Land Use Change Methods 2013/2014 – 2017/2018 08.05.2021

Overview:
The land use change method contains 4 approaches, each responsible for determining land use for 2013/2014 data for specific land cover change classes. These approaches are: Direct, New Structure, Context-Based, and Indirect. Several of these approaches rely on a common sub-approach, referred to as the Agriculture Sub-Approach. Once all 4 approaches have completed, 2013/2014 LU will be produced for all areas where land cover change was detected. The land use change is then produced using the 2013/2014 LU derived from land cover change and 2017/2018 land use.

Required Input Data:
In House Data
- Land cover change raster from UVM
- 2017/2018 land use
- 2017/2018 land cover segments unioned with parcel boundaries (psegs)
- Rasterized parcels

Ancillary Data
- NLCD 2011
- NLCD 2016
- CDL 2013
- LCMAP Derived Patterns (2011-2019)
- LCMAP Derived Patterns (1985-2019)

Agriculture Sub-Approach:
The purpose of this method is to determine if a parcel was cropland, orchard/vineyard/vineyard, pasture/hay/hay or non-agricultural in the 2013/2014 date. This is accomplished using a combination of the ancillary data and the 2017/2018 land use. Parcels that had a majority value of Cultivated Cropland or Pasture/hay/Hay in NLCD 2011 or NLCD 2016 or a majority value of Developed; Previously Low Vegetation in LCMAP (2010-2017) are selected as potentially agricultural. The selected parcels then have the total area for CDL 2013 classes cropland, fallow/idle, pasture/hay/hay and orchard/vineyards/vineyard calculated. If any of the CDL classes existed in the parcel, it is selected as most likely agricultural. Finally, the majority value of the 2017/2018 land use is used to differentiate between cropland, pasture/hay, and orchard/vineyard. If none of these classes are the majority in the parcel, it is given the value of “other”. Since cropland and pasture/hay will roll up to the same Phase 6 land use class, they are grouped together. The final result is a table relating the parcel with either cropland, orchard/vineyard, pasture/hay or “other”. This data is used in approaches: New Structure, Context-Based and Indirect.

Direct:

The Direct approach is a direct translation of the 2013/2014 land cover to the 2013/2014 land use where the 2013/2014 land cover is equal to a land use class. These include Impervious Roads, Impervious Surfaces, Structures, and Trees over impervious classes.

