



## Oklahoma and Texas Agriculture

*Mapping Grassland Productivity on South Central Oklahoma and North Texas Ranch Lands to Evaluate Management and Quantify Soil Carbon Fluxes*

### Project Team

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#### **Project Team:**

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### Project Overview

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#### **Project Synopsis:**

This project aimed to assess the variability of four net primary productivity models over 20 ranches in southern Oklahoma and northern Texas at temporal and spatial scales, while also evaluating Rangeland Analysis Platform biomass data to field measurements. This study advances our understanding of rangeland ecosystem productivity applications within Oklahoma and Texas and informs the public about the potential of using remote sensing for evaluating rangeland health.

#### **Abstract:**

Remote sensing offers valuable insights into the impacts of rangeland management practices and the enhancements of soil biogeochemical models. This collaborative project partners with the Noble Research Institute, US Department of Agriculture Agricultural Research Service, and Colorado State University to understand the intricate relationship between pasture and rangeland management decisions and ecosystem health. We conducted a comprehensive evaluation of the MOD17, Rangeland Analysis Platform (RAP), Robinson Landsat, and Robinson MODIS net primary production (NPP) models derived from NASA Earth observations across 2001 to 2019. This evaluation aimed to assess the variability of the NPP products at numerous spatial and temporal scales for select ranches in southern Oklahoma and northern Texas. We found that MOD17 and Robinson Landsat values were most similar across time and ranches. When we evaluated the NPP models by vegetation types, we found that some vegetations resulted in considerably different values between the NPP models. Furthermore, our team validated the RAP biomass data against field biomass data from Noble Research Institute from 2022 and 2023 to determine its accuracy. We found

the temporal variability in R<sup>2</sup> values between 2022 and 2023 underscores the importance of considering temporal dynamics when assessing the accuracy and reliability of NPP models in rangeland ecosystems. This study advances our understanding of rangeland ecosystem productivity applications within Oklahoma and Texas and informs the public about the potential of using remote sensing for evaluating rangeland health.

***Key Terms:***

MOD17, Robinson Landsat, Robinson MODIS, Net Primary Production, Rangeland Analysis Platform, Rangeland biomass, LANDFIRE

***Application Area:*** Rangeland Management

***Study Location:*** South Oklahoma and North Texas

***Study Period:*** January 2001 to December 2023

***Community Concerns:***

- Our project is addressing the community concerns laid out by the 3M project, which stands for monitoring, management, and metrics. As rangelands have become vulnerable to changing climates and grazing management, research has found an increase in rangeland degradation, which impacts forage growth and ultimately cattle production.

***Project Objectives:***

- Compare existing annual NPP products to each other between 2001 – 2019. This includes by spatial scale and vegetation composition
- Evaluate Rangeland Analysis Platform (RAP) biomass data to field measured biomass clippings for two Noble Research Institute ranches for 2022-2023

**Partner Overview**

***Partner Organization(s):***

Organization	Contact (Name, Position/Title)	Partner Type	Sector
Noble Research Institute	Isabella De Faria Maciel, Regenerative Systems Research Manager	End User	Non-profit
USDA, Agricultural Research Service	Martha Anderson, Research Physical Scientist Feng Gao, Research Physical Scientist Sean Kearney, Spatial Ecologist	End User	Federal Government
Colorado State University	Keith Paustian, Distinguished Professor Yao Zhang, Research Scientist	Collaborator	Academic

***Decision-Making Practices & Policies:***

The Noble Research Institute is an agricultural non-profit that promotes regenerative animal production practices, land stewardship, and producer profitability through research, education, consulting, and management on its 14,000 acres of ranch lands. They currently collaborate with other research institutions to explore remote sensing applications through the “Metrics, Management, and Monitoring: An Investigation of Pasture and Rangeland Soil Health and its Drivers” project, which is a large-scale research project aiming to study the relationship between grazing land management and ecosystem function and assess the impact of rural well-being on management decisions.

The Agricultural Research Service (ARS) is the U.S. Department of Agriculture’s research agency tasked with researching and developing solutions to the nations and globe’s agricultural challenges. Our partners at ARS are developing remote sensing tools to support agriculture. One of their initiatives is focused on improving mapping of rangeland NPP.

