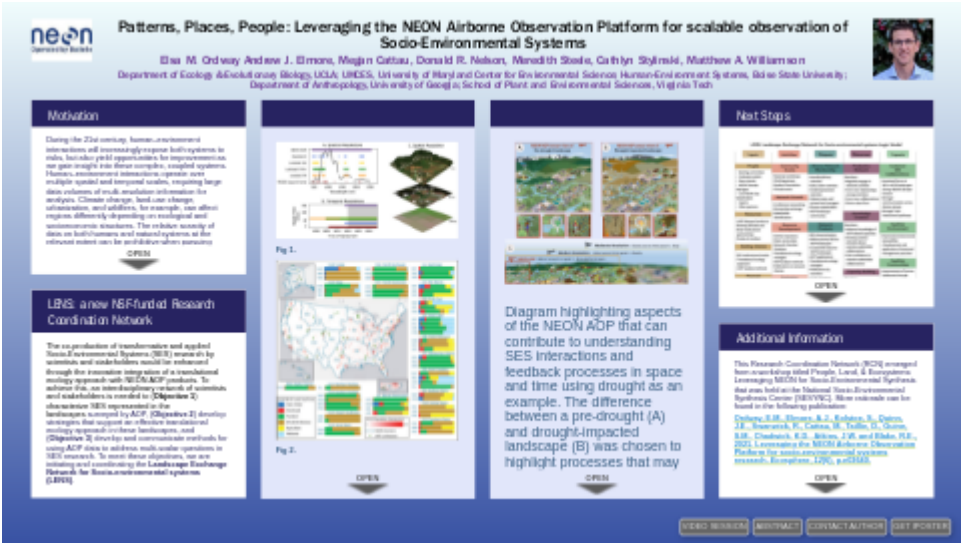


Patterns, Places, People: Leveraging the NEON Airborne Observation Platform for scalable observation of Socio-Environmental Systems



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PRESENTED AT:



MOTIVATION

During the 21st century, human–environment interactions will increasingly expose both systems to risks, but also yield opportunities for improvement as we gain insight into these complex, coupled systems. Human–environment interactions operate over multiple spatial and temporal scales, requiring large data volumes of multi-resolution information for analysis. Climate change, land-use change, urbanization, and wildfires, for example, can affect regions differently depending on ecological and socioeconomic structures. The relative scarcity of data on both humans and natural systems at the relevant extent can be prohibitive when pursuing inquiries into these complex relationships. Multitemporal, high-density, and high-resolution LIDAR, imaging spectroscopy, and digital camera data from the National Ecological Observatory Network's Airborne Observation Platform (NEON AOP) offer a valuable opportunity to leverage cutting edge data for Socio-Environmental Systems (SES) research. The coordinated, nationwide AOP remote sensing data, collected annually over the next 30 yr, offer exciting opportunities for cross-site analyses and comparison, upscaling metrics derived from LIDAR and hyperspectral datasets across larger spatial extents, and addressing questions across diverse scales. Integrating AOP data with other SES datasets will allow researchers to investigate complex systems and provide urgently needed policy recommendations for socio-environmental challenges. We urge the SES research community to further explore questions and theories in social and economic disciplines that might leverage NEON AOP data.

LENS: A NEW NSF-FUNDED RESEARCH COORDINATION NETWORK

The co-production of transformative and applied Socio-Environmental Systems (SES) research by scientists and stakeholders would be enhanced through the innovative integration of a translational ecology approach with NEON AOP products. To achieve this, an interdisciplinary network of scientists and stakeholders is needed to **(Objective 1)** characterize SES represented in the landscapes surveyed by AOP, **(Objective 2)** develop strategies that support an effective translational ecology approach in these landscapes, and **(Objective 3)** develop and communicate methods for using AOP data to address multi-scalar questions in SES research. To meet these objectives, we are initiating and coordinating the **Landscape Exchange Network for Socio-environmental systems (LENS)**.

