Spatial Variability of Soil Nitrogen, GPP and Biomass Relationships in the Conterminous United States

Elizabeth M. Smith1, Rodrigo Vargas1, Mario Guevara1,2, Tonantzin Tarin1,2, Richard Pouyat1
1Department of Plant and Soil Sciences, University of Delaware, Newark, DE 19716
2Present address: Centro de Geociencias, Universidad Nacional Autónoma de México, México City 04510, México

Introduction

Nitrogen (N) is a primary macronutrient needed for plant growth. Thus, it requires proper management and understanding to prevent mismanagement that could lead to environmental and economic issues.

In recent years, anthropogenic activities such as the burning of fossil fuels have altered the nitrogen cycle more than any other basic chemical cycle and humans continue to add more reactive nitrogen to the system (Fields 2004). As the human population continues to grow and utilize more resources it is important to understand the spatial variability of nitrogen in the soil for agricultural and environmental management.

Thus, this research seeks to provide a quantitative understanding of the spatial distribution of soil nitrogen concentration across the conterminous US, as well as its variation across depths, and relationship to gross primary productivity (GPP) and biomass using a digital soil mapping framework.

Methods

Environmental covariates
- Terrain analysis
- Regression matrix
- Principal component analysis
- Random forest
- Regression kriging
- Model evaluation
- Model prediction error maps
- Soil nitrogen variability maps

International Soil Carbon Network
- Descriptive statistics
- National Biomass and Carbon Dataset
- MODIS GPP

Results

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Soil Nitrogen (%)</th>
<th>Prediction Error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>0-5</td>
<td>0.133</td>
<td>0.082</td>
</tr>
<tr>
<td>5-15</td>
<td>0.130</td>
<td>0.081</td>
</tr>
<tr>
<td>15-30</td>
<td>0.125</td>
<td>0.077</td>
</tr>
<tr>
<td>30-60</td>
<td>0.155</td>
<td>0.072</td>
</tr>
<tr>
<td>60-100</td>
<td>0.105</td>
<td>0.069</td>
</tr>
<tr>
<td>100-200</td>
<td>0.096</td>
<td>0.067</td>
</tr>
</tbody>
</table>

Table 2. Descriptive statistics of soil N and prediction error across CONUS

Conclusion

- The spatial distribution of soil N became more variable with depth and differs across NEON domains.
- Soil N tends to decrease with depth, but model prediction uncertainty increases with depth.
- Climatic and biological soil forming factors are more relevant closer to the surface (0-60 cm).
- Topographic and hydrological related sources of information are more relevant at deeper depths (60-100 cm).
- The expected relationship between soil N, biomass, and GPP could be influenced by soil depth.
- Our results support the expected relationship between soil N and biomass.
- We did not find a significant relationship between soil N and GPP across CONUS.
- The probability distributions of the optimized locations are independent of the sample size of the hypothetical survey.

Acknowledgements

Thank you to the University of Delaware Graduate Student Award and NASA Carbon Monitoring Systems Grant for funding this research.