CAST Land Use Change: 2013-2017

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Land Use Workgroup Meeting
August 4, 2021

U.S. Department of the Interior
U.S. Geological Survey

2013 - 2017 Land Use Change Review for CAST-21

August – September 2021

August 4th: FWG briefed on the implications of the high-res land use change data on our understanding of forest trends.

August 4th: LUWG endorses use of the high-res land use change data as the "best available data" to inform CAST-21.

August 23rd: WQGIT decides to approve use of the high-res land use change data in CAST-21.
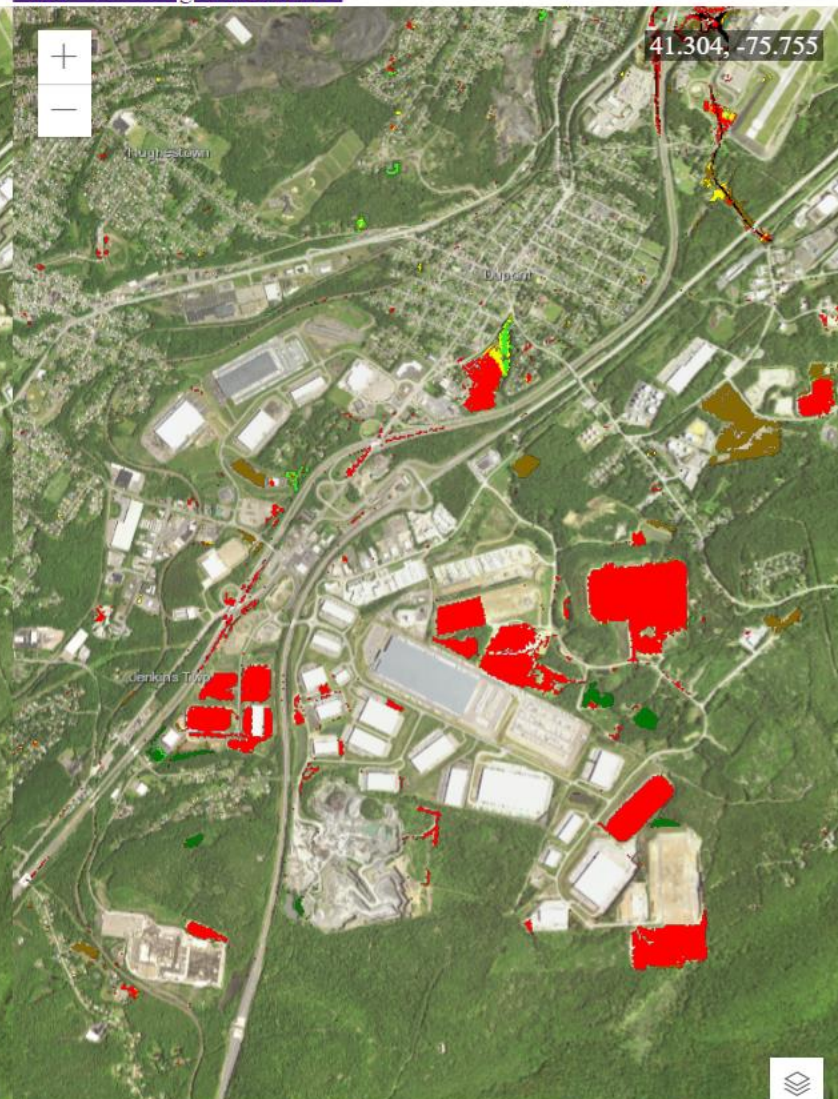
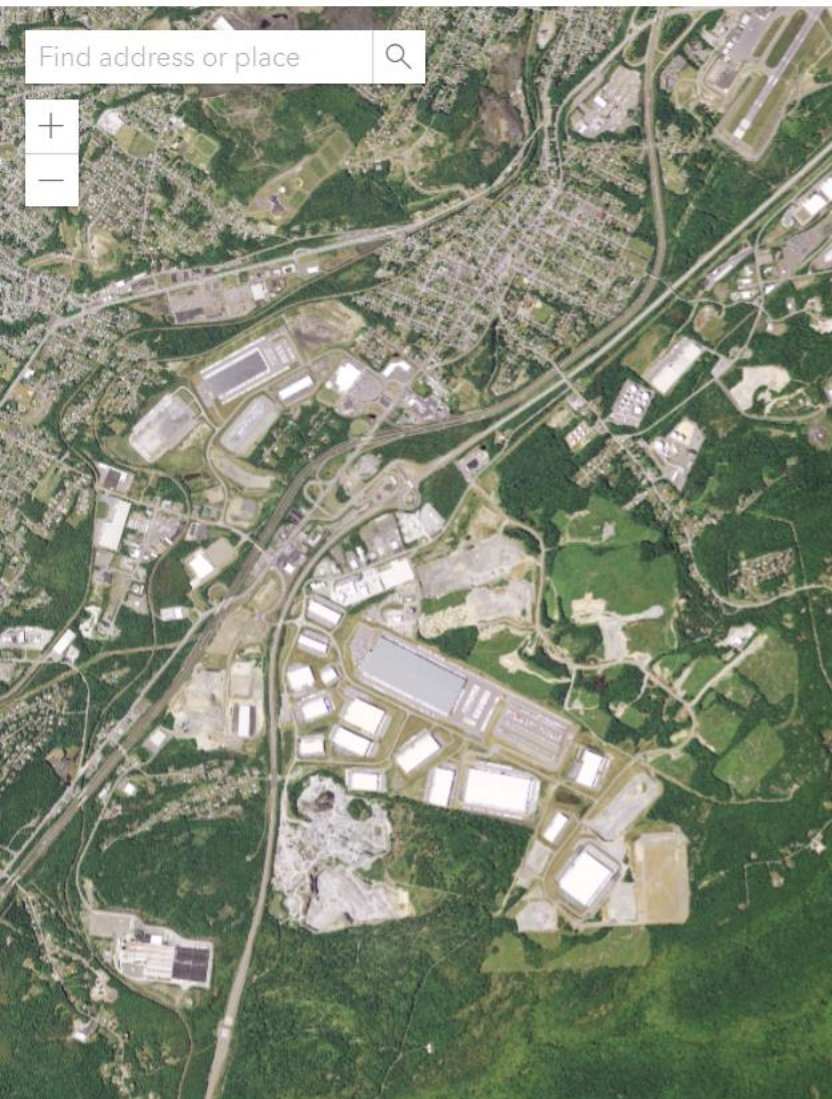September 1st: USGS delivers land use data to CAST team.