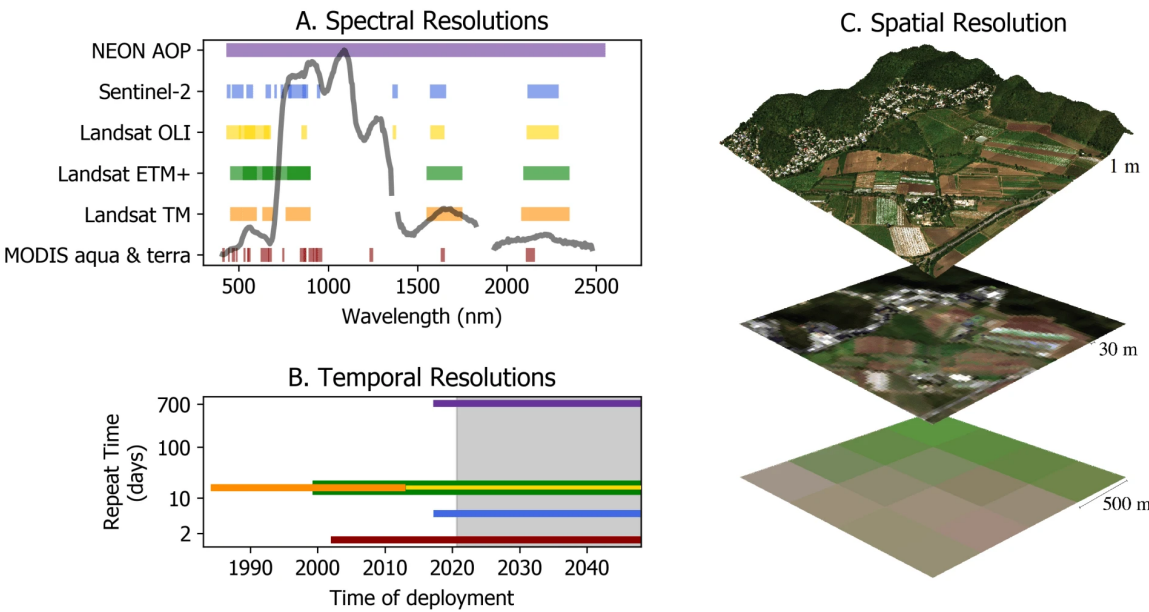


Fig 1.

