Spring 4-29-2024

CRADLE Explorer: CASFER Interactive Platform for Data and Model Visualization

Olatunde D. Akanbi
Case Western Reserve University, oda10@case.edu

Vibha S. Mandayam
Case Western Reserve University, vsm21@case.edu

Haiping Ai
Case Western Reserve University, hxa269@case.edu

Arafath Nihar
Case Western Reserve University, axn392@case.edu

Erika I. Barcelos
Case Western Reserve University, eib14@case.edu

See next page for additional authors

Authors

Olatunde D. Akanbi, Vibha S. Mandayam, Haiping Ai, Arafath Nihar, Erika I. Barcelos, Laura S. Bruckman, Jeffrey Yarus, Yinghui Wu, Huichun (Judy) Zhang, and Roger H. French

CRADLE Explorer: CASFER Interactive Platform for Data and Model Visualization

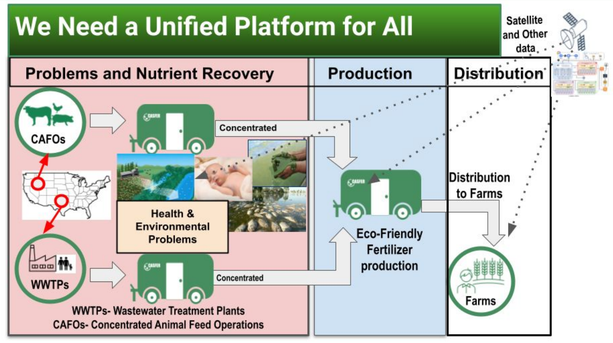
Olatunde D. Akanbi[1,2,5], Vibha Mandayam[1,3,5], Haiping Ai[1,4,5], Arafath Nihar[1,3], Erika I. Barcelos[1,2,5], Laura S. Bruckman[1,2,5], Jeffrey M. Yarus[1,2,5], Yinghui Wu[1,3,5], Huichun (Judy) Zhang[4,5], Roger H. French[1,2,3,5]

[1]SDLE, Department of Material Science and Engineering, Case Western Reserve University, Cleveland OH, USA
[2]Department of Material Science and Engineering, Case Western Reserve University, Cleveland OH, USA
[3]Department of Computer and Data Science, Case Western Reserve University, Cleveland OH, USA
[4]Department of Civil and Environmental Engineering, Case Western Reserve University, Cleveland OH, USA
[5]Center for Advancing sustainable and Distributed Fertilizer Production (CASFER)

Corresponding Author: Roger French, roger.french@case.edu

CASFER
An NSF Engineering Research Center

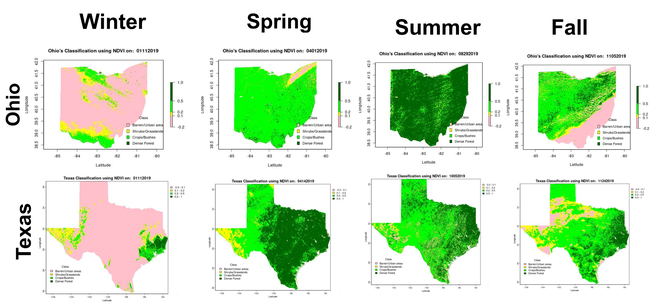
The Problem and the Objectives



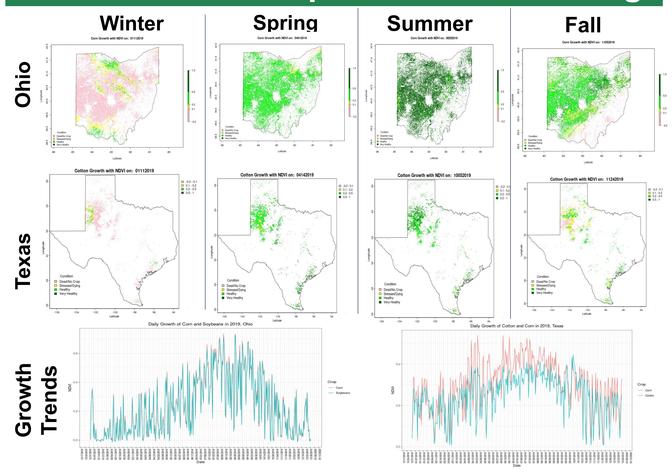
Objectives

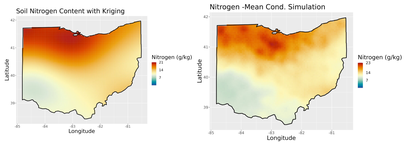
- A unified and interactive platform for CASFER reserchers
- Enable Farmers to monitor crops and enhance fertilizer application
- Enable stakeholders to view the outputs of the project
- Researchers can input their data to test and build models

