

Summary Report

GHG Inventory for Forests and Trees Outside Forests, 2006 to 2011 Prince William County, Virginia

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. Prince William County, Virginia 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 2006 to 2011, emissions from forests and trees were 59,290 t CO₂e per year.
- Over the period 2006 to 2011, the Net GHG balance of forests and trees was -261,225 t CO₂e per year.
- Roughly 49% of Prince William County's total land base of 88,824 hectares (219,489 acres) is forest. Many areas outside of forests are also covered by trees, including an average of nearly 0 percent tree canopy on lands outside of forest areas
- Over the same period, annual CO₂ removals from forests and trees were -320,515 t CO₂e per year. (Carbon removals are represented by negative values.)
- Total GHG emissions for Prince William 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. Prince William county's GHG fluxes from forests and trees for inventory period 2006 – 2011, all values reported in t CO₂e per year

	Removals(t CO ₂ e/yr)	Emissions(t CO ₂ e/yr)
Undisturbed Forest	-317,532	
Forest Disturbances		14,109
Non-Forest to Forest	-2,983	
Forest to Settlement		27,834
Forest to Grassland		11,971
Forest to other non-forest lands		5,375
Trees outside of forests		
Harvested Wood Products	0	
TOTAL	-320,515	59,290
Net GHG balance	-261,225	

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). Prince William County’s total land base is approximately 88,824 hectares (219,489 acres), with nearly 31.5% Settlement (i.e. developed areas of varying intensity), around 48.9% forest, 14.7% Grassland (which includes hay/pasture, shrub/scrub and other herbaceous cover), 2.2% cropland, 2.3% wetland and 0.3% other land.

Figure 1. Land cover in Prince William from the National Land Cover Database, 2011

