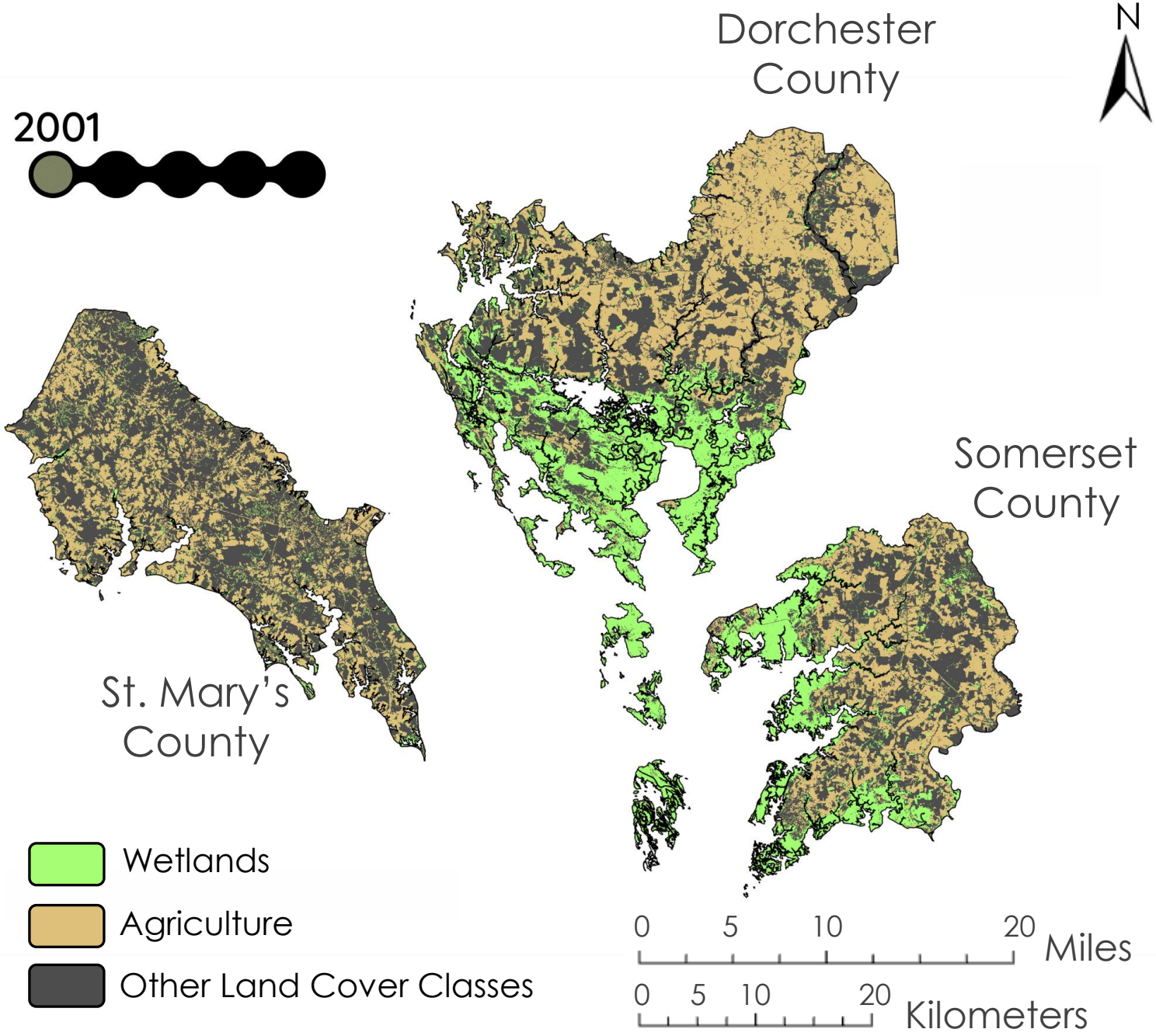
Marsh Migration

Changes in Wetlands & Agriculture (3 Counties)

