Coupling Advanced Forest Carbon Science with University Climate Action Planning

Lamb Rachel[1], Hurtt George[1], Albee Madeleine[1], Auger Rieley[1], Hoffman Delett Camille[1], Nicolette Jordan[1], and Sandborn Hilary[1]

[1]University of Maryland, College Park

November 16, 2022

Abstract

In support of the American College & University Presidents' Climate Leadership Commitments, the University of Maryland College Park (UMD) has established a goal to become climate neutral by 2050. While much progress has been made to lower the University's carbon footprint across multiple emissions sectors, tree conservation or restoration has traditionally been excluded due to concerns about the reliability and consistency of the science. For the past several years, faculty and students in UMD's Department of Geographical Sciences have been working with state governments across the region to inform climate action planning with advanced forest carbon science. However, with student support and leadership, we identified an opportunity to retool this same science to help UMD "walk the walk" and advance our own forest climate goals in parallel with Maryland and other U.S. Climate Alliance states. By partnering with the Office of Sustainability and other land management entities, we have been able to directly inform the campus climate action plan with robust forest carbon estimates as well as influence and support the carbon budgeting process of all universities that have pledged support for the "Carbon Commitment." Unlike state governments, the university's approach to sustainability broadly follows that of a corporation, requiring enhanced collaboration to ensure the science is provided in user-relevant formats while remaining consistent with science approaches utilized by state partners. Our experience during the first year of this project underscores the value of building out scientific approaches that meet specific stakeholder needs while remaining poised to adapt these tools in support of new partnerships and collaborations.

Coupling Advanced Forest Carbon Science with University Climate Action Planning

Rachel Lamb, George Hurtt, Madeleine Albee, Rieley Auger, Camille Hoffman Delett, Jordan Nicolette, Hilary Sandborn

Department of Geographical Sciences, University of Maryland, College Park

sustainableumd

PRESENTED AT:

AGU FALL MEETING
Online Everywhere | 1–17 December 2020

MOTIVATION

The Campus Forest Carbon Project is working to advance the University of Maryland's (UMD) climate mitigation goals by monitoring changes in forest carbon on university-owned and managed property to provide decision-relevant data about UMD's land use.

As a signatory to the American College & University Presidents' Climate Commitment, UMD has a Climate Action Plan which charts its path to carbon neutrality by 2050 (**Fig 1**).

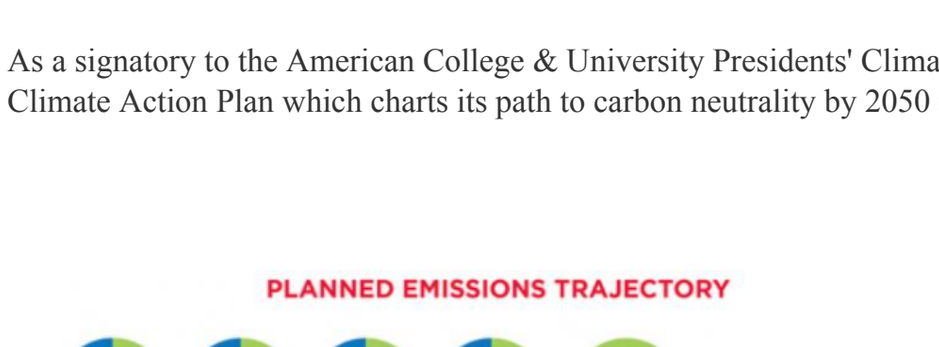


Fig. 1 University of Maryland goal to become carbon neutral by 2050 utilizing a range of carbon reduction strategies. Currently, these strategies do not include land-use.

Our project is supported by the UMD Sustainability Fund (**Fig 2**), which is fully funded by undergraduate student fees. Consequently, this project is managed by a graduate student and faculty mentor but carried out by undergraduate researchers.

- Students have the opportunity to engage in research in a project where the results lead to beneficial outcomes for the campus community and other participants.
- Undergraduates also play a leading role in shaping the management of their own campus.

UNIVERSITY OF MARYLAND sustainability fund

Fig. 2 The Sustainability Fund is funded by UMD students.

Vital to the project's success, we are working closely with many campus stakeholders to ensure our methods and results are congruent with their objectives. Such entities include:

- Office of Sustainability
- Campus Arboretum and Botanical Gardens
- Facilities Management
- Department of Agriculture and Natural Resources
- Department of Geographical Sciences

Externally, we are also collaborating with other universities to improve their carbon budgeting process as part of the Presidents' Climate Commitment.

PROJECT GOALS

Throughout our project, we are developing methods and contextualizing our results to achieve the goals of our campus partners.

