Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2004 to 2013

Ulster County, New York

Summary

Forests and trees play a key role in mitigating climate change, yet they are often not included in local greenhouse gas (GHG) inventories or climate action plans. Ulster County, New York has taken the first step towards understanding how local changes in land use and tree canopy have contributed to the county's net greenhouse gas profile. Unlike other sectors, land use (in this case, forests and trees) not only emit GHGs, they also remove CO2 from the atmosphere through photosynthesis, and play a critical role in regulating the planet's climate. The information contained in this summary report can be useful when designing climate actions that reduce GHG emissions and/or increase removals of GHGs from the atmosphere.

Key findings:

- Over the period 2004 to 2013, emissions from forests and trees were 104,963 t CO2e per year.

- Over the period 2004 to 2013, the Net GHG balance of forests and trees was -1,478,214 t CO2e per year.

- Roughly 81% of Ulster County's total land base of 300,591 hectares (742,776 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 23.6 percent tree canopy on lands outside of forest areas

- Over the same period, annual CO2 removals from forests and trees were -1,583,176 t CO2e per year. (Carbon removals are represented by negative values.)

- Total GHG emissions for Ulster County across all sectors could be reduced if additional forests/trees were added to its land base, and/or if losses of trees were reduced further.

Table 1. Ulster county's GHG fluxes from forests and trees for inventory period 2004 – 2013, all values reported in t CO2e per year

	Removals(t CO2e/yr)	Emissions(t CO2e/yr)
rbed Forest	-1,452,397	
isturbances		59,590
est to Forest	-4,096	
› Settlement		8,217
› Grassland		23,733
› other non-forest lands		8,271
tside of forests	-126,683	5,151
ed Wood Products	0	
TOTAL	-1,583,176	104,963
balance	-1,478,214	

Data Inputs

Data used as inputs into the GHG emission and removal calculations are described below.

Land and Forest Cover

GHG inventories for lands are reported in six “land use” categories which were defined by data on land cover—forest land, grassland, cropland, wetland, settlement and other land (barren, snow, ice). Ulster County’s total land base is approximately 300,591 hectares (742,776 acres), with nearly 7.5% Settlement (i.e. developed areas of varying intensity), around 80.8% forest, 7.2% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 0.9% cropland, 3.2% wetland and 0.3% other land.