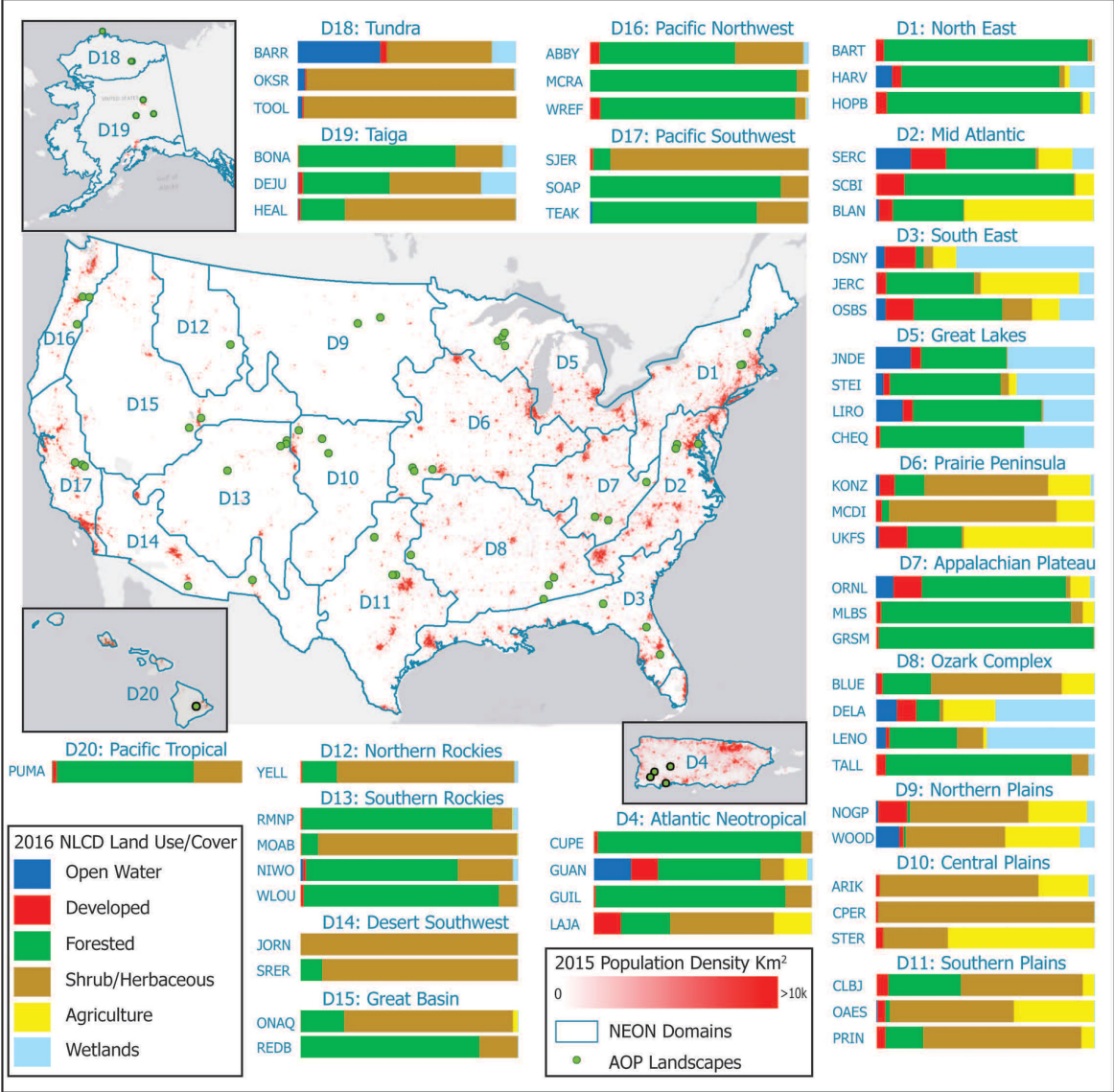


Fig 2.

Figure 1. Spectral (A), temporal (B), and spatial (C) resolution of NEON AOP data relative to other widely used, publicly available remote sensing datasets. (A) Spectral range for different sensors. Note that the NEON AOP is contiguous at 5 nm intervals while other sensors have much larger bandwidths. Overlapping bands are darker in color. The gray line is an example spectra for a vegetated pixel taken from an AOP acquisition to highlight the shape of the reflectance spectrum. (B) Duration of record vs. the repeat time for each sensor (colors designated in A). Future acquisitions are in gray. In (A, B), NEON AOP spectral resolution and temporal resolution are illustrated in purple, Sentinel-2 in orange, Landsat Operational Land Imager (OLI) in yellow, Landsat Enhanced Thematic Mapper Plus (ETM+) in green, Landsat Thematic Mapper (TM) in blue, and MODIS aqua and terra are in red. (C) AOP data at 1 m resolution overlain on LiDAR point cloud data in Guánica, Puerto Rico, compared with 30 m Landsat OLI OLI data and 500 m MODIS (MOD09A1) data at the same location.

Figure 2. Locations and fractional land cover of AOP landscapes with surveys and products available from the NEON website in mid-2020. The landscapes surveyed do not capture any of the major U.S. population centers (red areas on the map), but exhibit considerable land use diversity. While total developed land is less than 1% in about half of the AOP landscapes, 10 of the landscapes are more than 10% developed. Agricultural land ranges from less than 1% to nearly 70%. Data on populations is from the 2015 block-group level census and land cover is from the 2016 National Land Cover Database.