Utilizing high-resolution forest carbon data and tools from NASA Carbon Monitoring System (CMS), we proposed to accomplish four goals from 2020-2022:

1. Complete historical analysis of annual forest carbon change from 2011-2018 of UMD owned property (**Fig 3**).

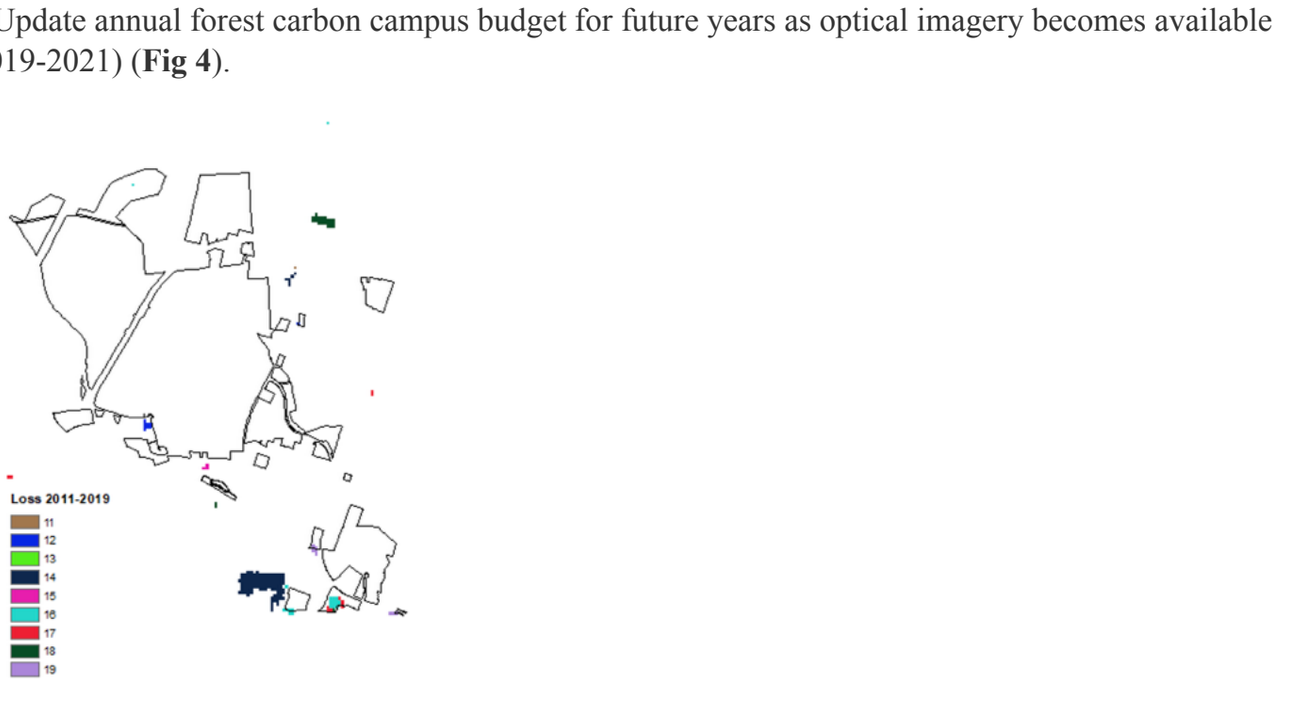


Fig. 3 Above ground biomass (kg/m²) of main campus (left) and one of nine AGNR properties (right)

2. Update annual forest carbon campus budget for future years as optical imagery becomes available (2019-2021) (**Fig 4**).

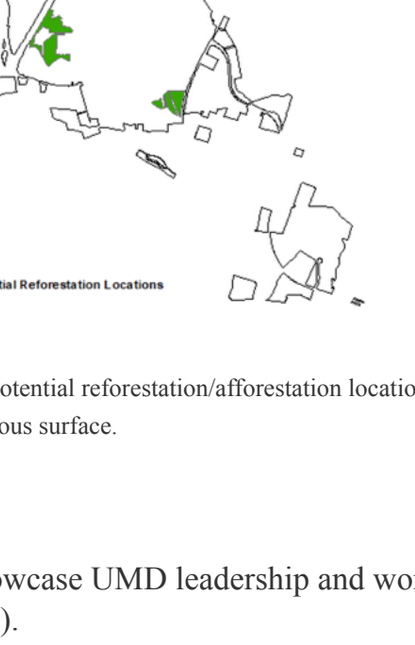


Fig. 4 Observed areas of loss updated annually from Global Forest Watch data (Hansen et al. 2012).

3. Quantify and make transparent the carbon impact of planned campus development activity, and identify strategic areas for reforestation (**Fig 5**).

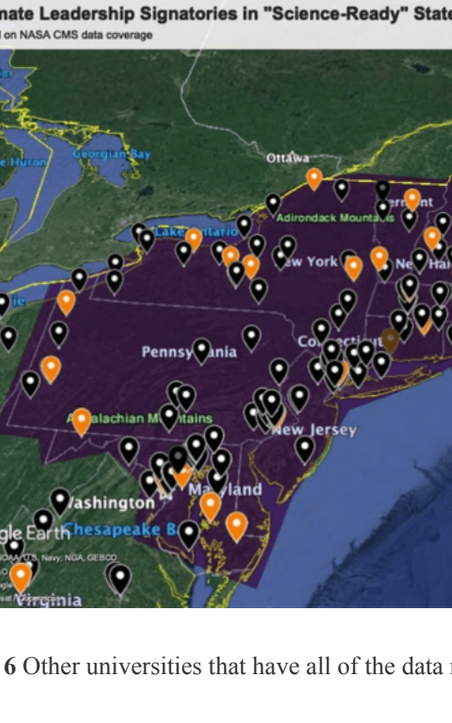


Fig. 5 Potential reforestation/afforestation location on UMD's main campus based on high carbon sequestration potential and low impervious surface.