Figure 1. Land cover in Ulster from the National Land Cover Database, 2013

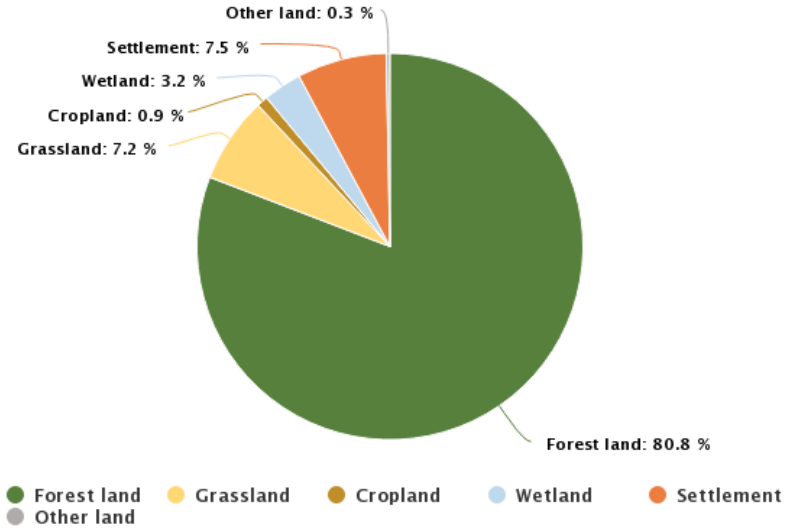
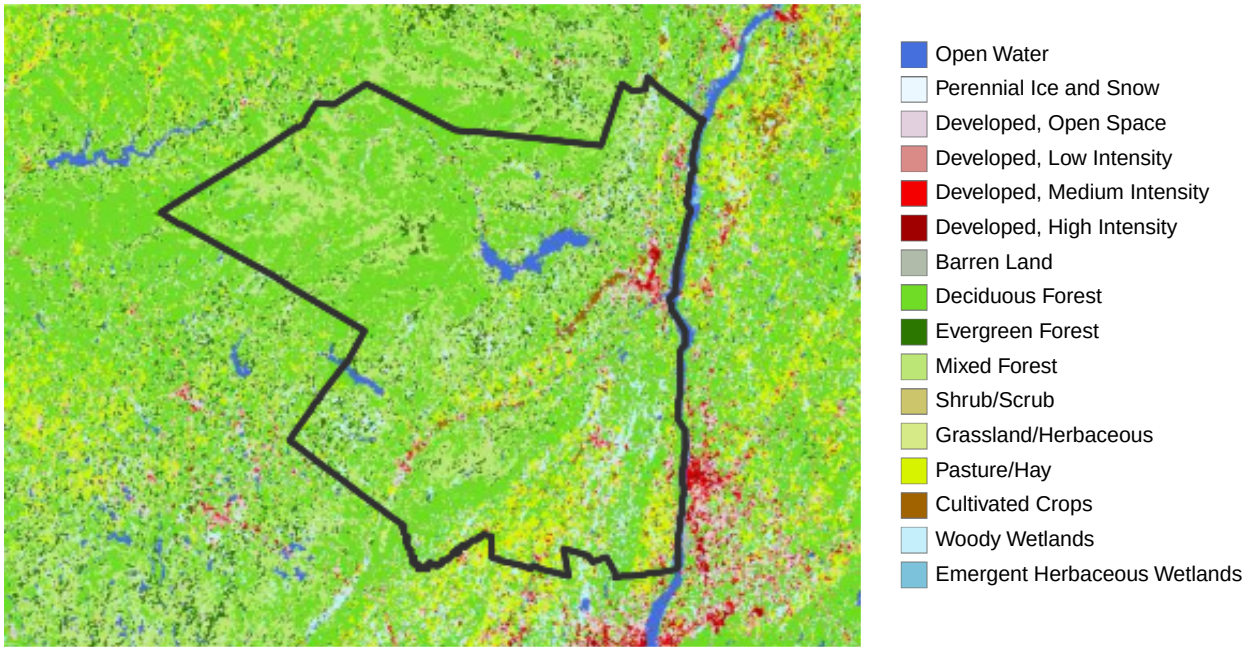


Figure 2. Land cover in Ulster from the National Land Cover Database, 2013



Forest Cover Change

Generating GHG estimates requires data not just on areas of land use, but also data on how land use has changed over time. Between 2004 and 2013, the county lost around 1,857 hectares (4,589 acres) of forest land, largely conversion to Grassland. Over the same period, the county gained around 592 hectares (1,463 acres) of forest land, largely from Wetland.

Figure 3. Loss of forest to other land use types between 2004 and 2013 (ha)

