Utilizing Satellite Earth Observation Analyses and the Environment-Vulnerability-Decision-Technology Modeling Framework to Support the Yurok Tribe in Mitigating Climate Change Impacts through Natural Resource Management

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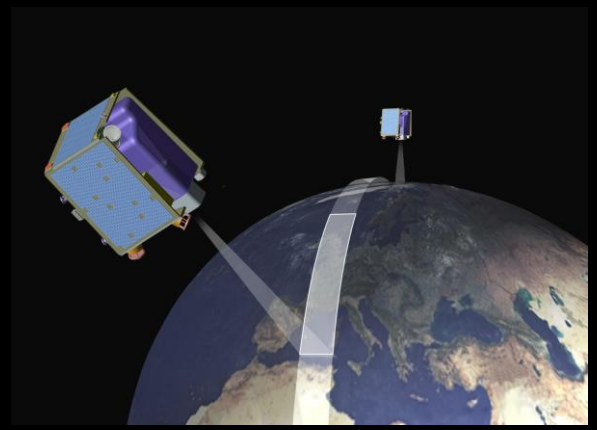
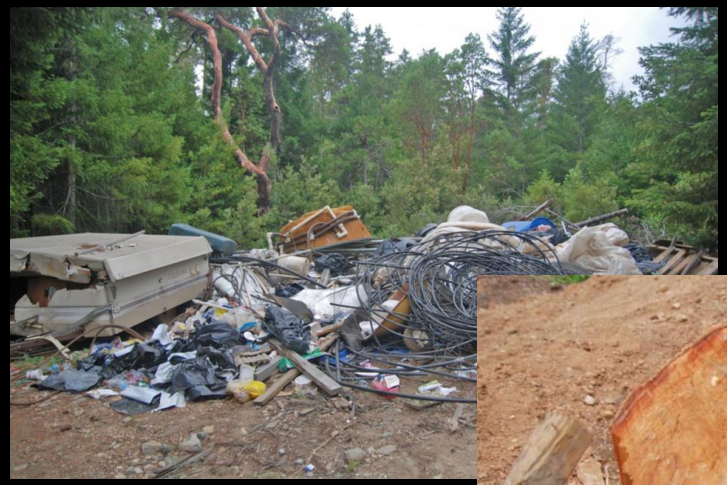
Collaborating with the Yurok Tribe

- Working to supplement the ongoing innovative work of the Yurok Tribe in natural resource management



Challenges and Innovations in Resource Management

- Challenges: previous unsustainable logging practices and uncontrolled fires threaten forests
- Conservation-based forest management is a potential solution



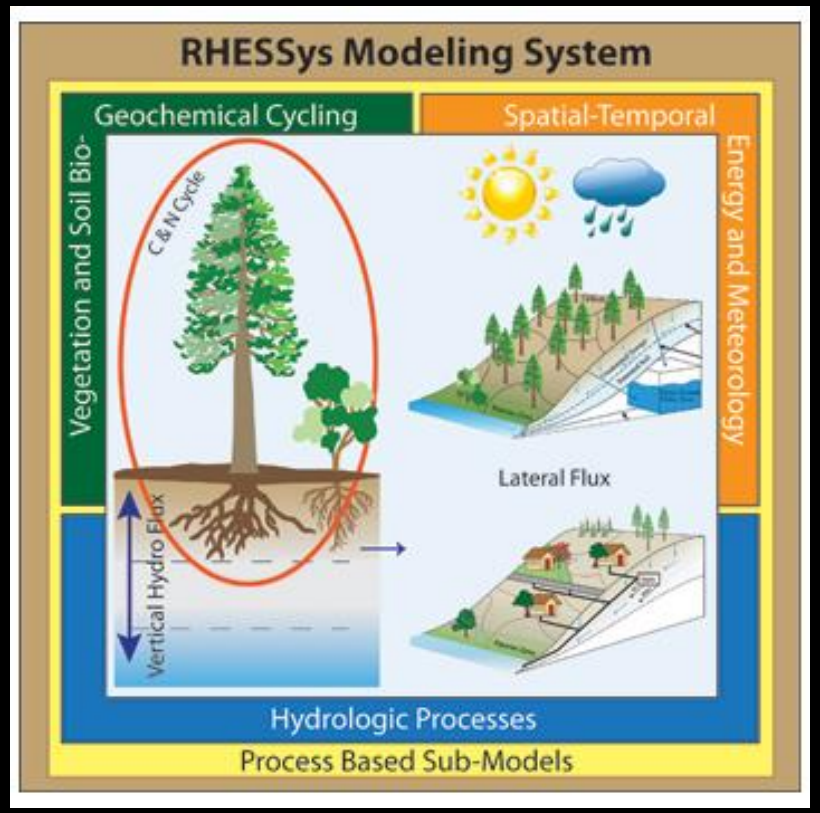
Challenges and Innovations in Resource Management