4. Showcase UMD leadership and work to replicate analysis across members of the Climate Commitment (**Fig 6**).

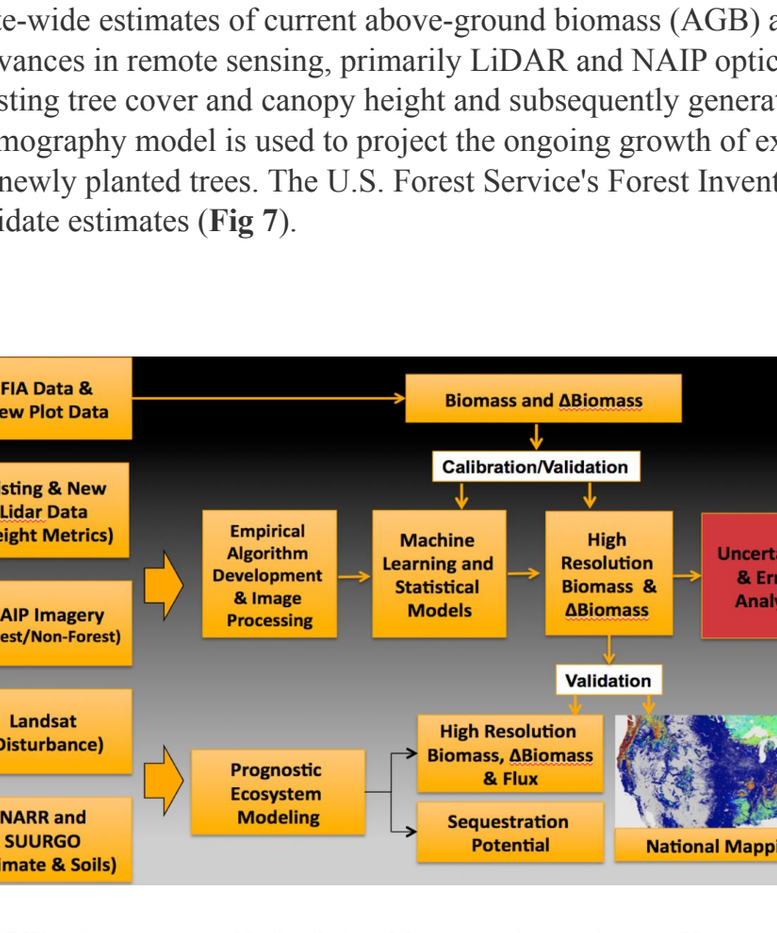


Fig. 6 Other universities that have all of the data necessary to adopt our methods.

SCIENCE METHODS AND RESULTS

This project seeks to harness the power of the current NASA Carbon Monitoring System (CMS) products already being used at the state and regional level. NASA products provide high resolution (90-meter) state-wide estimates of current above-ground biomass (AGB) and carbon sequestration potential (CSP). Advances in remote sensing, primarily LiDAR and NAIP optical imagery data are used to measure existing tree cover and canopy height and subsequently generate contemporary AGB. The Ecosystem Demography model is used to project the ongoing growth of existing trees as well as the carbon provided by newly planted trees. The U.S. Forest Service's Forest Inventory Analysis field plot data is used to validate estimates (**Fig 7**).

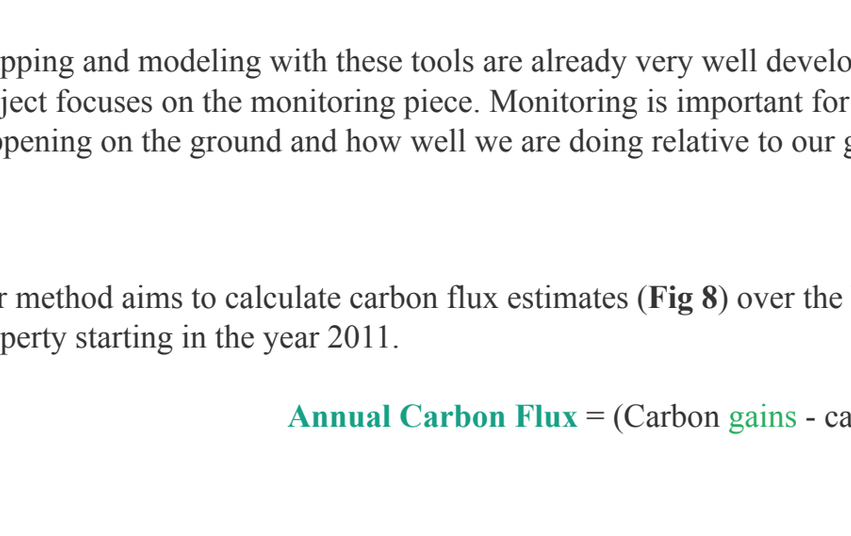


Fig. 7 Workflow of current NASA Carbon Monitoring System Science (Hurtt et al. 2019, Ma et al. 2020)

There are several uses for this kind of NASA CMS model and system (see the large image in poster to the right):

1. Mapping to establish a carbon baseline
2. Modeling to facilitate mitigation planning
3. Monitoring to provide assessment

Mapping and modeling with these tools are already very well developed applications. This specific project focuses on the monitoring piece. Monitoring is important for understanding what is actually happening on the ground and how well we are doing relative to our goals.