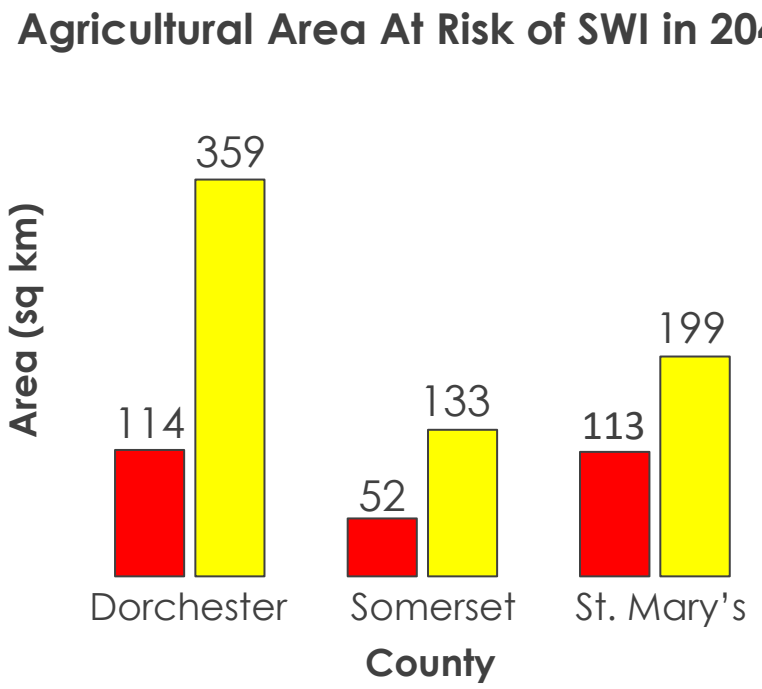


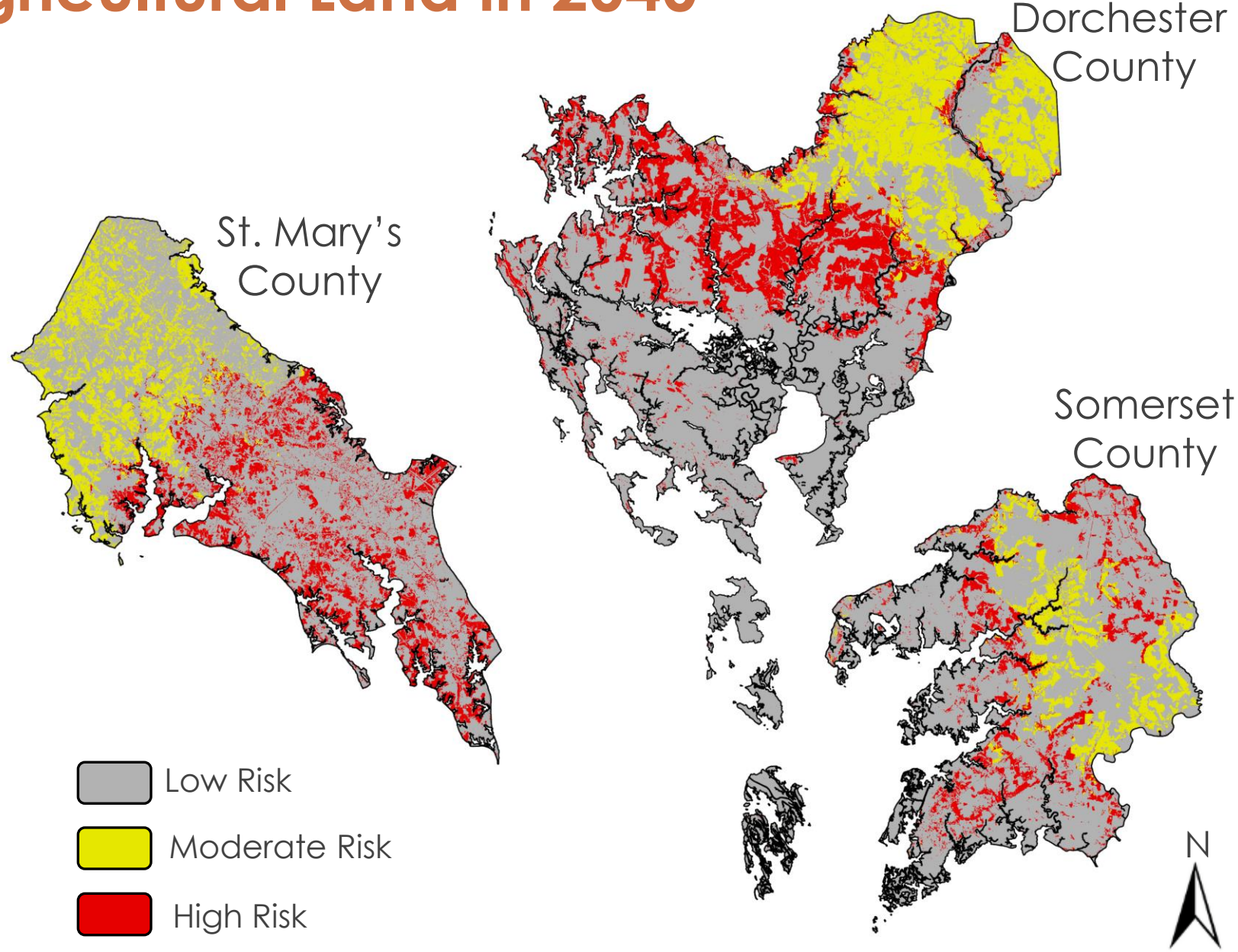
Transition Croplands → Wetlands (2001 – 2021)