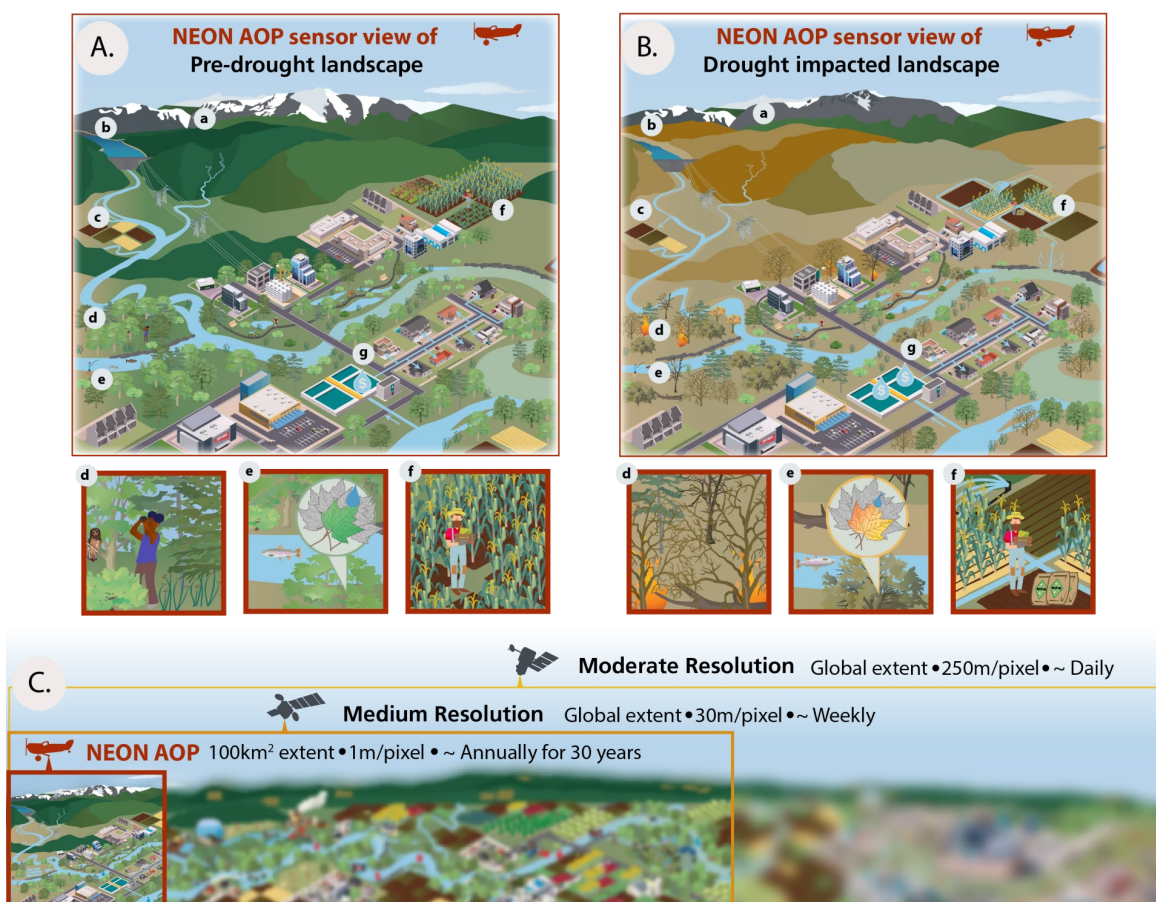


Diagram highlighting aspects of the NEON AOP that can contribute to understanding SES interactions and feedback processes in space and time using drought as an example. The difference between a pre-drought (A) and drought-impacted landscape (B) was chosen to highlight processes that may occur at various scales and in different locations across the landscape (a–g) over the 30-yr planned AOP lifespan. Aspects of socioenvironmental change that can be better understood within an AOP landscape are highlighted in comparisons of (d–f) in panels A and B. For example, fine-scale resolution AOP data will allow researchers to understand drought and related human behavioral impacts on plant species composition and vegetation structure (d), canopy water content (e), and crop yields (f). In addition, AOP data combined with ancillary datasets enables analysis at larger spatial scales (C). The higher temporal resolution of other sensors can also be used to understand change within years at a NEON AOP site (C) and how pressures like reduced snowpack reverberate throughout social, governance, and ecological systems (A a–g → B a–g). Symbols used with permission from UMCES IAN Symbol library (ian.umces.edu (<http://ian.umces.edu/>)).