LC Change	T1 LU	T2 LU	T1 LU Code
Emergent Wetlands to Barren	Wetland	Use T2 LU	5000
Emergent Wetlands to Low Vegetation	Wetland	Use T2 LU	5000
Emergent Wetlands to Other Impervious Surfaces	Wetland	Other Imp	5000
Emergent Wetlands to Roads	Wetland	Roads	5000
Emergent Wetlands to Structures	Wetland	Structures	5000
Emergent Wetlands to Tree Canopy	Wetland	Use T2 LU	5000
Emergent Wetlands to Water	Wetland	Water	5000
Other Impervious Surfaces to Barren	Other Impervious	Use T2 LU	2130
Other Impervious Surfaces to Low Vegetation	Other Impervious	Use T2 LU	2130
Other Impervious Surfaces to Roads	Other Impervious	Roads	2130
Other Impervious Surfaces to Structures	Other Impervious	Structures	2130
Other Impervious Surfaces to Tree Canopy	Other Impervious	Use T2 LU	2130
Other Impervious Surfaces to Tree Canopy Over Other Impervious Surf	Other Impervious	TC over Other Imp	2130
Other Impervious Surfaces to Water	Other Impervious	Use T2 LU	2130
Roads to Barren	Impervious Roads	Use T2 LU	2110
Roads to Low Vegetation	Impervious Roads	Use T2 LU	2110
Roads to Other Impervious Structures	Impervious Roads	Other Imp	2110
Roads to Structures	Impervious Roads	Structures	2110
Roads to Tree Canopy	Impervious Roads	Use T2 LU	2110
Roads to Tree Canopy Over Roads	Impervious Roads	Roads	2110
Roads to Water	Impervious Roads	Use T2 LU	2110
Scrub\Shrub to Tree Canopy	Natural Succession Scrub-Shrub	Use T2 LU	3430
Structures to Barren	Structures	Use T2 LU	2120
Structures to Low Vegetation	Structures	Use T2 LU	2120
Structures to Other Impervious Surfaces	Structures	Other Imp	2120
Structures to Roads	Structures	Roads	2120
Structures to Tree Canopy	Structures	Use T2 LU	2120
Structures to Tree Canopy Over Structures	Structures	Structures	2120
Structures to Water	Structures	Use T2 LU	2120
Tree Canopy Over Other Impervious Surfaces to Barren	TC over Other Impervious	Use T2 LU	2143
Tree Canopy Over Other Impervious Surfaces to Low Vegetation	TC over Other Impervious	Use T2 LU	2143
Tree Canopy Over Other Impervious Surfaces to Other Impervious Surf	TC over Other Impervious	Other Imp	2143
Tree Canopy Over Other Impervious Surfaces to Roads	TC over Other Impervious	Roads	2143
Tree Canopy Over Other Impervious Surfaces to Structures	TC over Other Impervious	Structures	2143
Tree Canopy Over Other Impervious Surfaces to Water	TC over Other Impervious	Use T2 LU	2143
Tree Canopy Over Roads to Barren	TC over Roads	Use T2 LU	2141
Tree Canopy Over Roads to Low Vegetation	TC over Roads	Use T2 LU	2141
Tree Canopy Over Roads to Other Impervious Surfaces	TC over Roads	Other Imp	2141
Tree Canopy Over Roads to Roads	TC over Roads	Roads	2141
Tree Canopy Over Roads to Structures	TC over Roads	Structures	2141
Tree Canopy Over Roads to Water	TC over Roads	Use T2 LU	2141
Tree Canopy Over Structures to Barren	TC over Structures	Use T2 LU	2142
Tree Canopy Over Structures to Low Vegetation	TC over Structures	Use T2 LU	2142
Tree Canopy Over Structures to Other Impervious Surfaces	TC over Structures	Other Imp	2142
Tree Canopy Over Structures to Roads	TC over Structures	Roads	2142
Tree Canopy Over Structures to Structures	TC over Structures	Structures	2142
Tree Canopy Over Structures to Tree Canopy	TC over Structures	Use T2 LU	2142
Tree Canopy Over Structures to Water	TC over Structures	Use T2 LU	2142
Water to Barren	Water	Use T2 LU	1000
Water to Buildings	Water	Structures	1000
Water to Low Vegetation	Water	Use T2 LU	1000
Water to Other Impervious Surfaces	Water	Other Imp	1000
Water to Scrub\Shrub	Water	Use T2 LU	1000
Water to Structures	Water	Structures	1000
Water to Tree Canopy	Water	Use T2 LU	1000

New Structure:

The New Structure approach tackles the classification of 2013/2014 land use for parcels that contain a land cover change from Low Vegetation to Structure or Barren to Structure. For land cover change of Low Vegetation to Structure, this method uses the agricultural data to determine if the 2013/2014 land use was cropland or pasture/hay. If it was non-agricultural, it is defined as suspended succession. Any other land cover change whose initial state (2013/2014) was low vegetation will be translated using the same approach.

Newly developed parcels are selected where the land cover change was from barren or low vegetation to structure. The land cover change is then used to calculate total structure area for the parcel in 2013/2014 by summing classes Structure and Tree Canopy over Structure. A newly developed parcel is a parcel with less than 55 square meters of total structure in 2013/2014. All low vegetation and barren land within newly developed parcels that are not agricultural are given a 2013/2014 land use of suspended succession.