- Challenges: Klamath River faces degradation and salmon depletion
- River restoration and removal of dams upstream represent solutions

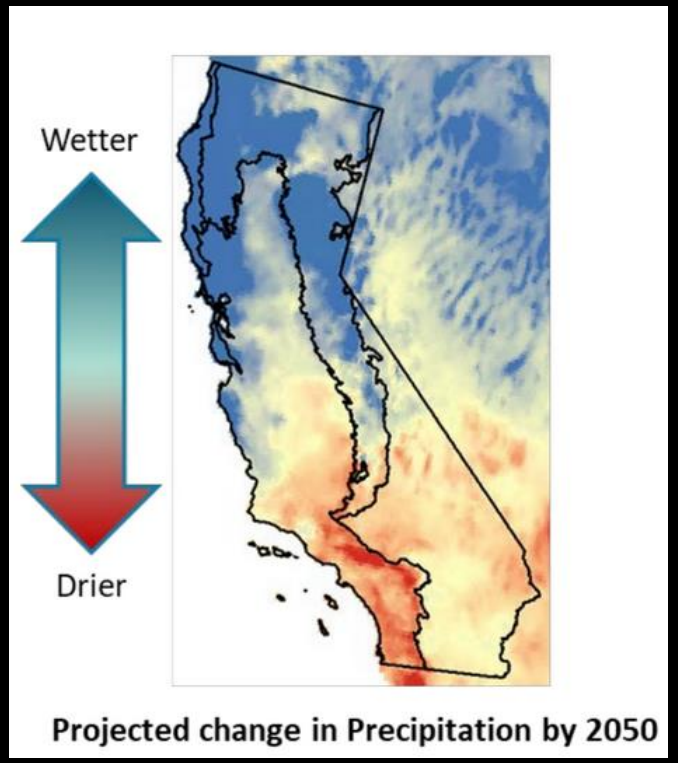
(Photo credit: U.S. Fish and Wildlife Service, AP Photo/Gillian Flaccus)

Challenges to Decision Making

- Complex dynamics in the phenomena under examination make decision making challenging in natural resource management



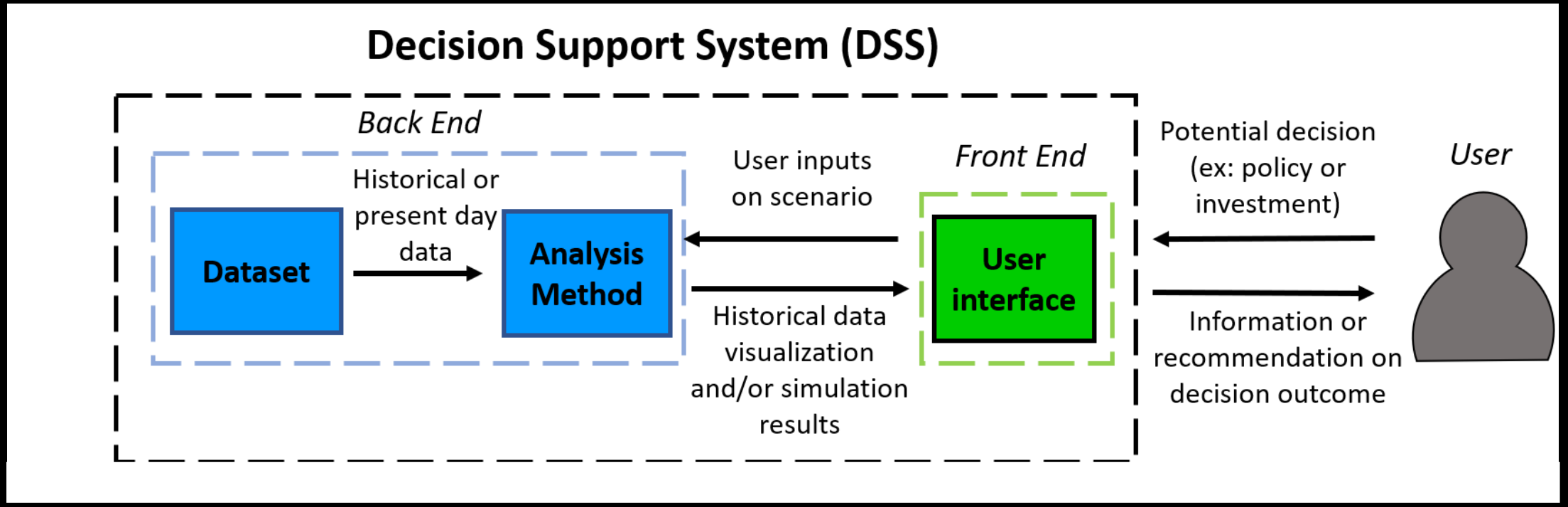
(RHESSys)



