Minimizing the Potential for Double Counting Timber Harvest Acres in CAST-21

Background

High-resolution land use change data, representing change from 2013 to 2017, will be incorporated into CAST-21. This is the first time such data have been used in any version of CAST. The largest acreage changes observed over this period are from the Phase 6 class "forest" to "mixed open" and from "mixed open" to "forest".   Most of these changes appear to be associated with timber harvests although a portion of the clearings may be associated with preparations for new development and in rare cases, associated with the expansion of cropland or pasture.

Three states reported annual acres of harvested forest over the 2013-2017 period (MD, VA, and WV). For the remaining states (DE, NY, and PA), CAST assumes a constant annual harvest rate of 1.5% of all forest acres. No harvests are assumed to take place in the District of Columbia or on federal lands. For the initial year of harvest, reported/calculated harvested forest acres load at 7x the rate of true forest for Total Nitrogen and 3x the rate of true forest for Total Phosphorus. In the second year, pollutant loads from timber harvests are assumed to be equal to true forests.

Over the 2013-2017 period, even the states reporting timber harvests tend to report similar acreages each year. CAST deducts the reported/calculated annual acres of harvested forest from true forest, but the deduction is not cumulative because harvested forests are assumed to function as forests again after the initial harvest year. For example, a rural county with 100,000 acres of true forest and reporting 5,000 acres of timber harvest annually from 2013-2017 will appear in CAST as having an unchanging 95,000 acres of true forest and a constant 5,000 acres of harvested forest. The trends over time in both true forest and harvest forest will be perfectly flat (zero slope). In this way, the acreages of forest and timber harvests in CAST are in equilibrium even though a different set of 5,000 acres is harvested each year. This is not how timber harvests appear in the high-resolution data.

Forest clearings are easily detected in the 2013-2017 high-res land use change data and appear to reflect the cumulative amount of clearing that occurred over the four-year period[1]. A county with 100,000 acres of true forest and reporting 5,000 acres of timber harvest annually from 2013-2017 will appear in the high-res data as having lost 20,000 acres of forest to mixed open over the same period. The high-res data also show mixed open lands transitioning back to forest on formerly harvested lands, but we do not yet know when these restored forests were previously cleared. The mapped acreages of land transitioning from forest to mixed open and from mixed open to forest from 2013-2017 do not appear to be in equilibrium, at least not over a four-year period.

Potential Double Counting

The deduction of reported/calculated annual acres of harvested forest from true forest in CAST has not been an issue previously because the mixed open land use in the original mapped high-res 2013 land use data informing all versions of CAST was specific to land uses such as abandoned and reclaimed mines, landfills, Unconventional Oil & Gas, beaches, waterbody margins, natural grasslands, and utility rights-of-way and portions of federal facilities. All low vegetation lands not mapped as turf grass or mixed open were assumed to be cropland or pasture and

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[1] The cumulative acres reported harvested in Buckingham County, VA for the years 2014, 2015, 2016, and 2017 is 26,400 acres while the extent of forest to mixed open change over this period is 24,700 acres. Regressing the acres of change from forest to mixed open against the cumulative total of reported timber harvests in Virginia from 2013-2017 yields a 0.80 R2. Accounting for a portion of forest to mixed open that may be destined for development and agriculture reduces the R2 value in Virginia to 0.71. The relationship between reported harvested forest acres and acres shifted is not strong in Maryland or West Virginia for reasons not yet determined. In the three states that don't report harvested forest acres, there's no relationship between the cumulative estimated 1.5% of forest presumed to be harvested annually and the acres shifted.

therefore recent timber harvests were often confused with and mapped as pasture in the original 2013 land use dataset.

For the 2013 to 2017 high-res land use change product (and all future high-res land use products), a concerted effort was made to accurately map cropland and pasture and differentiate it from mixed open land. In addition, 30 years of annual land use data from Landsat Imagery was introduced to the classification process enabling the mapping of forest harvest histories. The mixed open class has thus been redefined to include not only extractive lands and utility rights-of-way but all barren lands in preparation for construction, fallow lands undergoing succession, and recent timber harvests (I.e., lands that transitioned from forest to mixed open with historical evidence of rotation over the past 30 years). Given this expanded definition of mixed open, deducting reported/calculated annual acres of harvested forest from true forest will partially[2] double count the loading consequences of harvested forests which are now mapped as mixed open.

Solution

To minimize the potential for partial double counting while preserving the agreed upon decision rules in CAST, lands that were classed as forest in 2013 and mixed open in 2017 should be reclassified as forest. However, a portion of these recently cleared lands are not harvested with the intent of replanting but harvested to prepare for future development or agriculture. Therefore, only the portion of cleared forest that is expected to be replanted or managed for timber should be reclassified as forest. In counties with significant amounts of timber harvest that also report harvested acres to the Chesapeake Bay Program Office, double counting will all but be eliminated. In counties with minimal timber harvest activity, the acres shifted will likely be minimal because there will be few acres mapped transitioning from forest to mixed open.

The following formula and change matrix (aka "pivot table") below illustrate how this calculation was done. The acres of forest in 2013 transitioning to mixed open in 2017 (pink-ish) were multiplied by the proportion of mixed open in 2013 transitioning back to forest in 2017 (blue) over the total amount of mixed open conversion (yellow).