Generalized Phase 6 Land Use/Cover Classes

DEVELOPED (DEV)

1. **Impervious Roads**
   - 2.1 Impervious
     - 2.1.1 Roads

2. **Impervious Non-Roads**
   - 2.1 Impervious
     - 2.1.2 Structures
     - 2.1.3 Other Impervious
   - 4.2 Solar fields
     - 4.2.1 Impervious

3. **Tree Canopy Over Impervious**
   - 2.1 Impervious
     - 2.1.4 Tree Canopy over Impervious

4. **Turf Grass**
   - 2.2 Pervious, Developed
     - 2.2.1 Turf Grass

5. **Tree Canopy over Turf Grass**
   - 2.2 Pervious. Developed
     - 2.2.4 Tree Canopy over Turf Grass

NATURAL (NAT)

6. **Forest**
   - 3.1 Forest (>= 1 acre, 240-ft width)
   - 3.2 Tree Canopy in Agriculture

7. **Wetlands, Floodplain**
   - 5.2 Riverine, Wetlands

8. **Wetlands, Other**
   - 5.3 Terrene/Isolated, Wetlands

9. **Water**
   - 1.1 Lentic
     - 1.1.1 Estuary (tidal)
     - 1.1.2 Lakes & Ponds
   - 1.2 Lotic
     - 1.2.1 Streams
     - 1.2.2 Ditches

AGRICULTURE (AG)

10. **Cropland**
    - 4.1 Agriculture
      - 4.1.1 Cropland
      - 4.1.3 Orchard/vineyard

11. **Pasture**
    - 4.1 Agriculture
      - 4.1.2 Pasture

MIXED OPEN (MO)

12. **Mixed Open**
    - 2.2 Pervious, Developed
      - 2.2.2 Bare Developed
      - 2.2.3 Suspended Succession
    - 3.3 Harvested Forest (<= 3 years)
    - 3.4 Natural Succession (> 3 years)
    - 4.2 Solar fields
      - 4.2.2 Pervious
    - 4.3 Extractive (active mines)
    - 5.4 Bare shore, Water Margins

Generalized Land Use Changes: 2013 – 2017
CAST-21 (pre-BMP) vs CAST-19 (pre-BMP) vs CBLCM (urban growth)

Change: 2013 - 2017	CAST-21				CAST-19				CBLCM			
Land Use	DEV	NAT	AG	MO	DEV	NAT	AG	MO	DEV	NAT	AG	MO
Gains	121,510	4,772	3,960	279,934	116,785	237,171	172,142	25,095	86,947	-	-	2,952
Losses	-	(359,949)	(26,491)	(23,736)	(0)	(147,455)	(345,875)	(57,864)	-	(42,512)	(47,387)	-
Net Change	**121,510**	**(355,177)**	**(22,531)**	**256,198**	**116,785**	**89,716**	**(173,733)**	**(32,769)**	**86,947**	**(42,512)**	**(47,387)**	**2,952**

Why the differences:

CAST-21 relies on direct measures of land cover change from aerial imagery interpreted as changes in land use based on rules and ancillary data.

CAST-19 reconciles modeled urban development (from the CBLCM) with surveyed changes in cropland and pasture acres (from the Census of Agriculture. The reconciliation process, aka "true up", results in non-transparent and unverifiable changes in all land uses, some of which are illogical.

CBLCM simulates future changes in impervious surfaces and turf grass associated with residential and commercial development driven by state-produced, county-level projections of population and employment.

DEV = Developed (impervious surfaces and turf grass); NAT = Natural (forest, wetlands, and water), AG = Agriculture (cropland and pasture), MO = Mixed Open (natural and suspended succession, bare developed)

Generalized Land Use Changes: 2013 – 2017
CAST-21 (pre-BMP) vs CAST-19 (pre-BMP) vs CBLCM (urban growth)

Net Change: 2013-2017	CAST-21				CAST-19				CBLCM			
	DEV	NAT	AG	MO	DEV	NAT	AG	MO	DEV	NAT	AG	MO
Delaware	11,130	(4,454)	(2,560)	(4,116)	1,431	(7,534)	14,724	(8,621)	9,318	(1,976)	(7,634)	293
District of Columbia	86	(36)	-	(50)	64	(64)	-	(0)	64	(64)	-	-
Maryland	24,985	(11,316)	(8,128)	(5,540)	18,027	(2,077)	(9,693)	(6,257)	9,313	(5,294)	(4,411)	393
New York	7,597	(6,179)	(3,117)	1,699	28,305	132,912	(163,996)	2,779	654	(247)	(426)	20
Pennsylvania	34,672	(79,124)	(6,266)	50,718	36,453	49,781	(81,583)	(4,650)	19,101	(6,965)	(12,900)	764
Virginia	38,941	(242,427)	(2,033)	205,519	31,407	(65,551)	46,699	(12,555)	46,152	(27,309)	(20,256)	1,412
West Virginia	4,101	(11,641)	(428)	7,968	1,099	(17,751)	20,116	(3,464)	2,345	(656)	(1,760)	70

DEV = Developed (impervious surfaces and turf grass); NAT = Natural (forest, wetlands, and water), AG = Agriculture (cropland and pasture), MO = Mixed Open (natural and suspended succession, bare developed)