## Earth Observations & End Products Overview

### *Earth Observations:*

Platform & Sensor	Parameters	Use
<b>Landsat 5 Thematic Mapper (TM)</b>	Spectral bands and indices for NPP products	This dataset provided the temporal (16 days) and spatial (30 m <sup>2</sup> ) resolution needed for Landsat NPP products.
<b>Landsat 7 Enhanced Thematic Mapper (ETM+)</b>	Spectral bands and indices for NPP products	This dataset provided the temporal (16 days) and spatial (30 m <sup>2</sup> ) resolution needed for Landsat NPP products.
<b>Landsat 8 Observational Land Imager (OLI)</b>	Spectral bands and indices for NPP products	This dataset provided the temporal (16 days) and spatial (30 m <sup>2</sup> ) resolution needed for Landsat NPP products.
<b>Landsat 9 OLI-2</b>	Spectral bands and indices for NPP products	This dataset provided the temporal (16 days) and spatial (30 m <sup>2</sup> ) resolution needed for Landsat NPP products.
<b>Aqua Moderate Resolution Imaging Spectroradiometer (MODIS)</b>	Net Primary Production	MODIS primary production products are compared to other NPP products and to field data at various scales.
<b>Terra MODIS</b>	Net Primary Production	MODIS primary production products are compared to other NPP products and to field data at various scales.

### *Ancillary Datasets:*

- U.S. Forest Service and U.S. Department of Interior – Landscape Fire and Resource Management Planning Tools LANDFIRE – Used Existing Vegetation Type Analyze vegetation distribution
- Noble Research Institute – Field collected biomass – was used to compare accuracy of the RAP biomass dataset
- Noble Research Institute – Ranch boundaries – used to extract NPP values and vegetation types over those areas

### *Models:*

- Rangeland Analysis Platform (RAP) Biomass model (POC: Anthony Vorster [anthonny.vorster@colostate.edu](mailto:anthonny.vorster@colostate.edu), Nicholas Young [nicholas.young@colostate.edu](mailto:nicholas.young@colostate.edu))
- Rangeland Analysis Platform (RAP) NPP model (POC: Anthony Vorster [anthonny.vorster@colostate.edu](mailto:anthonny.vorster@colostate.edu), Nicholas Young [nicholas.young@colostate.edu](mailto:nicholas.young@colostate.edu))
- NPP<sub>M250</sub> (Robinson et al.) (POC: Anthony Vorster [anthonny.vorster@colostate.edu](mailto:anthonny.vorster@colostate.edu), Nicholas Young [nicholas.young@colostate.edu](mailto:nicholas.young@colostate.edu))
- NPP<sub>L30</sub> (Robinson et al.) (POC: Anthony Vorster [anthonny.vorster@colostate.edu](mailto:anthonny.vorster@colostate.edu), Nicholas Young [nicholas.young@colostate.edu](mailto:nicholas.young@colostate.edu))

### *Software & Coding Languages:*

- Google Earth Engine – NPP model derived NPP values and RAP Biomass

- R Studio 2023.03.0+386 – ANOVA, Linear Regression and Correlation Statistical analysis
- Tableau 2023.1 - Analysis of vegetation composition
- Python 3.10.8 - Data wrangling, data visualization

***End Product(s):***

End Product(s)	Earth Observations Used	Partner Benefit & Use
<b>NPP Model Analysis Plots</b>	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Landsat 9 OLI-2, Terra MODIS, Aqua MODIS	Multiple plots showing the Mean NPP data from the models compared at various spatial and temporal scales, against numerous vegetation types, and the RAP model against field data.
<b>NPP Values from Models</b>	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Landsat 9 OLI-2, Terra MODIS, Aqua MODIS	The raw data collected from Google Earth Engine shows the NPP values collected from each model.
<b>Remote Sensing Biomass</b>	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI	Biomass data collection from RAP biomass is provided from 2022-2023 for Noble ranches.
<b>Vegetation Distribution</b>	Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI	Data organized for vegetation composition across producer ranches.

***Product Benefit to End User:***

For the Noble Research Institute, this project will provide site-specific evaluation of various remote sensing products so that they can be accurately applied and interpreted by the institute and on the network of private ranches that the institute collaborates with. This will empower the use of remote sensing for research, monitoring, and adaptation of management practices on this extensive network of ranch lands. This DEVELOP term will leverage the extensive field monitoring work being conducted for this project and expand the institute's capacity and complexity of usage of NASA Earth observations. For the ARS, as one of their initiatives is focused on improving mapping of rangeland NPP, This project will support this effort by comparing research-phase remote sensing products to other NPP products and by evaluating and informing the improvement of how well these products transfer from research areas to new sites.

**References**

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Robinson, N. P., Allred, B. W., Smith, W. K., Jones, M. O., Moreno, A., Erickson, T. A., Naugle, D. E., & Running, S. W. (2018). Terrestrial primary production for the conterminous United States derived from Landsat 30 m and MODIS 250 m. *Remote Sensing in Ecology and Conservation*, 4(3), 264–280. <https://doi.org/10.1002/rse2.74>