LC Change	Captured in Method	T1 LU Options	T1 LU Code	Rule
Low Vegetation to Structures	Always	Cropland - Herbaceous	4112	Ancillary detects Ag, T2 LU is majority crop/orchard
Low Vegetation to Structures	Always	Pasture/Hay Herbaceous	4142	Ancillary detects Ag, T2 LU is majority pasture
Low Vegetation to Structures	Always	Suspended Sucession Herbaceous	2232	Not caught in other rules
Low Vegetation to Tree Canopy	If In parcel with LV to Structure	Same as LV to Structures		Same as LV to Structures
Low Vegetation to Barren	If In parcel with LV to Structure	Same as LV to Structures		Same as LV to Structures
Low Vegetation to Other Impervious	If In parcel with LV to Structure	Same as LV to Structures		Same as LV to Structures
Low Vegetation to Roads	If In parcel with LV to Structure	Same as LV to Structures		Same as LV to Structures
Low Vegetation to Scrub/Shrub	If In parcel with LV to Structure	Same as LV to Structures		Same as LV to Structures

Context Based:

The Context Based approach applies a defined set of rules for specific land cover change classes. These rules rely on the agricultural approach and the 2017/2018 land use. The goal of these rules is to limit the number of possibilities of what the 2013/2014 land use was using context of the change itself and what the result of the change was (2017/2018 land use). For example, a land cover change of Barren to Structure has 3 possible 2013/2014 land use values. If the parcel is either cropland or pasture/hay, according to the agricultural approach, it is cropland or pasture/hay. If it is not agricultural it is Bare Developed.