(CARB)

Decision Support Systems (DSS)

- Web-based decision support software systems can help address these challenges and facilitate informed decision making
- However, DSSs often fail to benefit users in sustainable development, or are not employed as often as expected due to lack of stakeholder engagement



Stakeholder Interviews and Analysis - Yurok

- Interviews conducted with stakeholders inside and outside the Tribe as inputs for targeting of analyses to stakeholder objectives

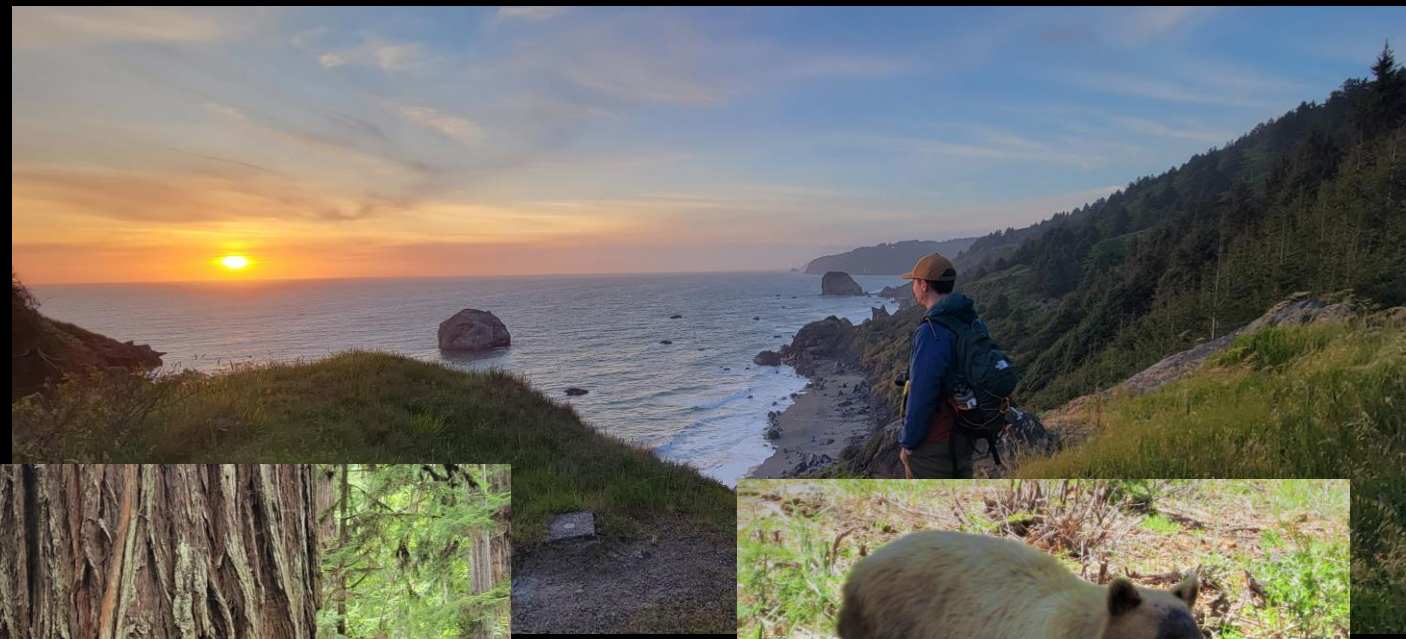
Stakeholder Category	Stakeholder Organization
Yurok Tribe	Carbon Projects – NRD
	Forestry - NRD
	River Restoration –NRD
	Wildlife – NRD
	Information Technology
	Geospatial Information Technology
State and Federal Government	CA Governor Tribal Advisor
	US Forest Service
Non Profits	Nature Conservancy
	Humboldt Area Foundation