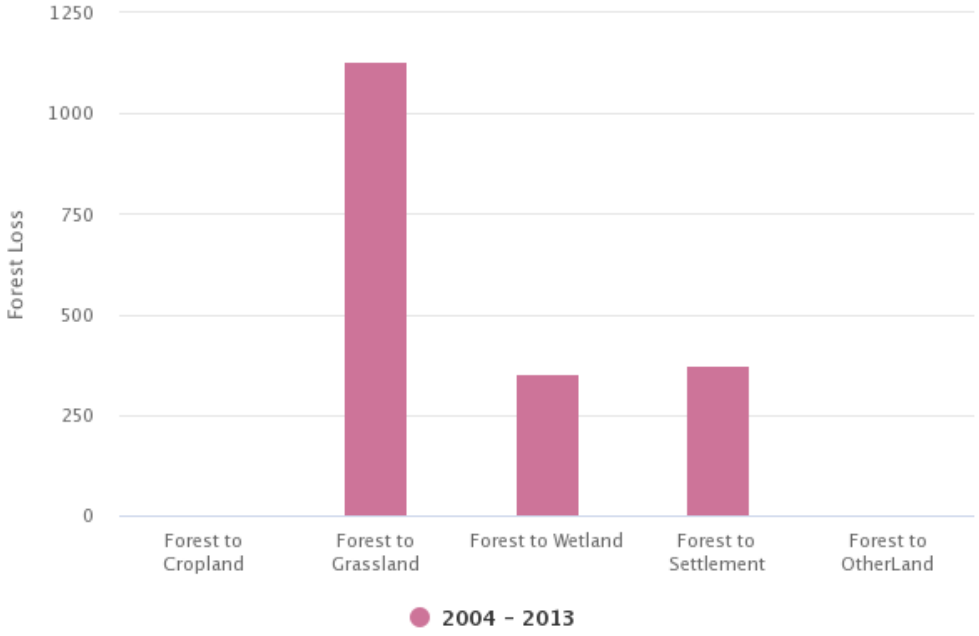
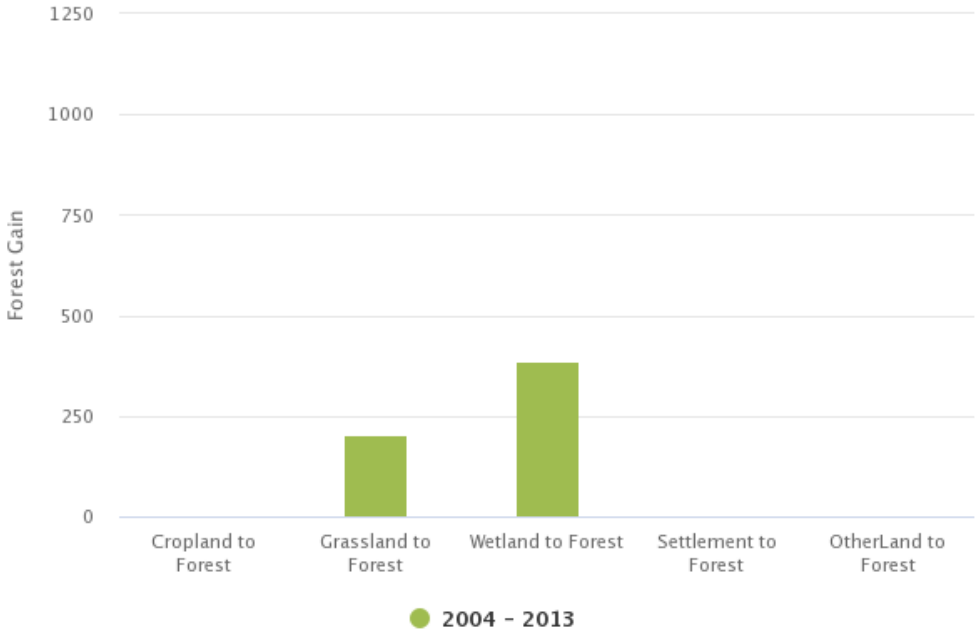


Figure 4. Gain of forest from other land use types between 2004 and 2013 (ha)



Forest Disturbances

Over the inventory period 2004 to 2013, forest disturbance from insects was the most significant in Ulster County, affecting 14058.4 hectares (34,739 acres), followed by harvests, which affected 534 hectares (1,320 acres) and fires, which affected 367.1 hectares (907 acres).

Trees Outside Forests

Figure 5 shows tree canopy captured by the NLCD tree canopy data. (Note that some areas with high tree canopy in Figure 5 overlap with the NLCD forest class shown in Figure 2.)

This data are available only for the years 2011 and 2016. Over this time period, Ulster County had an average of 13,125 hectares (32,432 acres) of tree canopy outside forests. Between 2011 and 2016, 27 hectares per year of tree canopy were lost, for a total of 134 hectares (330 acres) of tree canopy loss over the 5 year period. Most of this loss occurred within the Grassland class.