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LC Change	T1 LU Options	T1 LU Code	Rule	Rule Order
Barren to Low Vegetation	Bare Developed	2220	T2 LU is TG	1
Barren to Low Vegetation	Cropland Barren	4111	Ancillary detects Ag, T2 LU is majority crop/orchard	2
Barren to Low Vegetation	Pasture/Hay Barren	4141	Ancillary detects Ag, T2 LU is majority pasture	2
Barren to Low Vegetation	Floodplain Barren	5221	T2 LU is a floodplain wetland class with any LC type	3
Barren to Low Vegetation	Terrene/Isolated Wetlands Barren	5301	T2 LU is an other wetland class with any LC type	3
Barren to Low Vegetation	Tidal Barren	5101	T2 LU is a tidal wetland class with any LC type	3
Barren to Low Vegetation	Natural Succession Barren	3410	Not caught in other rules	4
Barren to Structures	Cropland - Barren	4111	Ancillary detects Ag, T2 LU is majority crop/orchard	1
Barren to Structures	Pasture/Hay Barren	4141	Ancillary detects Ag, T2 LU is majority pasture	1
Barren to Structures	Bare Developed	2220	Not caught in other rules	2
Barren to Tree Canopy	Suspended Sucession Barren	2231	T2 LU is TCT or Forest	1
Barren to Tree Canopy	Floodplain Barren	5221	T2 LU is a floodplain wetland class with any LC type	2
Barren to Tree Canopy	Terrene/Isolated Wetlands Barren	5301	T2 LU is an other wetland class with any LC type	2
Barren to Tree Canopy	Tidal Barren	5101	T2 LU is a tidal wetland class with any LC type	2
Barren to Tree Canopy	Cropland - Barren	4111	Ancillary detects Ag, T2 LU is majority crop/orchard	3
Barren to Tree Canopy	Pasture/Hay Barren	4141	Ancillary detects Ag, T2 LU is majority pasture	3
Barren to Tree Canopy	Natural Succession Barren	3410	Not caught in other rules	4
Low Vegetation to Scrub\Shrub	Floodplain Herbaceous	5222	T2 LU is a floodplain wetland class with any LC type	1
Low Vegetation to Scrub\Shrub	Terrene/Isolated Wetlands Herbace	5302	T2 LU is an other wetland class with any LC type	1
Low Vegetation to Scrub\Shrub	Tidal Herbaceous	5102	T2 LU is a tidal wetland class with any LC type	1
Low Vegetation to Scrub\Shrub	Cropland - Herbaceous	4112	Ancillary detects Ag, T2 LU is majority crop/orchard	2
Low Vegetation to Scrub\Shrub	Pasture/Hay Herbaceous	4142	Ancillary detects Ag, T2 LU is majority pasture	2
Low Vegetation to Scrub\Shrub	Natural Succession Herbaceous	3420	Not caught in other rules	3
Low Vegetation to Tree Canopy	Turf Grass	2210	T2 LU is TC over TG	1
Low Vegetation to Tree Canopy	Cropland - Herbaceous	4112	T2 LU is TC over Ag; Ancillary is majority crop/orchar	2
Low Vegetation to Tree Canopy	Pasture/Hay Herbaceous	4142	T2 LU is TC over Ag; Ancillary is majority pasture	2
Low Vegetation to Tree Canopy	Floodplain Herbaceous	5222	T2 LU is a floodplain wetland class with any LC type	3
Low Vegetation to Tree Canopy	Terrene/Isolated Wetlands Herbace	5302	T2 LU is an other wetland class with any LC type	3
Low Vegetation to Tree Canopy	Tidal Herbaceous	5102	T2 LU is a tidal wetland class with any LC type	3
Low Vegetation to Tree Canopy	Natural Succession Herbaceous	3420	Not caught in other rules	4
Scrub\Shrub to Barren	Floodplain Scrub-Shrub	5223	T2 LU is a floodplain wetland class with any LC type	1
Scrub\Shrub to Barren	Terrene/Isolated Wetlands Scrub-Sh	5303	T2 LU is an other wetland class with any LC type	1
Scrub\Shrub to Barren	Tidal Scrub-Shrub	5103	T2 LU is a tidal wetland class with any LC type	1
Scrub\Shrub to Barren	Orchard/Vineyard Scrub-Shrub	4133	Ancillary detects Ag, T2 LU is majority orchard	2
Scrub\Shrub to Barren	Pasture/Hay Scrub-Shrub	4123	Ancillary detects Ag, T2 LU is majority pasture	2
Scrub\Shrub to Barren	Natural Succession Scrub-Shrub	3430	Not caught in other rules	3
Scrub\Shrub to Low Vegetation	Floodplain Scrub-Shrub	5223	T2 LU is a floodplain wetland class with any LC type	1
Scrub\Shrub to Low Vegetation	Terrene/Isolated Wetlands Scrub-Sh	5303	T2 LU is an other wetland class with any LC type	1
Scrub\Shrub to Low Vegetation	Tidal Scrub-Shrub	5103	T2 LU is a tidal wetland class with any LC type	1
Scrub\Shrub to Low Vegetation	Orchard/Vineyard Scrub-Shrub	4133	Ancillary detects Ag, T2 LU is majority orchard	2
Scrub\Shrub to Low Vegetation	Pasture/Hay Scrub-Shrub	4123	Ancillary detects Ag, T2 LU is majority pasture	2
Scrub\Shrub to Low Vegetation	Suspended Sucession Scrub-Shrub	2233	T2 LU is suspended succession	3
Scrub\Shrub to Low Vegetation	Natural Succession Scrub-Shrub	3430	Not caught in other rules	4
Scrub\Shrub to Other Impervious Surfac	Orchard/Vineyard Scrub-Shrub	4133	Ancillary detects Ag, T2 LU is majority orchard	1
Scrub\Shrub to Other Impervious Surfac	Pasture/Hay Scrub-Shrub	4123	Ancillary detects Ag, T2 LU is majority pasture	1
Scrub\Shrub to Other Impervious Surfac	Natural Succession Scrub-Shrub	3430	Not caught in other rules	2
Scrub\Shrub to Roads	Orchard/Vineyard Scrub-Shrub	4133	Ancillary detects Ag, T2 LU is majority orchard	1
Scrub\Shrub to Roads	Pasture/Hay Scrub-Shrub	4123	Ancillary detects Ag, T2 LU is majority pasture	1
Scrub\Shrub to Roads	Natural Succession Scrub-Shrub	3430	Not caught in other rules	2
Scrub\Shrub to Structures	Orchard/Vineyard Scrub-Shrub	4133	Ancillary detects Ag, T2 LU is majority orchard	1
Scrub\Shrub to Structures	Pasture/Hay Scrub-Shrub	4123	Ancillary detects Ag, T2 LU is majority pasture	1
Scrub\Shrub to Structures	Natural Succession Scrub-Shrub	3430	Not caught in other rules	2