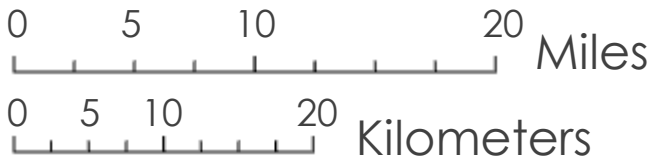




Soft Prediction for Agricultural Land in 2040

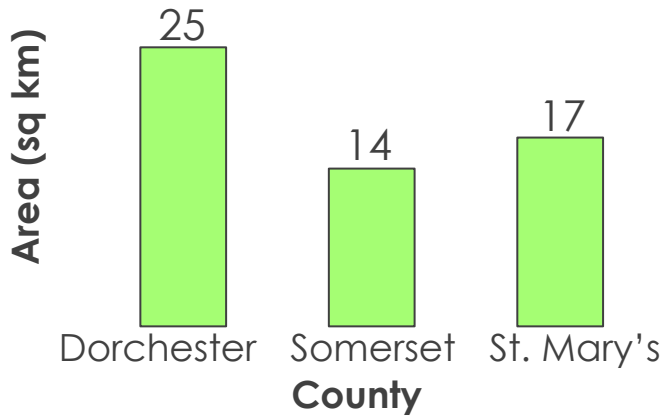


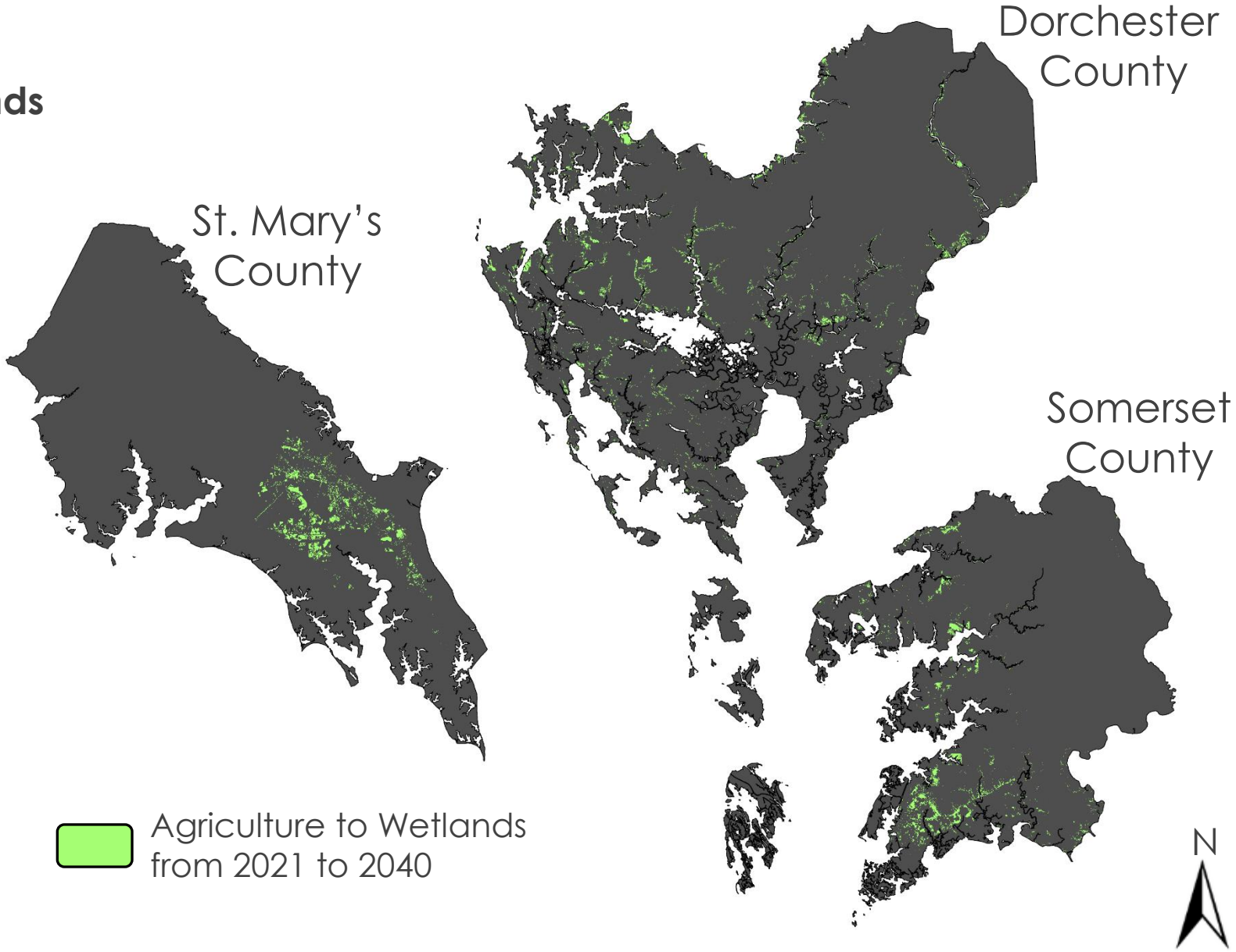




Hard Prediction for Agriculture → Wetlands transition

Potential Transition Croplands → Wetlands (2021 – 2040)





0 5 10 20 Miles

0 5 10 20 Kilometers

Conclusion: Main Takeaways

Wetlands have **replaced 60,000 acres** of cropland since 2001 in the study area