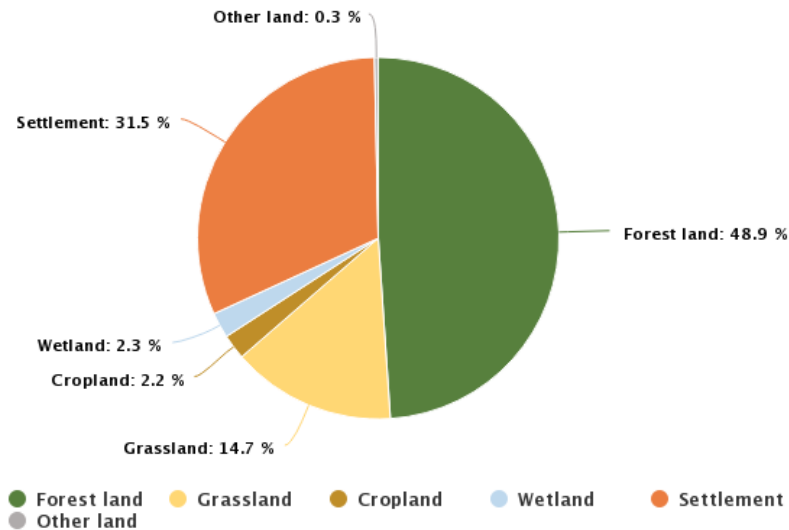
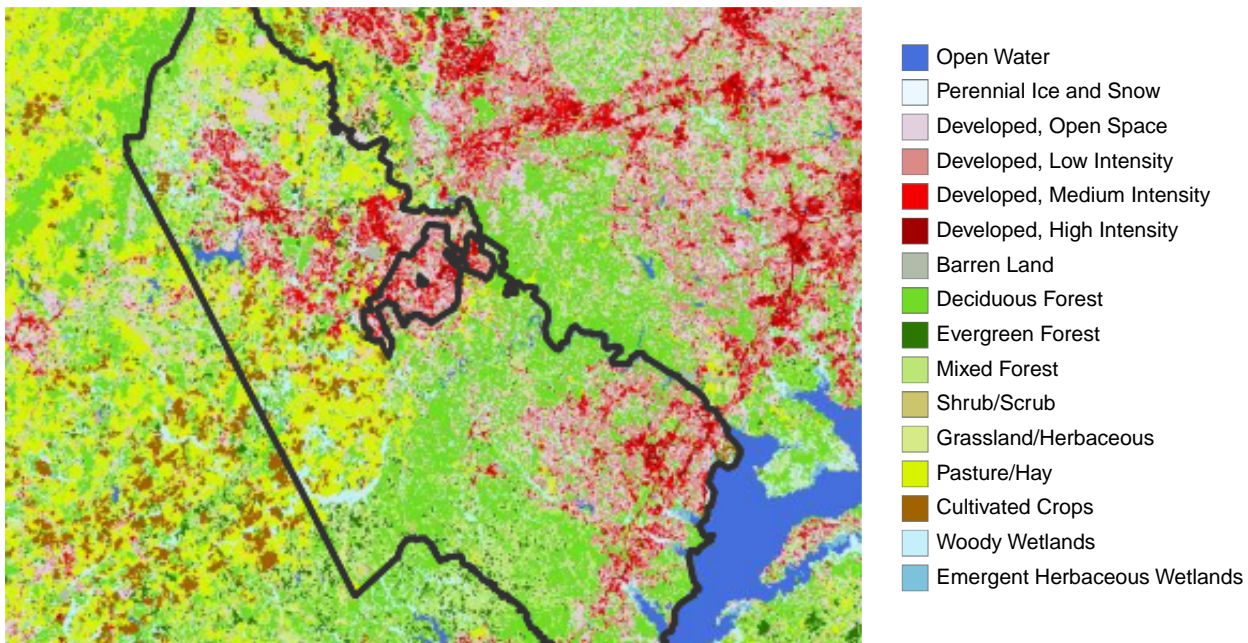
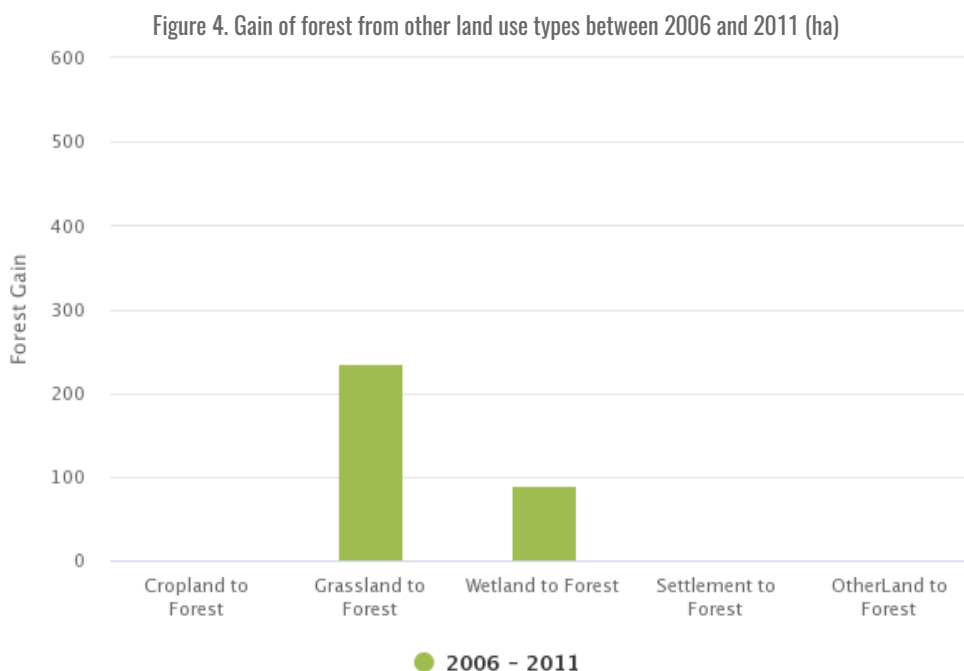
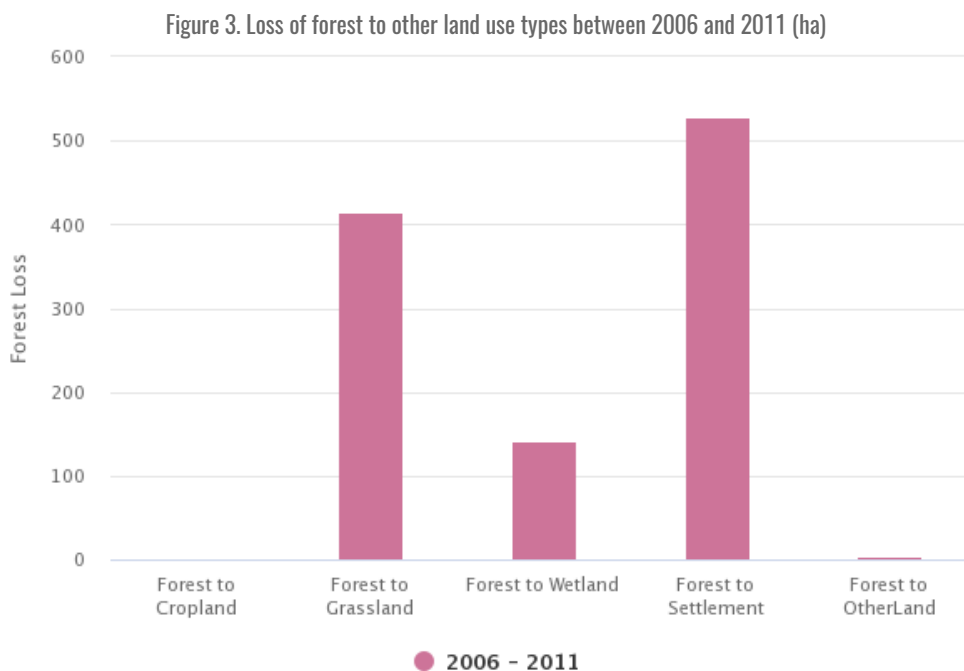