Figure 5. Tree canopy 2016 (Source: National Land Cover Database)

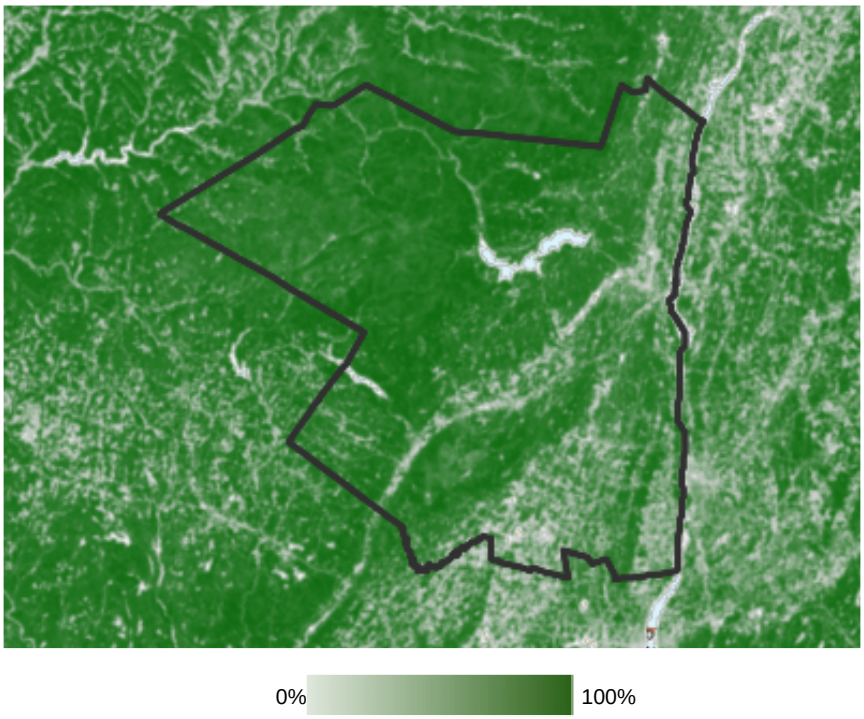


Figure 6: Average tree canopy (in hectares) and % tree canopy in different non-forest land use categories in Ulster County for the period 2011-2016. Note: bars relate to tree canopy area (left vertical-axis, hectares) and dots are the % tree cover per land use category (right vertical-axis). "Other" category not shown due to very low area.