Generalized Land Use Changes: 2013 – 2017

CAST-21 (pre-BMP)

FIPS	ST	CountyName	IMP	PERV	CRP	PAS	NAT*	MO*	HAR
10001	de	Kent	1,858	942	(400)	(97)	(503)	(1,790)	(8)
42033	pa	Clearfield	417	132	15	59	(3,823)	3,257	(58)
51101	va	King William	20	195	16	65	(1,792)	3,983	(2,457)

CAST-19 (pre-BMP)

FIPS	ST	CountyName	IMP	PERV	CRP	PAS	NAT*	MO*	HAR
10001	de	Kent	630	(630)	5,726	(1,401)	(1,636)	(2,684)	(4)
42033	pa	Clearfield	946	2,495	(6,067)	(12,945)	11,595	3,827	148
51101	va	King William	115	398	(1,025)	142	2,802	25	(2,457)

CAST-19 Issues:
- Kent: illogical loss of turf grass despite growing population and increase in impervious surfaces
- Clearfield: large decline in farmland and associated increase in natural lands despite mapped evidence to the contrary
- King William: no recognition of the dominant change in the county: timber harvest

Errors in the High-resolution Land Use Data for CAST

Localized errors in the high-resolution land use data are inevitable. Causes for errors vary and include:

- Differences in NAIP image quality (e.g., seasonality, sun angle, atmospheric haze) for 2013/14 vs 2017/18
- Issues with 2013/14 land cover data (e.g., Virginia)
- Poor quality or temporally-offset LiDAR imagery (e.g., 2012 LiDAR + 2018 NAIP)
- Poor quality ancillary data (e.g., local land use, parcels, Microsoft buildings)
- Lack of ancillary data (e.g., timber harvest, abandoned mines, landfills)
- Over-generalized land use decision rules

A preliminary accuracy assessment of the high-resolution data will be conducted in the fall/winter of 2021.

Two errors identified at the July 14th Land Use Workgroup ~~...~~ ed to be systematic:

1. Under-classification of timber harve~~...~~ ~~...~~nsition from forest to cropland or pasture.
2. Mis-interpretation of pre~~...~~ ~~...~~spended succession instead of cropland or pasture.

Both fixed for Version 1 Land Use Change data

Benefits of High-resolution Land Use Data for CAST

1. Transparent

2. Verifiable

3. Logical

http://cicapps.org/obj1lu/

T1-T2 LU	IR	INR	TCI	TG	TCT	FORE	WLF	WLO	WLT	MO	CRP	PAS	WAT	Loss
IR	-	-	12	-	0	0	-	-	-	-	-	-	-	12
INR	3	-	28	24	0	1	0	-	-	8	1	4	0	70
TCI	0	17	-	6	-	-	-	-	-	5	0	0	-	28
TG	10	42	-	-	86	2	-	-	-	54	-	0	-	194
TCT	0	57	-	40	-	1	-	-	-	64	1	1	-	164
FORE	24	160	1	625	310	-	-	-	-	10,985	16	78	1	12,202
WLF	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WLO	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WLT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MO	34	270	0	440	14	1,126	-	-	-	-	0	7	19	1,910
CRP	3	3	-	3	-	1	-	-	-	19	-	18	0	47
PAS	5	29	-	22	2	130	-	-	-	27	7	-	10	232
WAT	-	-	-	-	0	1	0	-	-	1	-	3	-	5
Gain	80	577	41	1,160	412	1,262	0	-	-	11,165	24	111	31	14,863
TotGain	80	577	41	1,160	412	1,262	0	-	-	11,165	24	111	31	
TotLoss	12	70	28	194	164	12,202	-	-	-	1,910	47	232	5	
Net	68	508	13	967	248	(10,940)	0	-	-	9,255	(23)	(121)	26	

Generalized Development Changes: 2013 – 2017
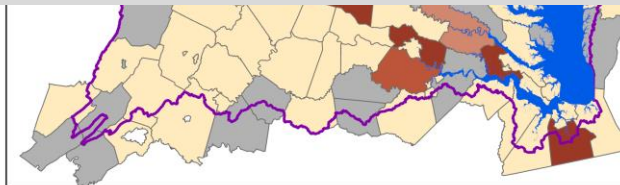## CAST-21 (pre-BMP) vs CAST-19 (pre-BMP) vs CBLCM (urban growth)