Indirect:
The indirect approach is used for land cover change classes that were not captured in the Direct or New Structure approaches and cannot be determined using the Context Based approach. These changes all have a 2013/2014 land cover type of either Barren, Emergent Wetland, Low vegetation, Scrub Shrub or Tree Canopy. This method has two parts. The first uses the 2017/2018 land use and the psegs to determine if surrounding areas can be used to determine the 2013/2014 land use. For the areas where this approach fails, the change will undergo a set of rules based on its land cover type to classify its land use value.

The first step is to select the 2017/2018 psegs whose land cover type is natural (barren, emergent wetland, low vegetation, scrub shrub and tree canopy). The natural land cover psegs are intersected with the change to determine what psegs are touching the change segments. The area of each 2017/2018 land use class is calculated for each pseg touching land cover change. The wetland classes are rolled up based on their parent wetland class (tidal, floodplain, other). Any change segment that is touching a wetland type segment, is classed as the same type of wetland (with appropriate land cover class). The emergent wetland land cover class is classed as tidal, floodplain or other wetland with low vegetation as its land cover class. In the case that the emergent wetland land cover was not touching any wetland classes in the 2017/2018 psegs, it is assigned to other wetland. For segments whose land cover is not emergent wetland and that are not touching any wetland classes, the area of the 2017/2018 land use classes for the psegs with the same land cover class as the change are summed for each change area. The land use value with the greatest area is assigned as the 2013/2014 land use for the change area.

For data on the viewer, wetlands classes were given precedence if detected. This rule is being modified to not class any new wetlands.

The change that was not classified in the first step is defined using a set of rules based on its 2013/2014 land cover type. Each land cover type has its own set of rules, which are summarized below.

Barren:
If the change is touching a developed class in 2017/2018, the 2013/2014 land use is Bare Developed. If LCMAP Patterns (1985-2017) detects forest rotation within that change, the 2013/2014 land use is Harvested Forest. If the Agricultural Sub-Approach detected cropland or pasture/hay, the 2013/2014 land use is cropland or pasture/hay. Any remaining change in this class without a 2013/2014 land use is Natural Succession.

Low Vegetation:
If LCMAP Patterns (1985-2017) detects forest rotation within that change, the 2013/2014 land use is Harvested Forest. If the Agricultural Sub-Approach detected cropland or pasture/hay, the 2013/2014 land use is cropland or pasture/hay. Any remaining change in this class without a 2013/2014 land use is Suspended Succession.

Scrub Shrub
If the Agricultural Sub-Approach detected orchard/vineyard or pasture/hay, the 2013/2014 land use is orchard/vineyard or pasture/hay. Any remaining change in this class without a 2013/2014 land use is Natural Succession.

Tree Canopy
If the area of change is greater than or equal to an acre, the 2013/2014 land use is Forest. If under an acre, determine if other change with 2013/2014 land cover as Tree Canopy have a 2013/2014 land use. If so, copy the land use of the neighboring change segments. If the Agricultural Sub-Approach determined the change is in a parcel with cropland, orchard/vineyard or pasture/hay, class the 2013/2014 land use as Trees in Agriculture. If the change is in a non-agricultural parcel, class the 2013/2014 land use as Tree Canopy over Turf Grass.

Land Use Change Methods Update 2013/2014 – 2017/2018 08.05.2021

Overview:
Version 1.0 of the land use change data contained 2 systematic errors. The first is the misclassification of Forest to Agriculture due to under-detection of timber harvest practices in 2017/2018. The second is the under-classification of agriculture classes (Cropland and Pasture) in 2013/2014, which is usually misclassed as Mixed Open. This document describes the updates made to address these two issues.