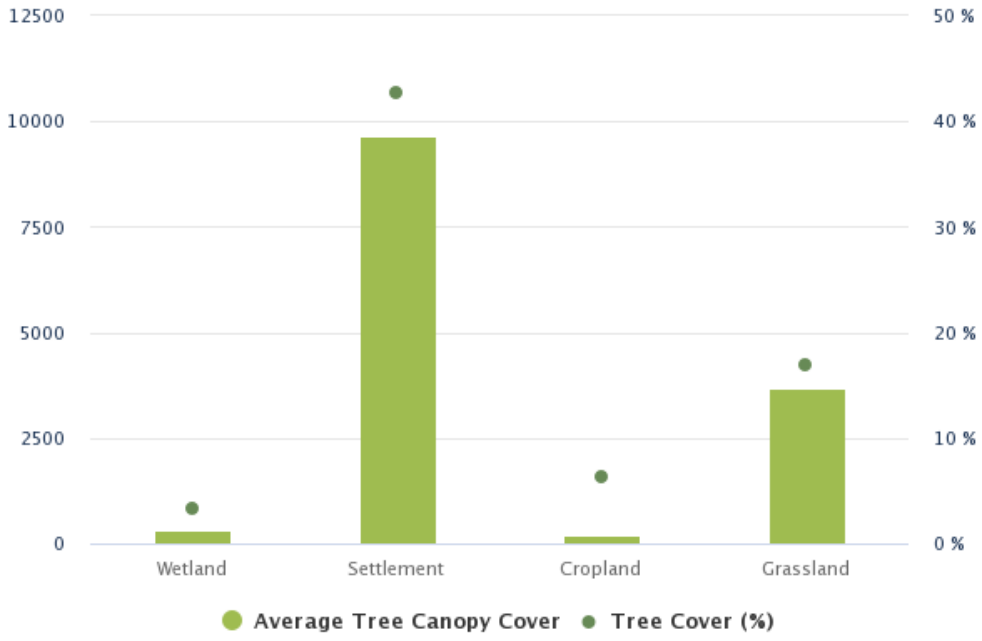
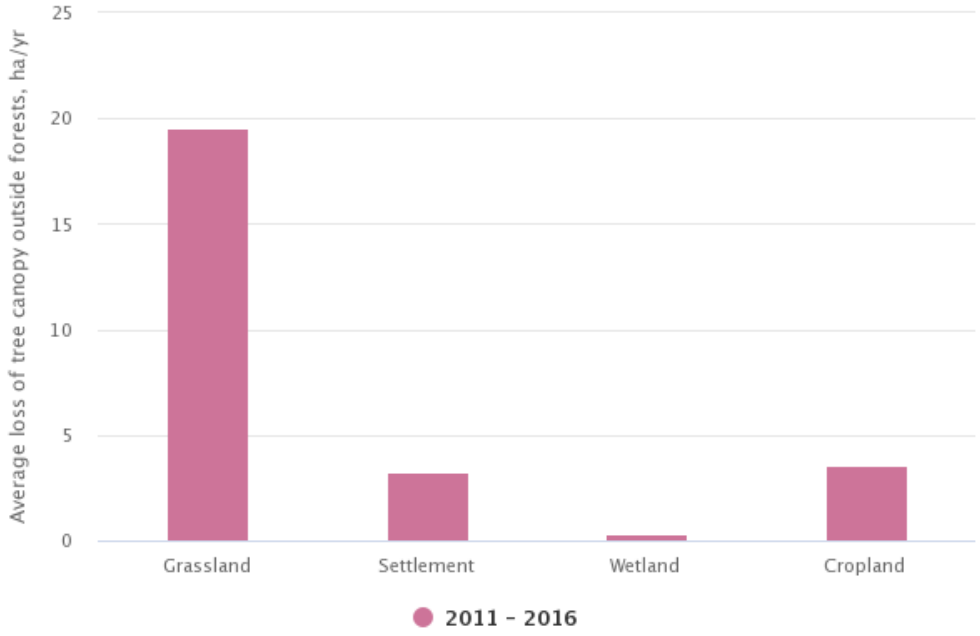


Figure 7: Average area of tree canopy loss in different non-forest land use categories in Ulster County over the period 2011 to 2016 (hectares per year). Note: other category not shown due to very low area.



Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2004 to 2013. All areas are in hectares.

2013: Top 2004: Left	Deciduous Forest	Evergreen Forest	Mixed Forest	Woody Wetlands	Cultivated Crops	Pasture/Hay	Grassland/Herbaceous	Shrub/Scrub	Open Water	Emergent Herbaceous Wetlands	Developed, Open Space	Developed, Low Intensity	Developed, Medium Intensity	Developed, High Intensity	Barren Land	Perennial Ice/Snow	Total
Deciduous Forest	148,906	12	56	5	1	87	425	390	4	8	151	83	50	12	2	0	150,189
Evergreen Forest	3	11,860	4	0.3	0	2	53	5	4	0.2	4	5	4	0.8	0.2	0	11,944
Mixed Forest	19	15	63,171	1	0.3	5	94	50	4	0.5	11	8	4	2	0	0	63,385
Woody Wetlands	3	0	0	18,377	0	19	0.5	0.4	49	283	22	10	6	1	0.3	0	18,771
Cultivated Crops	0	0	0	0.2	2,758	18	0	0	0.3	1	7	9	9	4	1	0	2,808
Pasture/Hay	65	1	9	10	73	19,377	12	57	2	16	140	116	62	10	2	0	19,950
Grassland/Herbaceous	51	3	6	1	3	13	688	37	3	2	17	23	15	4	4	0	871
Shrub/Scrub	49	0.8	8	0.2	0	6	16	162	0.4	1	2	4	2	0.1	0	0	253
Open Water	8	5	7	77	0	0.4	23	0.3	8,518	97	8	3	2	0.4	10	0	8,758
Emergent Herbaceous Wetlands	8	0.2	2	280	2	72	1	0.3	28	604	2	2	2	0.5	0.2	0	1,002
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	15,074	24	83	7	0	0	15,188
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	4,476	35	25	0	0	4,537
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	1,463	4	0	0	1,467
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	566	0	0	566
Barren Land	3	0	0	0	0.9	3	1	0	10	0.3	8	13	22	6	839	0	908
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**149,115**	**11,897**	**63,261**	**18,750**	**2,839**	**19,601**	**1,314**	**702**	**8,623**	**1,012**	**15,446**	**4,775**	**1,760**	**642**	**858**	**0**	**0**