CBCLM over-estimated commercial densities or underestimated employment demand in Luzerne County
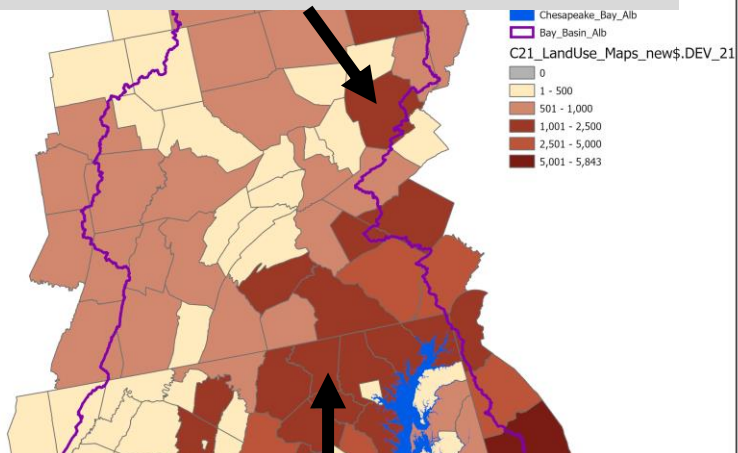
CBLCM over-estimated infill rates for Carroll County.
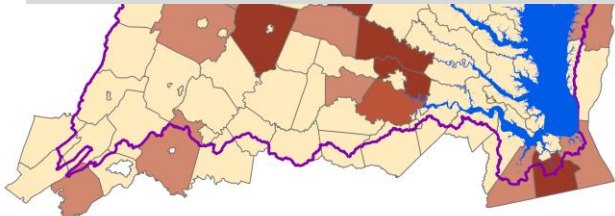
The CBLCM is designed to forecast future residential and commercial growth based on long-term historic trends. While interpolated future growth estimated by the CBLCM correlate with observed high-res development in CAST-21 (R2 = 0.71) from 