Our method aims to calculate carbon flux estimates (**Fig 8**) over the University of Maryland (UMD) property starting in the year 2011.

Annual Carbon Flux = (Carbon gains - carbon losses)

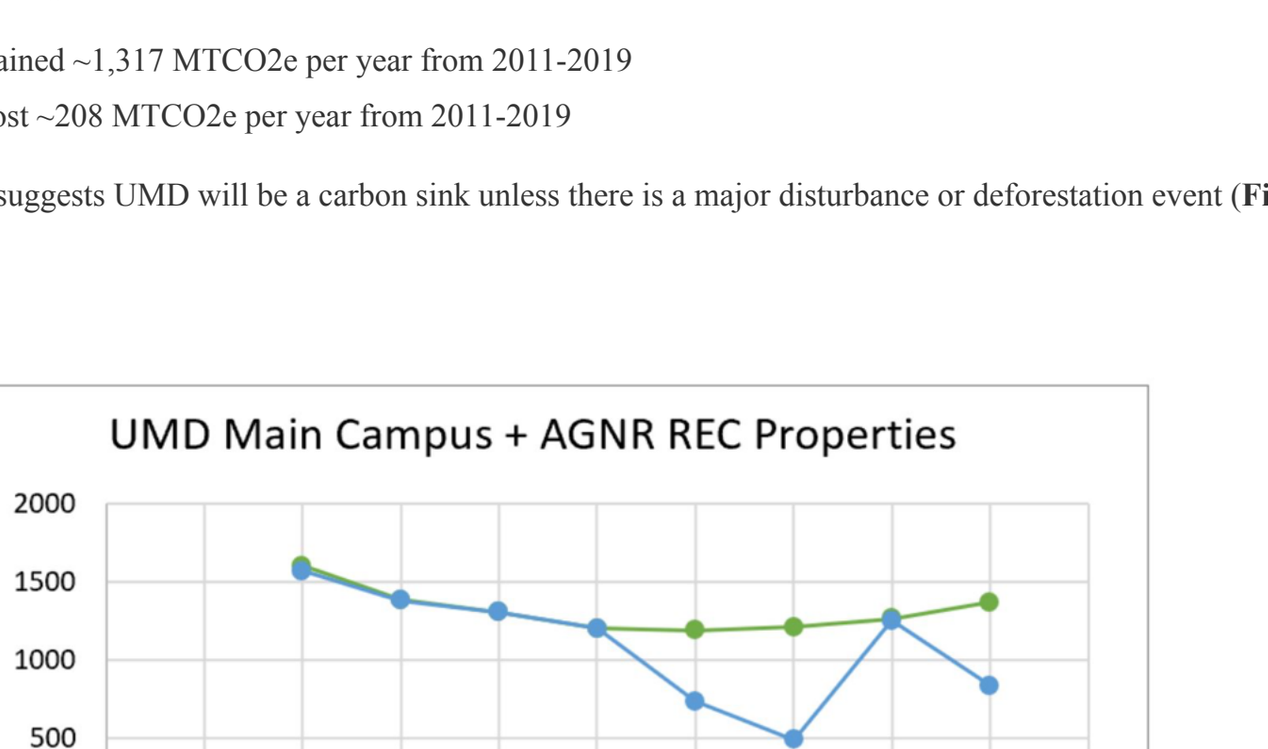


Fig. 8 Visualizations of carbon gain and loss data used in the methodology.

On average UMD:

- Gained ~1,317 MTCO2e per year from 2011-2019
- Lost ~208 MTCO2e per year from 2011-2019

This suggests UMD will be a carbon sink unless there is a major disturbance or deforestation event (**Fig 9**).