The area of marshland in the study area **increase by 150,000 acres** over the past 20 years

Forecasting models suggest similar trends to the present, with a **potential loss of 58,000 acres** of agricultural land through 2040

Image Credit: DEVELOP Team

Limitations and Future Work

GEE Classifications

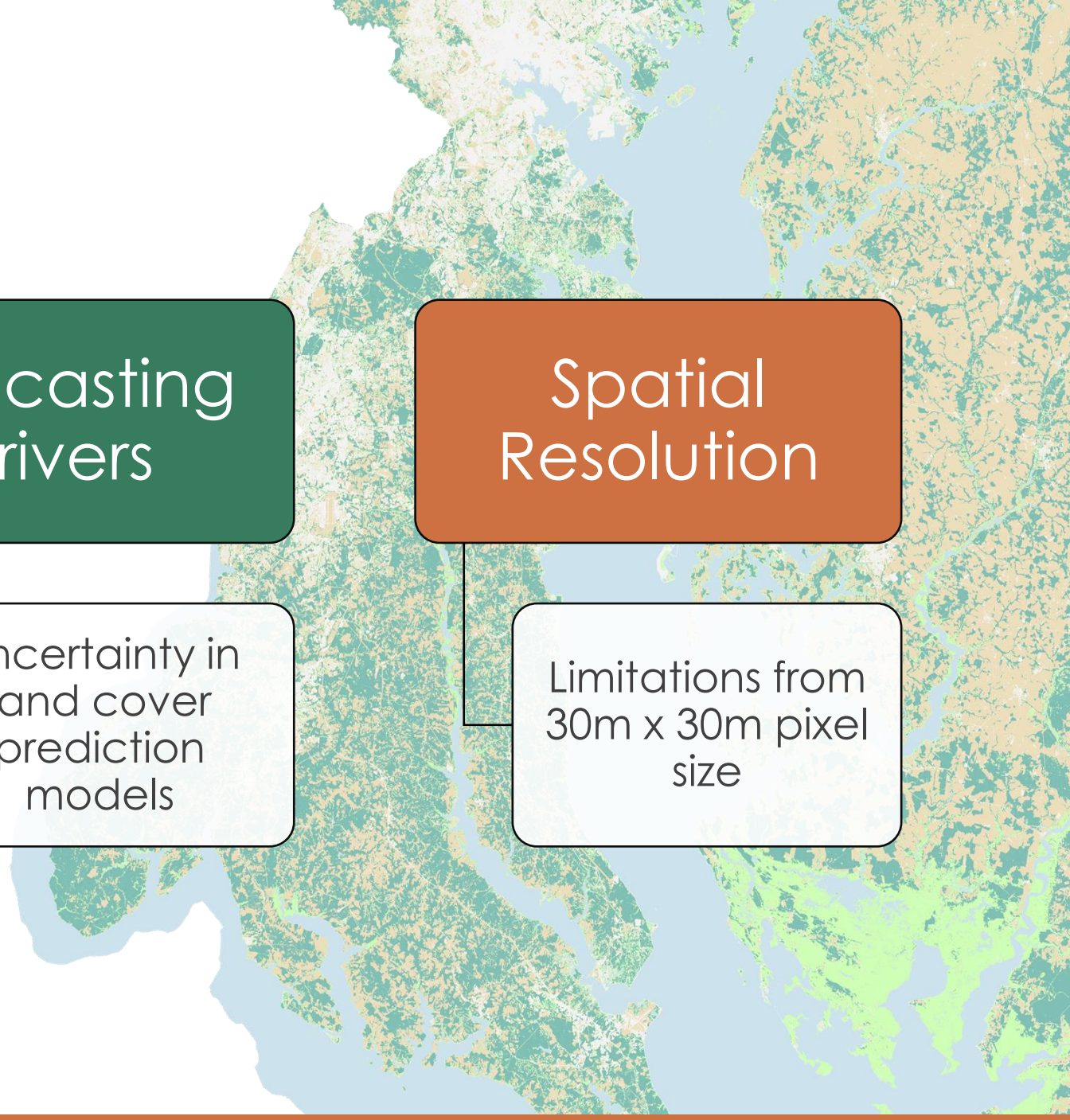
Errors in land cover classification and data acquisition