2013-2017, the CBLCM under-estimated the amount of observed growth in DC and all states except Virginia, where growth was over-estimated. The reasons for these discrepancies vary and include differences in short-term change vs long-term trends, infill/redevelopment rates, vacancy rates, development densities and patterns, condition and age of residential and commercial buildings, components of population and employment change, and infrastructure investments.
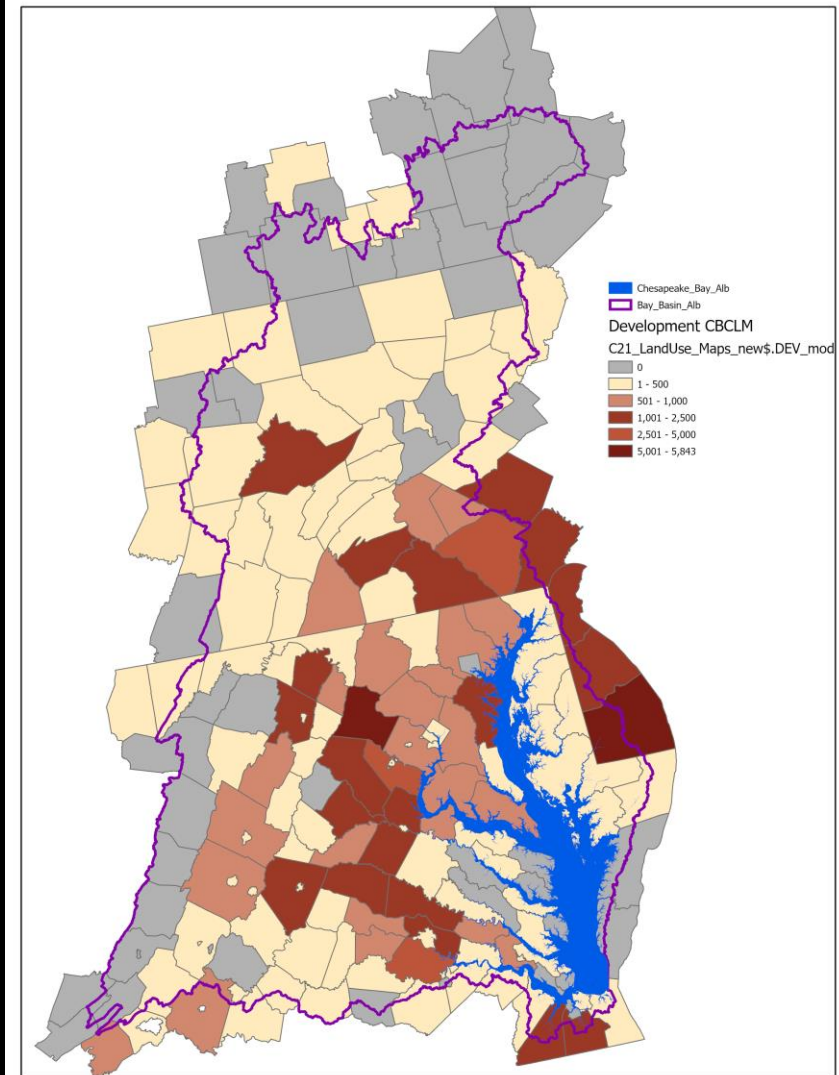
Generalized Agriculture Changes: 2013 – 2017
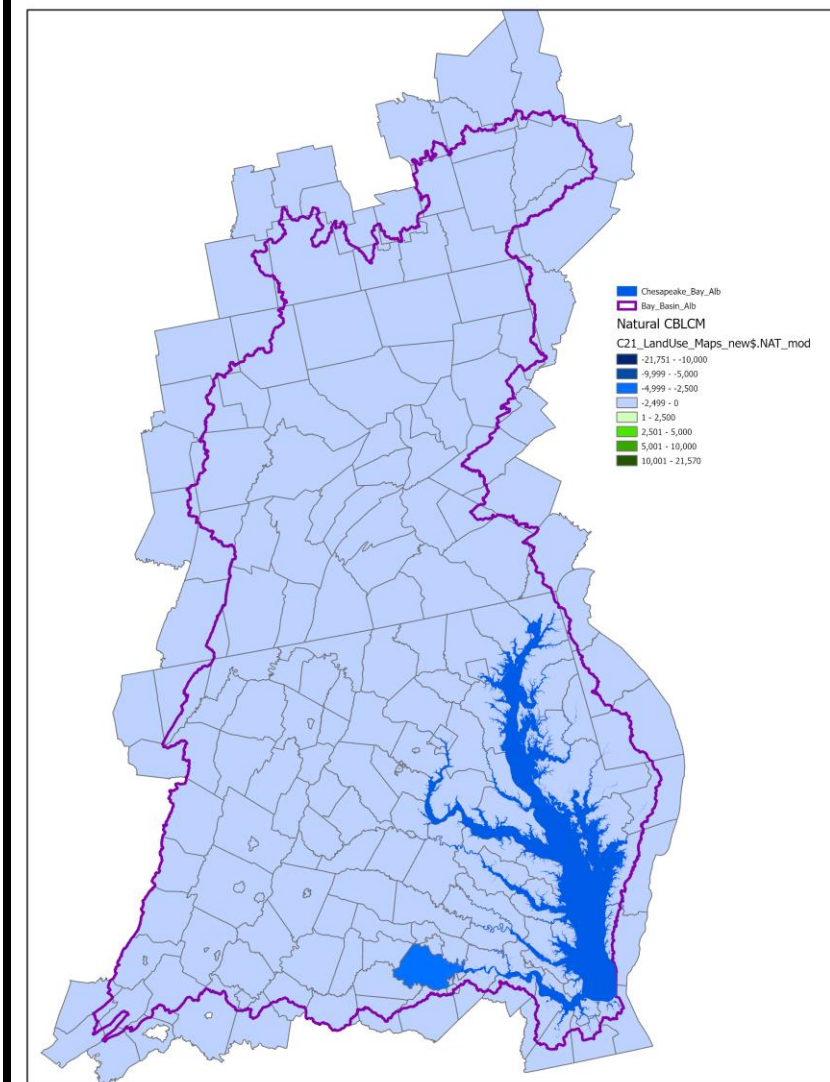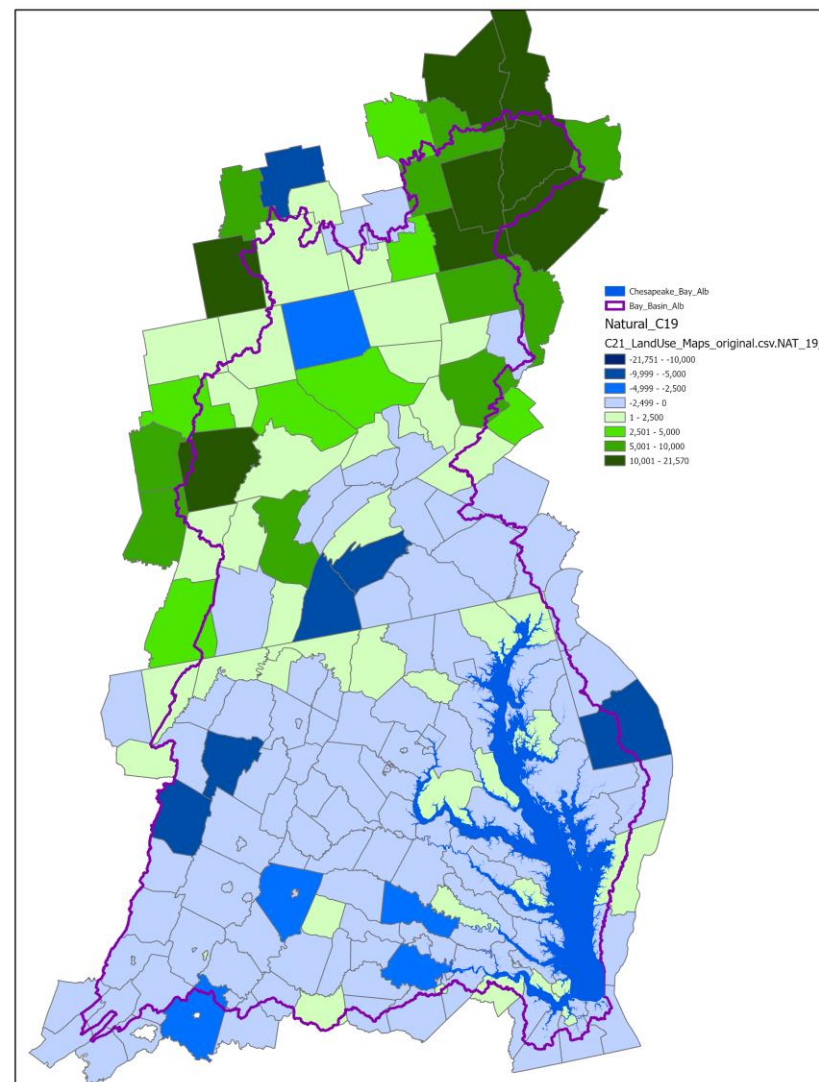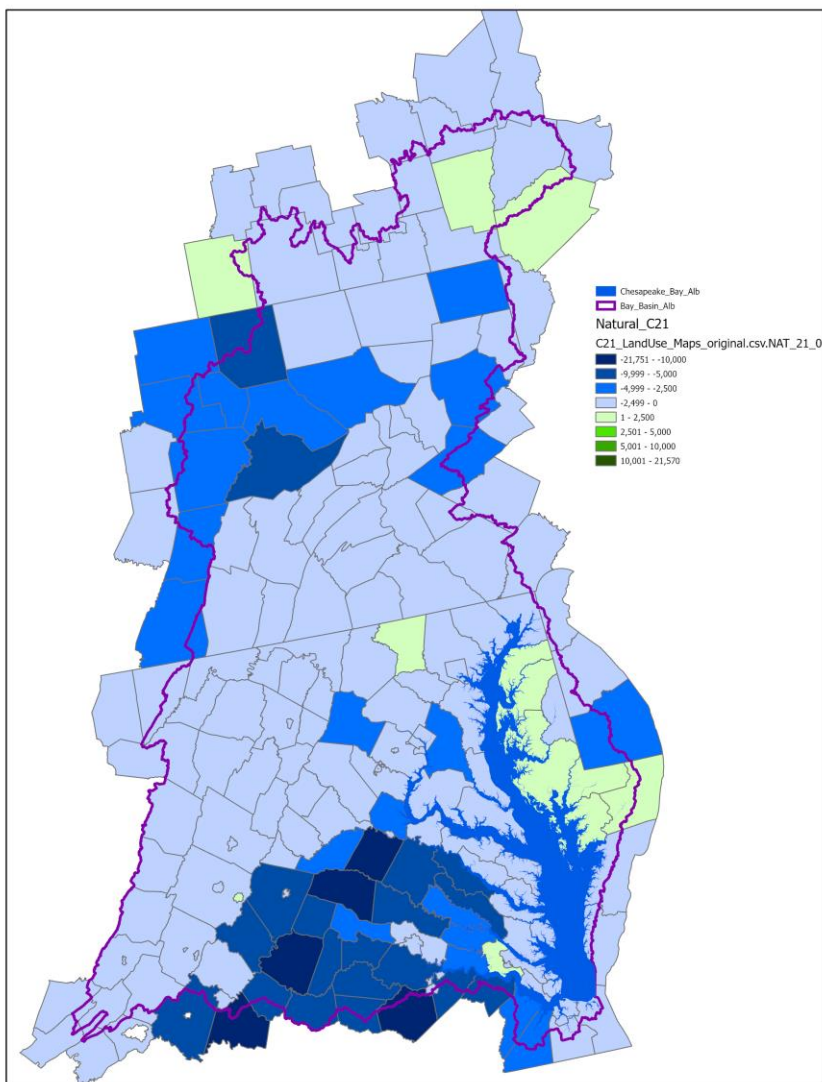## CAST-21 (pre-BMP) vs CAST-19 (pre-BMP) vs CBLCM (urban growth)
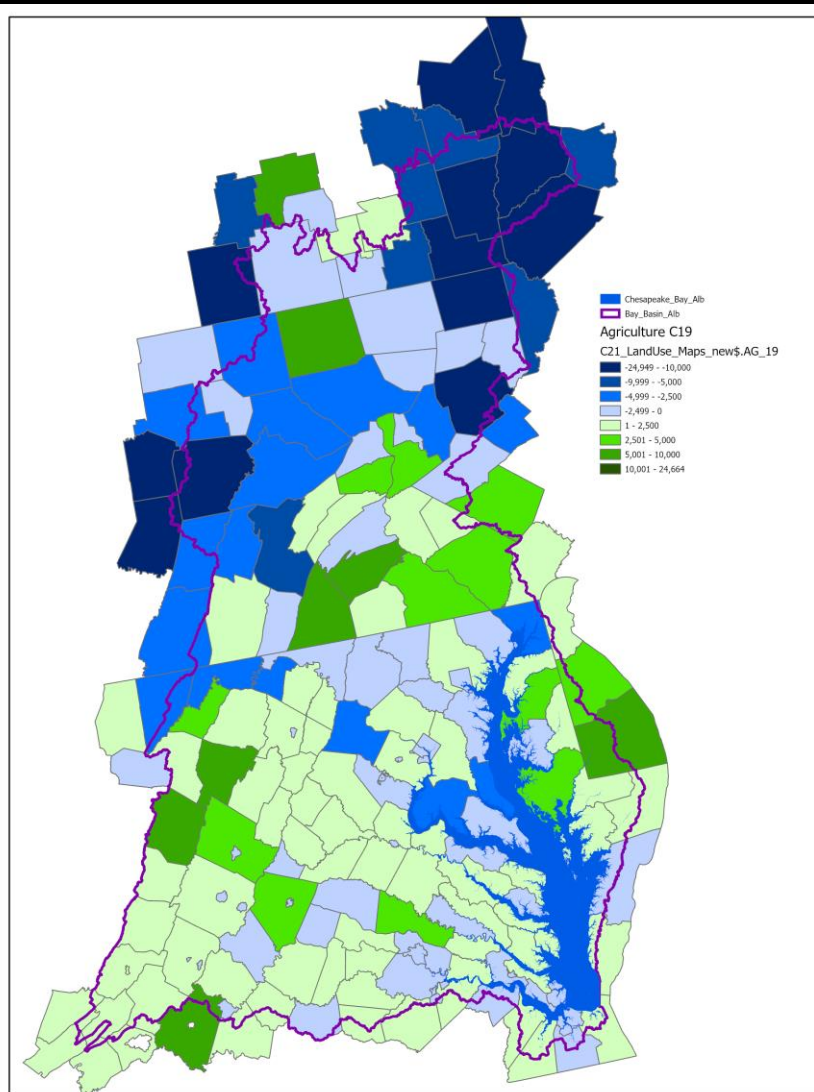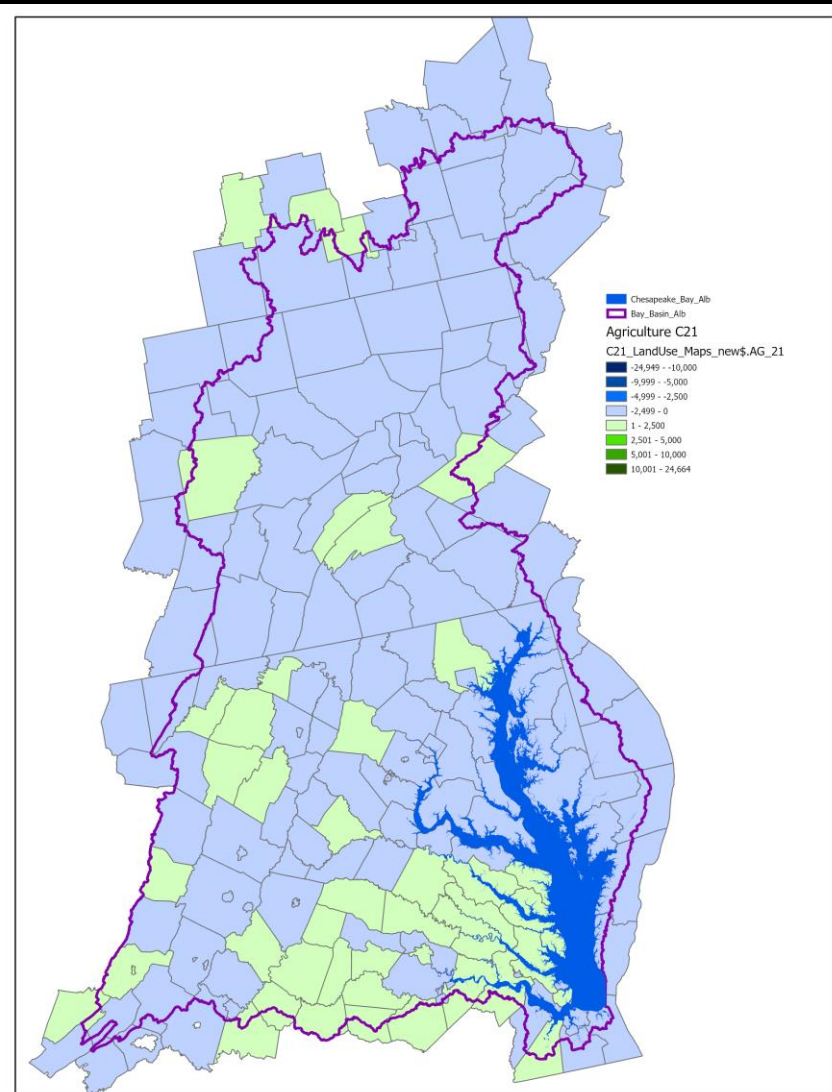
CAST-19 indicates large decreases in agricultural land in production in northern and western PA and NY that are not evident in the imagery. The