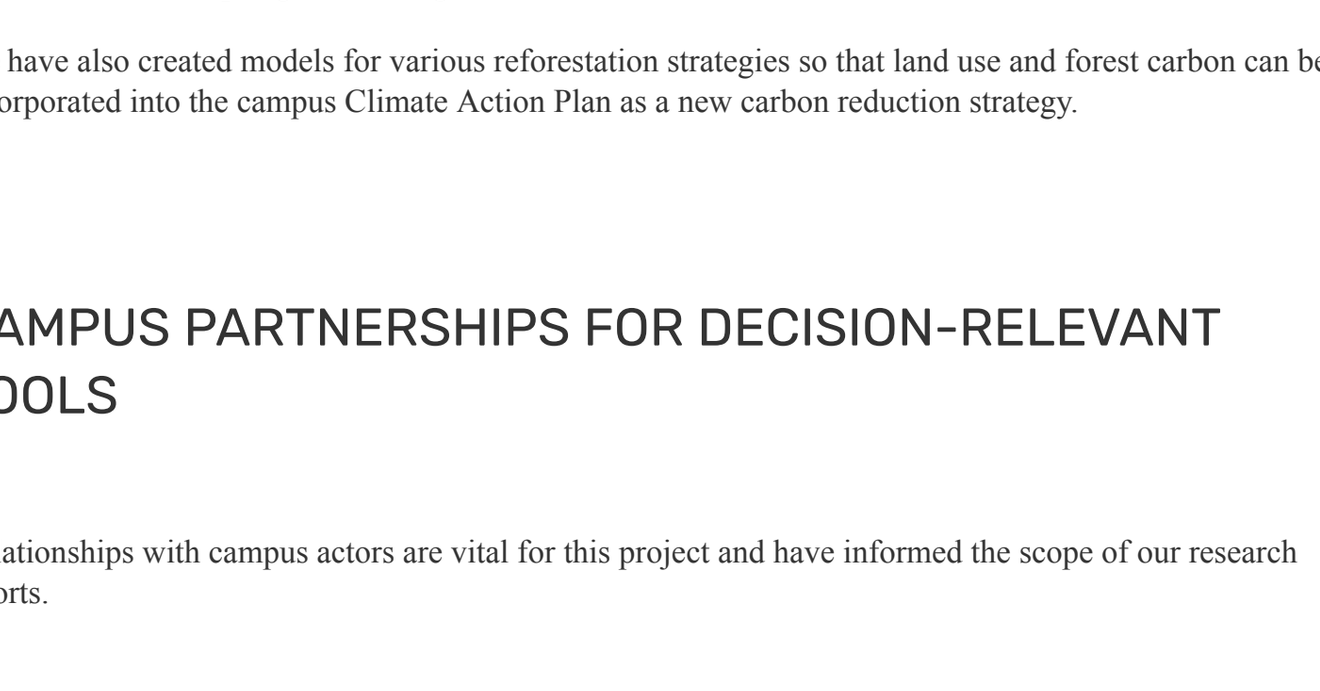


Fig. 9 Results for carbon gain, loss, and flux over UMD Main Campus and associated agricultural properties.

Our monitoring framework is designed to become incorporated into the greenhouse gas inventory, where forest gains would show negative values, and forest losses would show positive values, providing a more holistic view of campus greenhouse gas emissions.

We have also created models for various reforestation strategies so that land use and forest carbon can be incorporated into the campus Climate Action Plan as a new carbon reduction strategy.

CAMPUS PARTNERSHIPS FOR DECISION-RELEVANT TOOLS

Relationships with campus actors are vital for this project and have informed the scope of our research efforts.

Support from Sustainability Council

The University Sustainability Council exists to advise the President, the Office of Sustainability, and the campus community about issues related to the integration of sustainability into campus operations. The Sustainability Council determines the annual recipients of the Sustainability Grant and approves changes to the campus climate plan. Presenting our findings to the council has been important for securing buy-in and for demonstrating progress. We have been funded for the first of three project years, and we hope to be renewed for the next calendar year.

Collaboration with the Office of Sustainability

The Office of Sustainability (OS) supports the implementation of campus climate initiatives. Our collaboration with the OS has improved our understanding of campus planning and budging processes. As a result, we have shaped our research products to facilitate smooth integration within the campus budget and third version of the campus climate action plan. Currently, the budget and plan do not include emissions associated with land-use changes (**Fig 10**), and that is where our project will fill the gap.