Site Visit – Yurok Tribe

- Gathered geolocated tree species information to incorporate into analyses
- Learned about forest management techniques

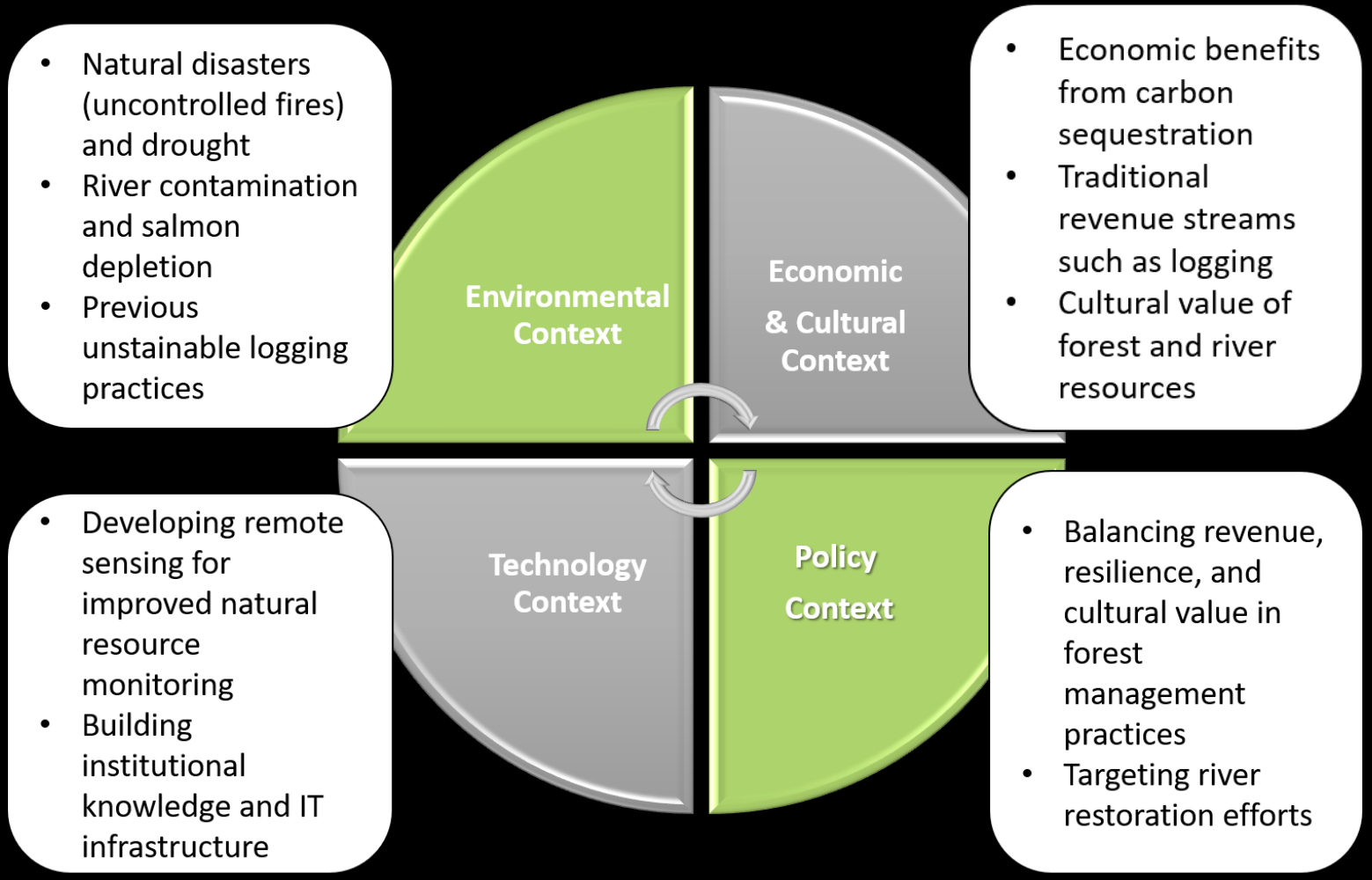
Site Visit – Yurok Tribe

- Learned about Yurok Tribe culture and Tribe's relationship to natural resources