Table 3. Simplified land cover change matrix for 2004 to 2013.All areas are in hectares.

2013: Top 2004: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
rest Land	242,431	1	1,129	352	372	2	**244,288**
opland	0.2	2,758	18	1	29	1	**2,808**
assland	203	76	20,370	24	395	6	**21,073**
etland	386	2	96	9,247	19	10	**9,760**
ttlement	0	0	0	0	21,757	0	**21,757**
ther Land	3	0.9	5	11	50	839	**908**
otal	**243,023**	**2,839**	**21,617**	**9,635**	**22,622**	**858**	**0**

Emission and Removal Factors

A summary of the emission and removal factors used in the calculations is provided in Table 4.

	Emission Factor (t C/ha)	Removal Factor (t C/ha/yr)
Forest Change		
Deforestation		
To Cropland	39.31	
To Grassland	51.54	
To Settlement	54.13	
To Wetland	57.01	
To Other	76.42	
Reforestation (Non-Forest to Forest)		-1.88
Forest Remaining Forest		
Undisturbed		-1.74
Disturbed		
Fire	28.35	
Insect/Disease	6.88	
Harvest/Other	73.17	
Trees Outside Forest		
Tree canopy loss	94.80	
Canopy maintained/gained		-2.63

Harvested Wood Products

Harvested wood products (HWP) temporarily store carbon from the forest ecosystem as the wood goes through a series of production processes and end-uses, with eventual disposal (and emission to the atmosphere). The delay represents a net benefit to the atmosphere. The period of storage varies from long-lived solid wood products that remain in use for long periods of time to products that are quickly disposed of in landfills.

In the web tool, the HWP Calculator tracks carbon in harvested wood through four different “fates,” from harvest to timber products to primary wood products to end-use to disposal, applying best estimates for product ratios and half-lives at each stage. Based on user inputs entered about annual harvest volumes in Ulster County, the change in the harvested wood pool over the inventory period 2004 to 2013 is estimated as 0 t CO2e per year.

Caveats

Information presented here represents a snapshot in time of the net GHG balance and many of the factors contributing to that balance. The estimates can help identify where policies may be designed to reduce net GHG emissions. This inventory currently uses a simplifying assumption that a loss of forest or trees results in immediate emissions to the atmosphere (rather than delayed emissions in the case of various use cases from long-term storage to shorter decay timelines if sent to landfills). In general, it is important to consider that these estimates represent a relatively short period of time compared with the long-term consequences of policy decisions and land management actions. For example, a forest converted to settlement represents a permanent loss of removal capacity. Over the long term, maintaining forests will sustain a higher rate of carbon removal, depending on age-related growth rates and occurrence of disturbances.

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

Finally, it is recommended that additional analyses be done using models that project impacts of alternatives over coming decades. Such models are available and have been used in other studies at county scale. The GHG inventory presented here is only the first step to providing science-based information to support policy decisions. To more fully explore the potential impacts of alternate policies, projection models can be used to compare long-term results among the alternatives which typically include a “business as usual” (i.e. no change in policy) alternative. This feature may be added into the web tool in the future.