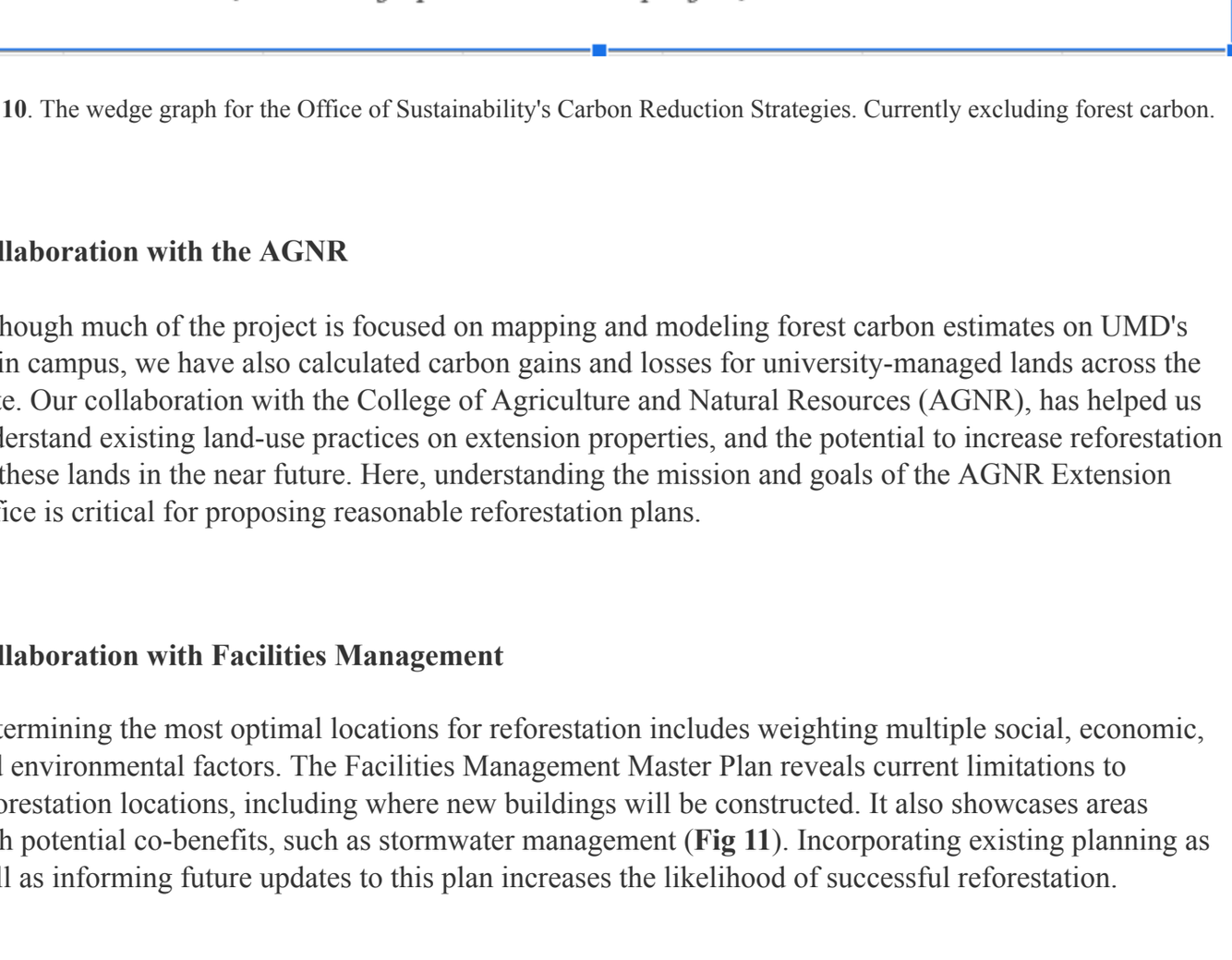


Fig 10. The wedge graph for the Office of Sustainability's Carbon Reduction Strategies. Currently excluding forest carbon.

Collaboration with the AGNR

Although much of the project is focused on mapping and modeling forest carbon estimates on UMD's main campus, we have also calculated carbon gains and losses for university-managed lands across the state. Our collaboration with the College of Agriculture and Natural Resources (AGNR), has helped us understand existing land-use practices on extension properties, and the potential to increase reforestation on these lands in the near future. Here, understanding the mission and goals of the AGNR Extension Office is critical for proposing reasonable reforestation plans.

Collaboration with Facilities Management

Determining the most optimal locations for reforestation includes weighting multiple social, economic, and environmental factors. The Facilities Management Master Plan reveals current limitations to reforestation locations, including where new buildings will be constructed. It also showcases areas with potential co-benefits, such as stormwater management (**Fig 11**). Incorporating existing planning as well as informing future updates to this plan increases the likelihood of successful reforestation.