Figure 2. Land cover in Prince William from the National Land Cover Database, 2011



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 2006 and 2011, the county lost around 1,088 hectares (2,688 acres) of forest land, largely conversion to Settlement. Over the same period, the county gained around 329 hectares (813 acres) of forest land, largely from Grassland.



Forest Disturbances

Over the inventory period 2006 to 2011, forest disturbance from harvests/other disturbance was the most significant in Prince William County, affecting 315.1 hectares (779 acres), followed by fires, which affected 0 hectares (0 acres) and insects, which affected 0 hectares (0 acres).

Land Cover Change Matrix

Table 2. Full NLCD land cover change matrix for 2006 to 2011. All areas are in hectares.

2011: Top 2006: 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	23,376	0.2	2	0.7	0.9	9	230	47	12	2	189	131	77	19	3	0	24,099
Evergreen Forest	2	2,062	2	0.1	0.2	0.3	72	22	3	0	12	13	16	4	0	0	2,207
Mixed Forest	2	1	12,268	0	0.2	2	19	12	2	0	11	6	2	0.5	0.2	0	12,327
Woody Wetlands	0	0	0	5,417	0	0	0	0.5	16	106	19	13	11	5	0.1	0	5,587
Cultivated Crops	0	0	0	0	1,825	0.2	0.5	0	0.2	0	14	16	9	1	0.4	0	1,865
Pasture/Hay	8	4	6	0	153	11,374	4	66	2	0.7	77	75	36	13	0.3	0	11,818
Grassland/Herbaceous	39	4	7	0	4	6	455	169	3	0.3	138	141	94	16	2	0	1,077
Shrub/Scrub	90	31	48	0.1	0.1	12	37	518	1	0	17	15	8	4	0.2	0	781
Open Water	10	1	1	7	0	0.1	2	0.2	1,420	16	2	1	1	0.6	1	0	1,464
Emergent Herbaceous Wetlands	0.2	0	0	71	0	0.1	0.2	0.1	27	418	8	13	3	1	0.2	0	542
Developed, Open Space	0	0	0	0	0	0	0	0	0	0	12,796	43	151	45	0	0	13,034
Developed, Low Intensity	0	0	0	0	0	0	0	0	0	0	0	8,269	47	38	0	0	8,355
Developed, Medium Intensity	0	0	0	0	0	0	0	0	0	0	0	0	4,393	4	0	0	4,397
Developed, High Intensity	0	0	0	0	0	0	0	0	0	0	0	0	0	966	0	0	966
Barren Land	2	0.5	0	0.2	0.1	0.1	0.4	0.4	1	0.8	1	5	10	2	282	0	306
Perennial Ice/Snow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	23,528	2,104	12,334	5,496	1,983	11,403	820	835	1,488	544	13,282	8,741	4,858	1,119	290	0	0

Table 3. Simplified land cover change matrix for 2006 to 2011. All areas are in hectares.

2011: Top 2006: Left	Forest Land	Cropland	Grassland	Wetland	Settlement	Other Land	Total
Forest Land	43,132	1	414	141	528	3	44,220
Cropland	0	1,825	0.7	0.2	40	0.4	1,865
Grassland	236	157	12,640	7	633	3	13,676
Wetland	90	0	3	1,881	30	1	2,005
Settlement	0	0	0	0	26,752	0	26,752
Other Land	3	0.1	0.9	2	18	282	306
Total	43,461	1,983	13,058	2,031	28,000	290	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	87.04	
To Grassland	39.42	
To Settlement	71.80	
To Wetland	49.62	
To Other	65.13	
Reforestation (Non-Forest to Forest)		
		-2.47
Forest Remaining Forest		
Undisturbed		
		-2.02
Disturbed		
Fire	0	
Insect/Disease		
Harvest/Other	61.01	
Trees Outside Forest		
Tree canopy loss		
Canopy maintained/gained		

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 Prince William County, the change in the harvested wood pool over the inventory period 2006 to 2011 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 $\pm 45\%$ (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.