Data Needs:

- Ancillary
    - LCMAP 1985-2019 patterns resampled to 10m
    - LCMAP succession age resampled to 10m
    - LCMAP 2011-2019 patterns resampled to 10m
    - NLCD 2011 (2019 ed.) resampled to 10m
    - NLCD 2016 (2019 ed.) resampled to 10m
    - CDL 2013 – reclassed and resampled to 10m
    - MD Forest Vector Data
    - PA Forest Vector Data
    - VA Forest Point Data
    - DE Forest Vector Data

- County Data
  - LU Change vector data
  - 2017/2018 LU raster
  - 2013/2014 LU raster (produced from change NOT the original 2013/2014 LU)
  - Parcels vector data (temp_dataprep.gdb)

Under-Classification of Harvested Forest in 2017/2018:

Problem: Harvested forest (MO) is being incorrectly classed as agriculture (CRP, PAS) in the 2017/2018 time period. This is evident in the Tree Canopy to Low Vegetation and Tree Canopy to Barren land cover change classes.

Cause: the order of operations in the land use model, which places higher confidence in the Cropland Data Layer (CDL) dataset than timber harvest detecting datasets (LCMAP and state data). Additionally, lack of timber harvest data in 5 out of 7 states (we now have data for 4 states).

Affected Polygons: land cover change is tree canopy to low vegetation or barren and whose 2017/2018 land use is crop or pasture

Solution: Select the land use change polygons that were affected.

Determine if LCMAP 1985-2019 data detects at least 20% of the polygon as forest rotation and deforestation and of the LCMAP data at least 15% is forest rotation. If these thresholds are met, check the LCMAP succession age raster to determine if the polygon is timber harvest or natural succession in 2017/2018. If the area was cut prior to 2015 according to LCMAP, it is natural succession. If there are affected records that were not detected by LCMAP, determine if the polygons intersect state harvested forest data.

For DE, MD and PA, intersect the affected polygons with the state polygons. For VA, buffer the points by 60m and intersect them with the affected polygons. LC Change polygons intersecting state data become natural succession. If there are still affected records that were not changed, select the parcels that these polygons are in.

Determine if the NLCD 2019 agriculture classes (Cultivated Crops and Pasture/Hay) make up less than 5% of the parcel or if Natural Classes (forested, scrub-shrub, herbaceous, woody wetland and emergent wetland) make up at least 70% of the parcel. Half of Developed Open Space class is added to the agricultural total if agriculture exists (this class appears to be ag about half the time so reduce its count). Any affected change polygons who have not been updated and are associated with the PIDs that meet the NLCD 2019 requirements are classed as natural succession in 2017/2018. If there are affected polygons greater than or equal to half an acre that are still not updated, re-run the NLCD rules for the polygons (not parcel).

Under-Classification of Agriculture in 2013/2014:

Problem: Agriculture is being incorrectly classed as Succession (MO) in the 2013/2014 time period.

Cause: a code issue involving the CDL 2013 data. Thresholds favored MO classes to Agriculture.

Affected Polygons:

Any polygon who could have been classed as agriculture in 2013/2014 that was not classed as agriculture will undergo this update. This applies to all Low Vegetation, Barren and Scrub Shrub areas in 2013/2014 that changed in 2017/2018.

Solution: Select the land use change polygons that were affected. Re-run zonal statistics and tabulate area on NLCD 2011, CDL 2013 and LCMAP 2011-2019 for the parcels containing these polygons and the parcels who contain a new structure. Using updated tabulations, re-run the thresholds that determine if a parcel is crop, pasture or other (non-agricultural). The thresholds for ancillary data were reduced from 50% to 25% to call a parcel agricultural. Re-calculate the majority GRP_TYPE field for new structure parcels. If the new tabulations call the parcel crop or pasture, update the 2013/2014 land use to crop or pasture. For context methods, re-run context rules with new TYPE field. Remove the context method polygons whose classification did not change using the updated TYPE field. For the indirect polygons, if the poly TYPE was updated to crop or pasture, call it crop or pasture. Otherwise, remove the record as it did not change.