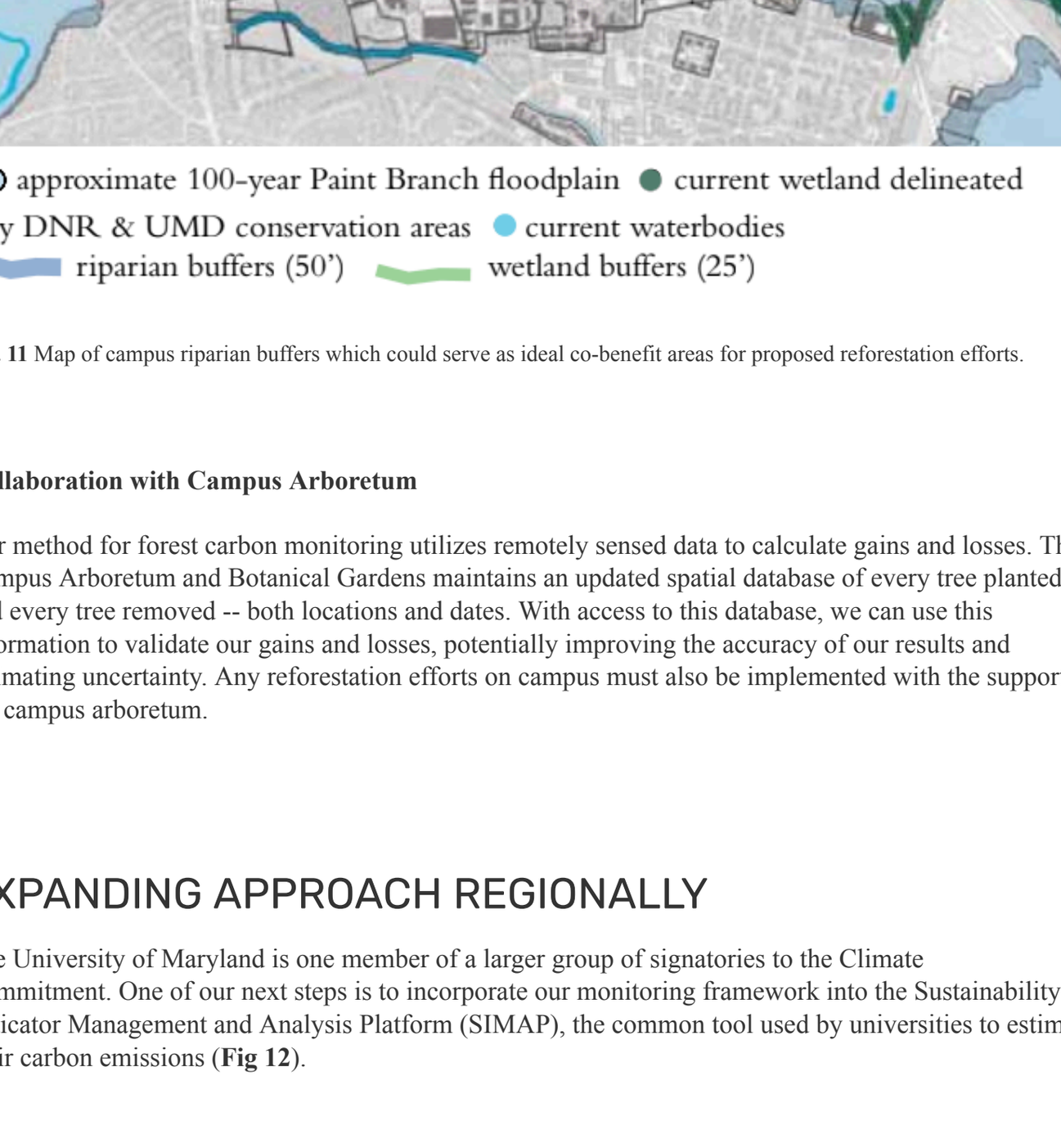


Fig. 11 Map of campus riparian buffers which could serve as ideal co-benefit areas for proposed reforestation efforts.

Collaboration with Campus Arboretum

Our method for forest carbon monitoring utilizes remotely sensed data to calculate gains and losses. The Campus Arboretum and Botanical Gardens maintains an updated spatial database of every tree planted and every tree removed -- both locations and dates. With access to this database, we can use this information to validate our gains and losses, potentially improving the accuracy of our results and estimating uncertainty. Any reforestation efforts on campus must also be implemented with the support of the campus arboretum.

EXPANDING APPROACH REGIONALLY

The University of Maryland is one member of a larger group of signatories to the Climate Commitment. One of our next steps is to incorporate our monitoring framework into the Sustainability Indicator Management and Analysis Platform (SIMAP), the common tool used by universities to estimate their carbon emissions (**Fig 12**).

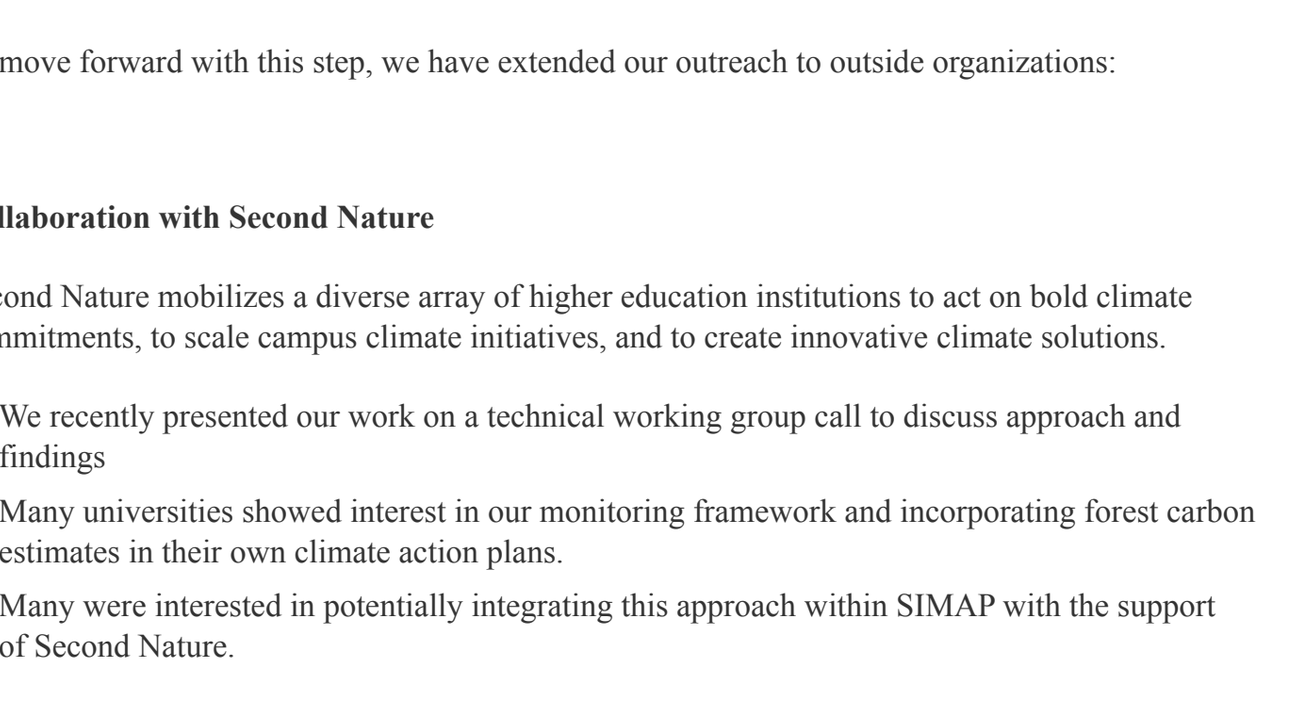


Fig. 12 The SIMAP carbon calculator currently includes space for recording "non-additional" carbon sequestration estimates but does not provide universities with the option of recording carbon emissions related to land-use change.