true-up process moderated the magnitude of the decrease in agricultural land but also increased urban and natural lands to compensate for it.
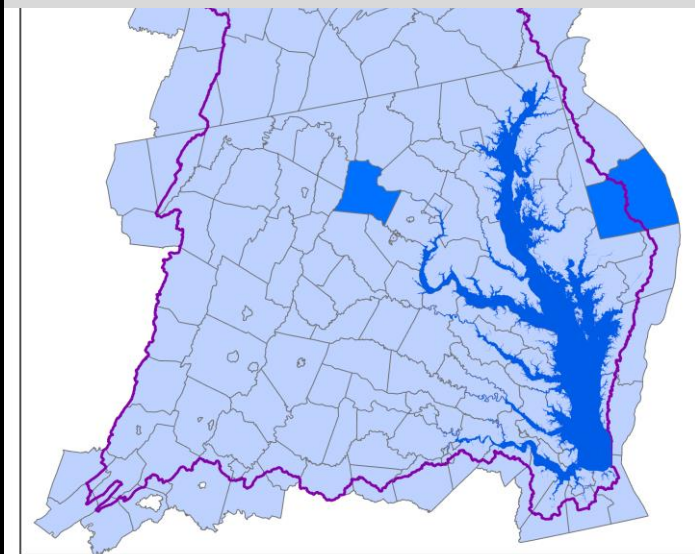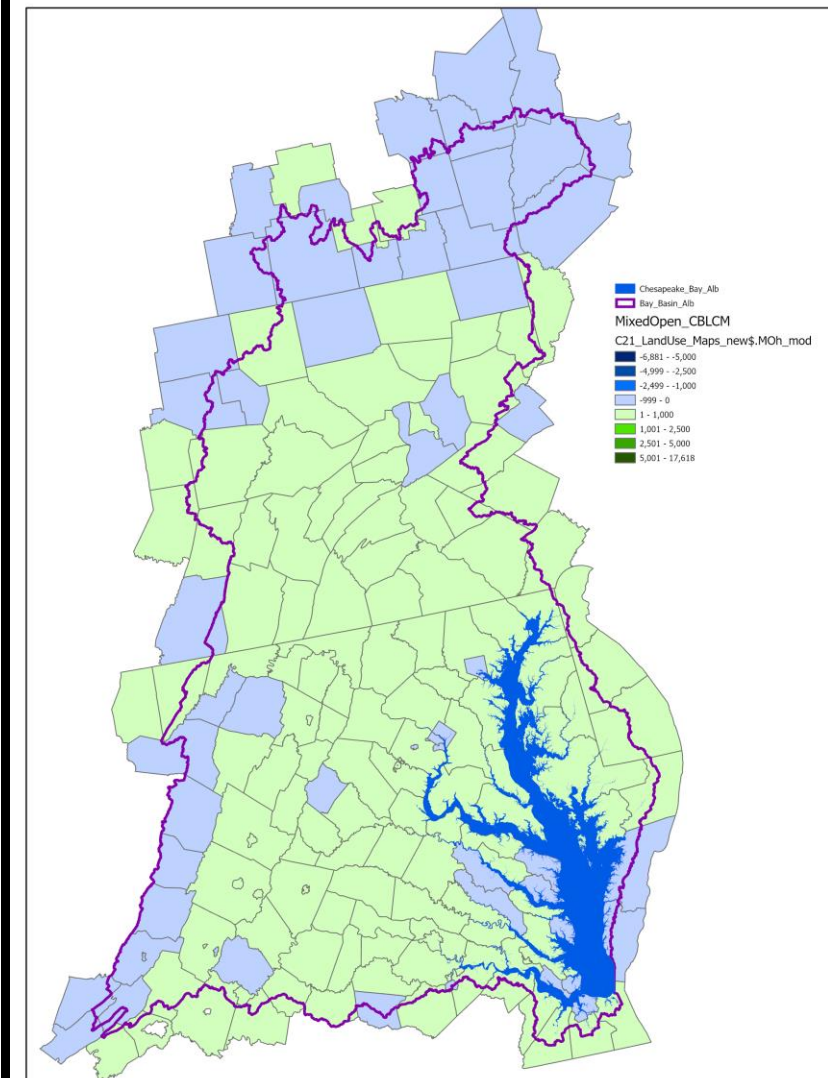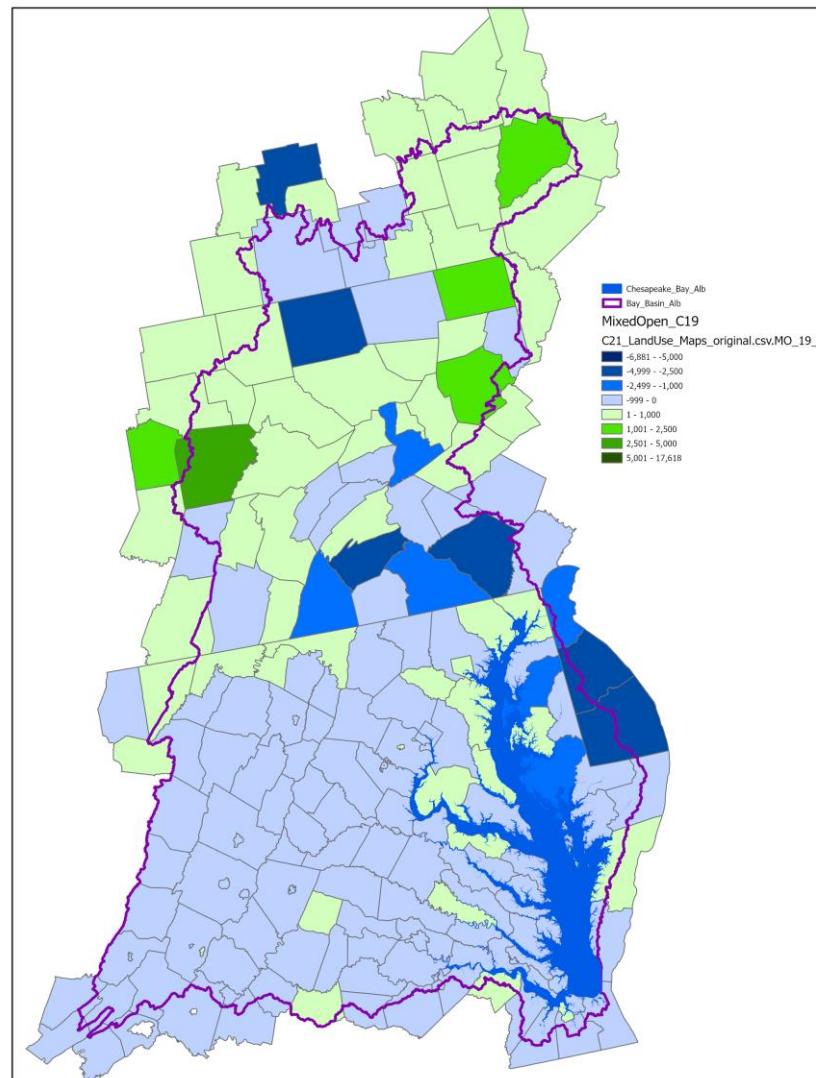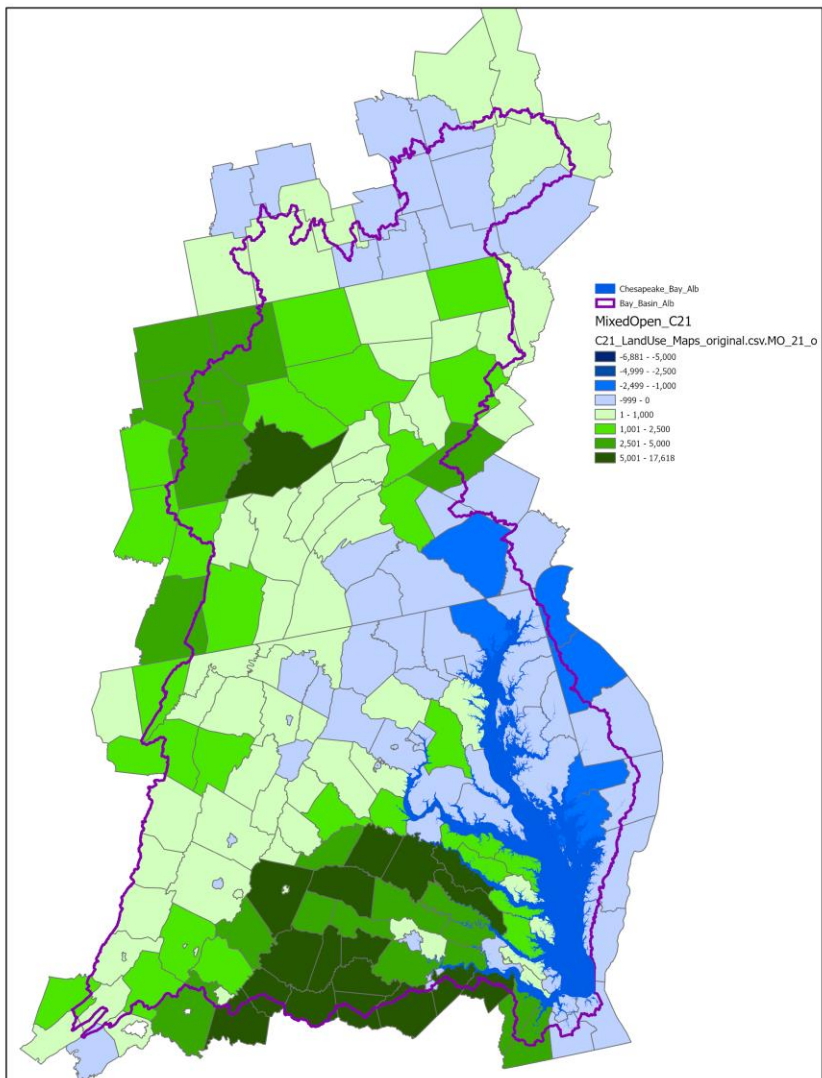
Generalized Natural Changes: 2013 – 2017
CAST-21 (pre-BMP) vs CAST-19 (pre-BMP) vs CBLCM (urban growth)

Generalized Mixed Open Changes: 2013 – 2017
CAST-21 (pre-BMP) vs CAST-19 (pre-BMP) vs CBLCM (urban growth)

High-resolution Land Use Data for CAST-21
Summary

The 2013-2017 high-resolution land use change data are transparent, verifiable, and logical. Comparatively, the modeled land use change data are not transparent, challenging to verify, and sometimes illogical.

Question

Are the 2013/14 – 2017/18 high-resolution land use change data the best available data to inform CAST-21?

USGS

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