NEXT STEPS

LENS: Landscape Exchange Network for Socio-environmental systems Logic Model

Inputs	Activities	Outputs	Outcomes	Impacts
People <ul style="list-style-type: none"> Steering committee Graduate student Data scientist NEON Domain Managers Core NEON Site Stakeholders Experts Other partners 	Community Events <ul style="list-style-type: none"> National workshops Working groups Student Association Virtual events 	Diverse Network Membership <ul style="list-style-type: none"> Interdisciplinary scientists Early career scientists Underrepresented scientists Federal, state, and private land managers Diverse stakeholders AOP landscape community 	Productive Network <p>Members:</p> <ul style="list-style-type: none"> Regularly engage in network activities Form new relationships among members Form new collaborations Derive value from 	Sustained SES Collaborations <ul style="list-style-type: none"> Sustained focus on SES in AOP landscapes during NEON's 30-year horizon Stronger communication across diverse groups Stronger inter-institutional pathways
Resources <ul style="list-style-type: none"> AOP data and products Existing SES data sets Inter-institutional partnerships Codes of conduct 	Network Growth <ul style="list-style-type: none"> Conference networking Partnership exchange Stakeholder identification 	Network Products <ul style="list-style-type: none"> SES characterization Define priority SES for AOP landscapes Curated SES-data for AOP landscapes AOP applications Translational ecology strategies Publications by members Code repository 	Knowledge Creation <p>Members:</p> <ul style="list-style-type: none"> Advance knowledge of AOP-related capacities Develop positive attitudes about scientist-stakeholder collaborations Gain confidence in scientist-stakeholder collaborations 	Healthier Environment <ul style="list-style-type: none"> Improved environmental stewardship Development and application of improved management practices
Existing Science <ul style="list-style-type: none"> SES methods and results Translational ecology approach AOP analysis methods 	Resource Development <ul style="list-style-type: none"> GitHub repository Open access data Network Member Database Translational ecology strategies AOP analysis methods Publication on network themes 	Communication <ul style="list-style-type: none"> Website with LENS products and findings List-serve Newsletter Research briefs Social media Virtual events Publications on network 	Capacity Building <p>Members:</p> <ul style="list-style-type: none"> Use AOP landscapes and translational ecology strategies for SES research Share network opportunities and products with broader community Broaden views of participant diversity in research framing 	Healthier Communities <ul style="list-style-type: none"> Improvement of human livelihoods through development of actionable science Increased recognition of the importance and impact of co-developed science
Financial <ul style="list-style-type: none"> Previous SESYNC support for first workshop NEON assets assigned RCN award (this proposal) 	Evaluation <ul style="list-style-type: none"> Membership demographics, attendance and participation Annual "pulse checks" Post Questionnaire Online resource analytics 			

ADDITIONAL INFORMATION

This Research Coordination Network (RCN) emerged from a workshop titled People, Land, & Ecosystems: Leveraging NEON for Socio-Environmental Synthesis that was held at the National Socio-Environmental Synthesis Center (SESYNC). More rationale can be found in the following publication:

Ordway, E.M., Elmore, A.J., Kolstoe, S., Quinn, J.E., Swanwick, R., Cattau, M., Taillie, D., Guinn, S.M., Chadwick, K.D., Atkins, J.W. and Blake, R.E., 2021. Leveraging the NEON Airborne Observation Platform for socio-environmental systems research. *Ecosphere*, 12(6), p.e03640. (<https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/ecs2.3640>)

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ABSTRACT

During the 21st century, human–environment interactions will increasingly expose both systems to risks, but also yield opportunities for improvement as we gain insight into these complex coupled-systems. Human–environment interactions operate over multiple spatial and temporal scales, requiring large data volumes of multi-resolution information for analysis. Climate change, land-use change, urbanization, and wildfires, for example, can affect regions differently depending on ecological and socioeconomic structures. The relative scarcity of data on both humans and natural systems at the relevant extent can be prohibitive when pursuing inquiries into these complex relationships. We explore the value of multitemporal, high-density, and high-resolution LiDAR, imaging spectroscopy, and digital camera data from the National Ecological Observatory Network’s Airborne Observation Platform (NEON AOP) for Socio-Environmental Systems (SES) research. We outline specific applications for addressing SES questions, highlight current challenges, and provide recommendations for the SES research community to improve and expand its use of this platform for SES research. The coordinated, nationwide AOP remote sensing data, collected annually over the next 30 years, offer exciting opportunities for cross-site analyses and comparison, upscaling metrics derived from LiDAR and hyperspectral datasets across larger spatial extents, and addressing questions across diverse scales. Integrating AOP data with other SES datasets will allow researchers to investigate complex systems and provide urgently needed policy recommendations for socio-environmental challenges. We urge the research community to further explore interdisciplinary questions and theories that might leverage NEON AOP data, and present a new Research Coordination Network aimed at supporting these efforts.