Acres shifted from mixed open to forest =
FOREST -> MIXED OPEN * ((MIXED OPEN -> FOREST) / (MIXED OPEN Loss))

Table 1. High-res Land Use Change Matrix for the Chesapeake Bay watershed, 2013-2017

T1-T2 LU	IR	INR	TCI	TG	TCT	FORE	WLF	WLO	WLT	MO	CRP	PAS	WAT	Loss	
IR	-	56	1,143	6	47	217	3	0	0	24	1	2	0	1,499	
INR	598	-	2,632	4,652	532	230	41	12	4	3,983	442	1,124	16	14,267	
TCI	114	1,307	-	2,167	13	6	11	1	0	2,703	57	90	0	6,470	
TG	250	5,901	0	-	11,197	354	17	3	2	1,875	45	69	13	19,726	
TCT	104	5,954	0	11,366	-	99	-	-	-	4,663	398	424	4	23,012	
FORE	1,152	15,165	17	10,660	15,775	-	-	-	-	325,781	8,069	8,572	143	385,335	
WLF	0	0	-	2	-	-	-	-	-	-	-	-	0	2	
WLO	-	-	-	2	-	-	-	-	-	-	-	-	-	2	
WLT	-	-	-	0	-	-	-	-	-	-	-	-	-	0	
MO	1,353	26,550	1	28,069	830	99,624	-	-	-	-	708	1,111	691	158,937	63%
CRP	155	4,229	0	424	77	4,659	-	-	-	2,523	-	384	163	12,614	
PAS	124	5,581	0	768	222	10,897	-	-	-	6,198	647	-	76	24,515	
WAT	1	103	-	2	25	192	14	0	9	264	29	19	-	657	
Gain	3,853	64,846	3,794	58,118	28,719	116,278	85	17	14	348,015	10,396	11,795	1,108	647,036	
TotGain	3,853	64,846	3,794	58,118	28,719	116,278	85	17	14	348,015	10,396	11,795	1,108		
TotLoss	1,499	14,267	6,470	19,726	23,012	385,335	2	2	0	158,937	12,614	24,515	657		
Net	2,353	50,579	(2,676)	38,392	5,706	(269,057)	83	15	14	189,077	(2,218)	(12,720)	450		

					FORE -> MO		Pct Timber Harvest		Acres shifted back to Forest				
					325,781	*	63%	=	204,203				

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[2] Mixed open generally loads slightly higher than true forest. If a county reports 500 acres of harvested forest, those acres will be assigned the load for harvested forest (7x TN and 3x TP). In addition, 500 acres of mapped mixed open land that used to be forest will contribute an increase in loads associated with the difference between forest and mixed open loading rates.

From 2013-2017 in the Chesapeake Bay watershed 325,781 acres of forest transitioned to mixed open and a separate 99,624 acres of mixed open transitioned to forest representing 63% of the total mixed open loss (the remainder transitioned to development, agriculture, or open water). Assuming that 63% of the 325,781 acres of forest to mixed open change will eventually grow back to forest, the estimated acres of mapped timber harvest to shift from mixed open to forest in 2017 is 204,203 acres. One can apply this similar logic and math to any of the county-level change matrices available online: http://cicapps.org/obj1lu/

Shifting acres from mixed open to forest will maintain the presumed equilibrium between harvested forest and true forest in CAST. However, the CAST land use data will no longer be representative of observed mapped land use patterns and trends in tree canopy. Shifting the majority of forest to mixed open acres to true forest will nullify the largest observed land use change in the Bay watershed and make the CAST data unusable for tree canopy inventories and for assessing and monitoring habitat change for forest interior dwelling species. Fortunately, the published high-res land use change data will remain independent of CAST and not affected by this internal CAST shift in acres made to minimize double counting and accommodate current CAST assumptions.

Comparison of CAST-19 and CAST-21 Land Use

Below are tables showing a summary of land use change data for 2013-2017 from CAST-19 (left-hand table) compared to CAST-21 (right-hand table). The CAST-21 data are updated with the methods explained above and revised since the data were last presented to the LUWG on September 1st. Shifting the majority 2017 mixed open acres that were forest in 2013 back to forest greatly reduced the losses in natural lands and mixed open lands over this period.

C19 2013-2017	DEV	NAT	AG	MO
Delaware	1,431	(7,534)	14,724	(8,621)
District of Columbia	64	(64)	-	(0)
Maryland	18,027	(2,077)	(9,693)	(6,257)
New York	28,305	132,912	(163,996)	2,779
Pennsylvania	36,453	49,781	(81,583)	(4,650)
Virginia	31,407	(65,551)	46,699	(12,555)
West Virginia	1,099	(17,751)	20,116	(3,464)
Total	**116,785**	**89,716**	**(173,733)**	**(32,769)**

C21 2013-2017	DEV	NAT	AG	MO
Delaware	11,180	(2,541)	(2,568)	(6,072)
District of Columbia	78	(24)	-	(54)
Maryland	24,996	(2,104)	(8,212)	(14,679)
New York	7,624	(2,034)	(3,104)	(2,487)
Pennsylvania	34,652	(34,720)	(6,327)	6,396
Virginia	38,925	(20,497)	(2,423)	(16,004)
West Virginia	4,108	(5,145)	(387)	1,424
Total	**121,563**	**(67,065)**	**(23,022)**	**(31,477)**