Forecasting Drivers

Uncertainty in land cover prediction models

Spatial Resolution

Limitations from 30m x 30m pixel size



ACKNOWLEDGEMENTS

- **Partners:**
  - Larisa Prezioso (ESLC)
  - Jason Dubow (Maryland Department of Planning)
  - Deborah Herr Cornwell (Maryland Department of Planning)
- **Advisors:**
  - Sean McCartney (NASA GSFC, SSAI)
  - Dr. Anthony Campbell (University of Maryland, Baltimore County, NASA GSFC)
  - Dr. Temilola Fatoyinbo (NASA GSFC)
  - Dr. Pinki Mondal (University of Delaware)
  - Dr. Kate Tully (University of Maryland)
- **Additional Support:**
  - Dr. Cheryl Doughty (NPP Post Doc, NASA GSFC)
  - Dr. John Bolten (NASA GSFC)
- **Project Fellow:** Dr. Nicole Ramberg-Pihl (NASA GSFC, SSAI)

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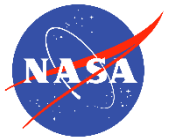

Extra Slides for Partners

Accuracy Data for LULC Maps

0.832540429	Avg Wetland Accuracy
0.896426522	Avg Agriculture Accuracy

Year	OA	kappa	Class	User's Accuracy	Producer's Accuracy
2021	0.869772366	0.835824555	1 - Water	0.982543641	0.968058968
			2 - Developed	0.893129771	0.839712919
			3 - (4)Forest	0.971153846	0.768060837
			4 - (6) Agriculture	0.77970297	0.931952663
			5 - (7) Wetlands	0.650909091	0.895

Year	OA	kappa	Class	User's Accuracy	Producer's Accuracy
2007	0.814851485	0.765909729	1 - Water	0.980246914	0.945238095
			2 - Developed	0.889908257	0.642384106
			3 - (4)Forest	0.895196507	0.779467681
			4 - (6) Agriculture	0.678756477	0.933491686
			5 - (7) Wetlands	0.61752988	0.775

Confusion Matrices for LULC Maps

2021	Water	Developed	Forest	Agriculture	Wetlands
Water	394	3	1	0	9
Developed	1	351	3	45	18
Forest	0	20	404	40	62
Agriculture	0	14	2	315	7
Wetlands	6	5	6	4	179

2007	Water	Developed	Forest	Agriculture	Wetlands
Water	397	16	0	0	7
Developed	2	291	23	113	24
Forest	0	4	410	53	59
Agriculture	0	12	10	393	6
Wetlands	6	4	15	20	155

Forecasting Accuracy

	Chesapeake Bay		Dorchester		Somerset		St. Mary's	
Variables in model	Order of Influence	accuracy %	Order of Influence	accuracy %	Order of Influence	accuracy %	Order of Influence	accuracy %
With all variables		60.5		69.8		63.3		63.8
Excluding DEM	1	50.3	1	50.1	1	50	3	63.6
Excluding Distance to Water	3	60.7	2	68.8	3	62	2	63.6
Excluding but MHHL	2	60.4	3	69.7	2	61.2	1	57.4
Excluding Salinity	4	61.2	4	70.1	4	64.4	4	63.8