To move forward with this step, we have extended our outreach to outside organizations:

Collaboration with Second Nature

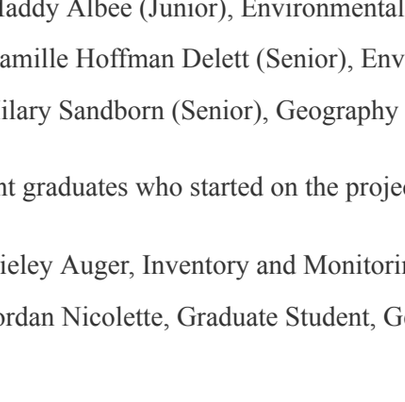
Second Nature mobilizes a diverse array of higher education institutions to act on bold climate commitments, to scale campus climate initiatives, and to create innovative climate solutions.

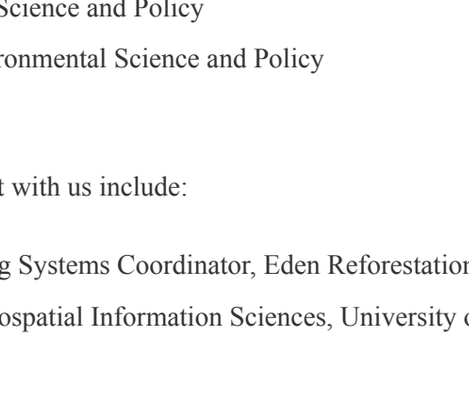
- We recently presented our work on a technical working group call to discuss approach and findings
- Many universities showed interest in our monitoring framework and incorporating forest carbon estimates in their own climate action plans.
- Many were interested in potentially integrating this approach within SIMAP with the support of Second Nature.

Collaboration with other University Signatories

University signatories to the Climate Commitments vary considerably in size, location, and access to existing data on forest carbon.

- A science challenge here would be the geographic extent of existing data. Currently, the LiDAR data does not extend wall-to-wall across all states, and implementation will need to follow a tiered approach based on data sophistication.
- Several universities have already shown interest in a peer-to-peer effort to have undergraduates train other undergraduates in how to apply our modeling and monitoring methods.


***Mapping** to Establish Baseline*


***Modeling** to Facilitate Planning*

***Monitoring** to Provide Assessment*

AUTHOR INFORMATION

Rachel L. Lamb is a PhD Candidate in the Department of Geographical Sciences at the University of Maryland, College Park (UMD). Her current work focuses on the socioeconomic applications of NASA Carbon Monitoring System science products to advance climate-smart land use with benefits for biodiversity. Rachel also earned Master's degrees in Public Policy, and in Sustainable Development and Conservation Biology from UMD, as well as a BS in Environmental Studies and BA in International Relations from Wheaton College (IL). A full bio can be found here: https://geog.umd.edu/gradprofile/lamb/rachel

Follow Rachel on twitter @Rachel_L_Lamb

Rachel currently leads this project with Dr. George Hurtt, Professor and Research Director for the Department of Geographical Sciences at the University of Maryland, College Park.

Audio has been provided by three undergraduate students currently working on the project, including:

- Maddy Albee (Junior), Environmental Science and Policy
- Camille Hoffman Delett (Senior), Environmental Science and Policy
- Hilary Sandborn (Senior), Geography

Recent graduates who started on the project with us include:

- Rieley Auger, Inventory and Monitoring Systems Coordinator, Eden Reforestation Projects
- Jordan Nicolette, Graduate Student, Geospatial Information Sciences, University of Maryland

ABSTRACT

In support of the American College & University Presidents' Climate Leadership Commitments, the University of Maryland College Park (UMD) has established a goal to become climate neutral by 2050. While much progress has been made to lower the University's carbon footprint across multiple emissions sectors, tree conservation or restoration has traditionally been excluded due to concerns about the reliability and consistency of the science. For the past several years, faculty and students in UMD's Department of Geographical Sciences have been working with state governments across the region to inform climate action planning with advanced forest carbon science. However, with student support and leadership, we identified an opportunity to retool this same science to help UMD "walk the walk" and advance our own forest climate goals in parallel with Maryland and other U.S. Climate Alliance states. By partnering with the Office of Sustainability and other land management entities, we have been able to directly inform the campus climate action plan with robust forest carbon estimates as well as influence and support the carbon budgeting process of all universities that have pledged support for the "Carbon Commitment." Unlike state governments, the university's approach to sustainability broadly follows that of a corporation, requiring enhanced collaboration to ensure the science is provided in user-relevant formats while remaining consistent with science approaches utilized by state partners. Our experience during the first year this project underscores the value of building out scientific approaches that meet specific stakeholder needs, while remaining poised to adapt these tools in support of new partnerships and collaborations.