Initial Results- Land Use



Initial results- Crop Growth & Modeling



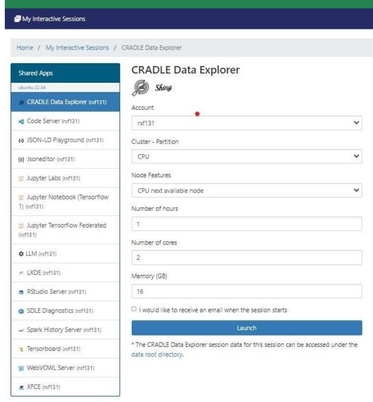


Results

- Daily monitoring of crop and land use
- Soil Nitrogen Prediction

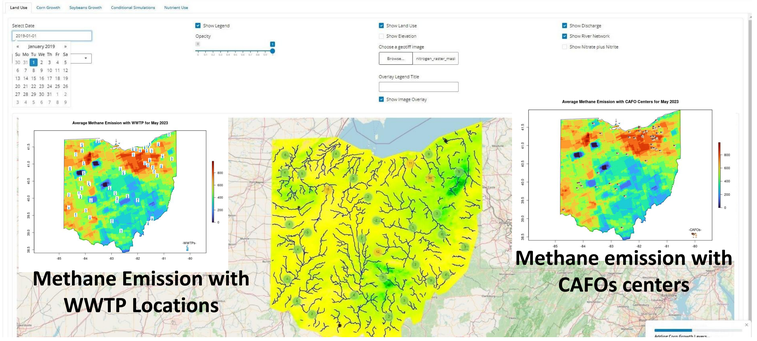
How can we see all these results without GIS softwares, make our inputs, take decisions and build a nitrogen circular economy without coding experience?

Graphical User Interface



Highlights

- Several Interactive features to enhance smooth running and navigation by users (Vast data streams integrated)
- Data and model visualization with Spinner and loader to monitor map rendering



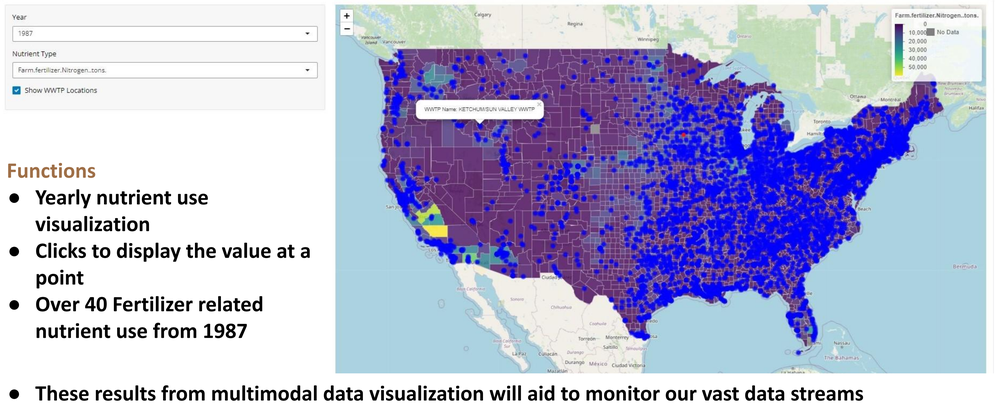
- Application Launch from Open OnDemand
- Secured access but can be launched publicly

Crop Growth, Elevation, and Hydrological Dynamics

Functions

- Time series visualization (Daily)
- County level visualization for better look Clicks to display the value at a point (e.g Nitrate plus Nitrite) Users can import image to overlay and write what the legend would be

Nutrient Use per County

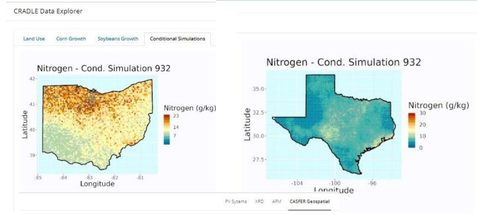


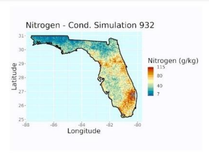
Functions

- Yearly nutrient use visualization
- Clicks to display the value at a point
- Over 40 Fertilizer related nutrient use from 1987

- These results from multimodal data visualization will aid to monitor our vast data streams
- Take decisions on precision agriculture and nutrient management
- See down into what happens at county level

Soil Nitrogen Modeling





Highlights

- Conditional simulation results with 1000 realizations
- Animations of Soil Nitrogen Simulation
- Results show high nitrogen accumulation close to rivers and farmlands

Takeaways

- **Farmers' Guidance**
  - Plant crops based on soil suitability
  - Recommend best soil types for planting
- **Monitoring for Nitrogen Economy**
  - Track metrics for efficient nitrogen use
  - Identify nitrogen accumulation areas for CASFER trailer placement
  - Researchers/users can input their data to visualize
- **Optimizing Soil Nutrients**
  - Determine optimal times for land application
  - Align crop choice with suitable soil and timing
  - Recognize soil properties influencing nutrient distribution
- **Next Steps**
  - Integrate weather, CAFOS, precipitation data for spatiotemporal Graphical Neural Networks

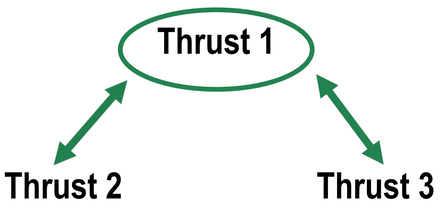
Acknowledgement

- This material is based upon work supported by the National Science Foundation under Grant No. 2133576.
- Hendrik Hamann and IBM Environmental Intelligence Suite acknowledged
- This work made use of the High Performance Computing Resource in the Core Facility for Advanced Research Computing at Case Western Reserve University.

References

- Akanbi, O.D., Bhuvanagiri, D.C., Barcelos, E.I. et al. Integrating Multiscale Geospatial Analysis for Monitoring Crop Growth, Nutrient Distribution, and Hydrological Dynamics in Large-Scale Agricultural Systems. J geovis spat anal 8, 9 (2024). https://doi.org/10.1007/s41651-023-00164-y

Thrust Interactions



Animations

Vegetation, Crop Growth & Correlations

Conditional Simulations