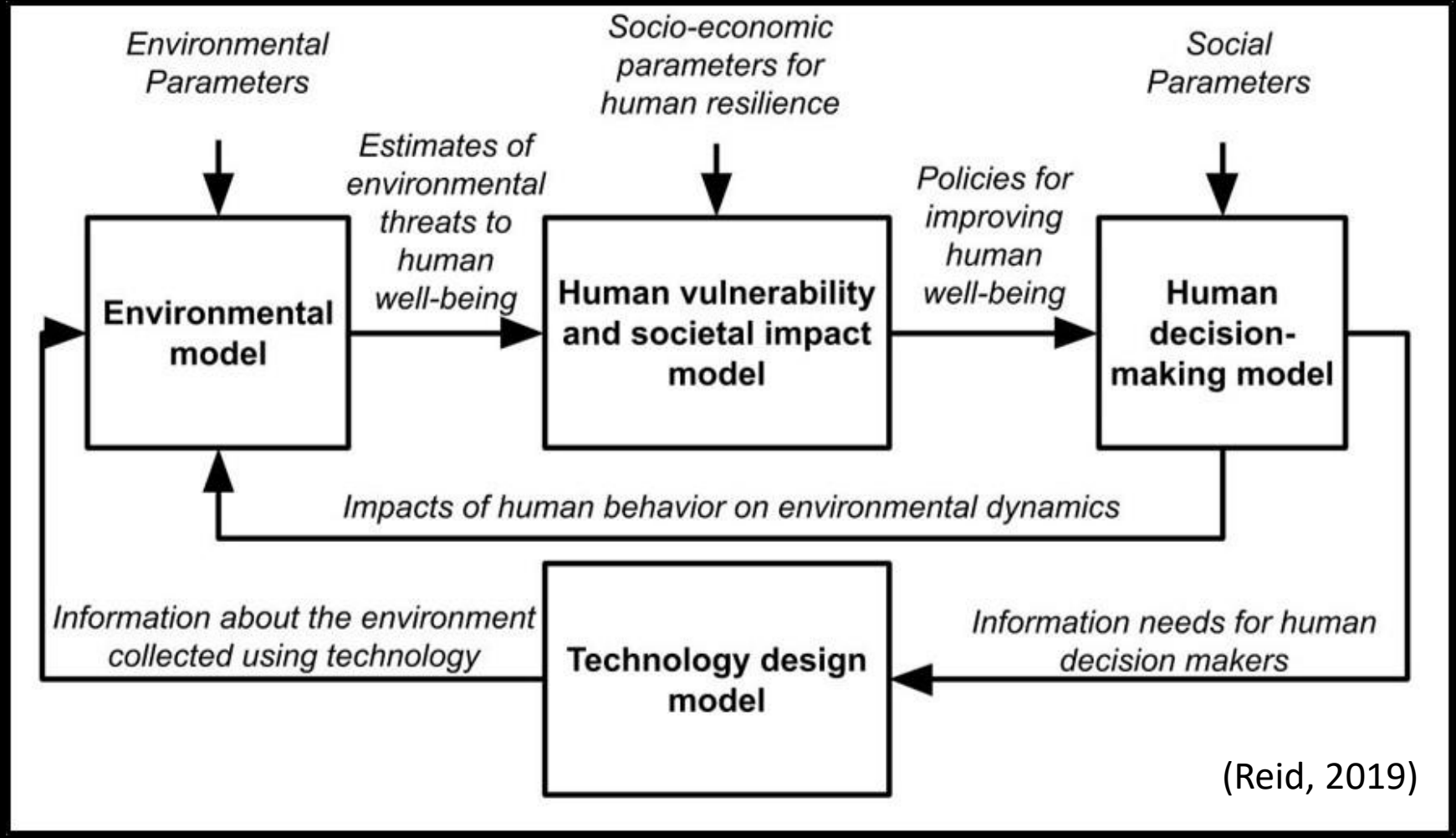
Challenges to Decision Making

- Intersecting societal domains pose another challenge to decision makers in natural resource management



EVDT

- The EVDT framework considers relevant societal components to guide DSS development



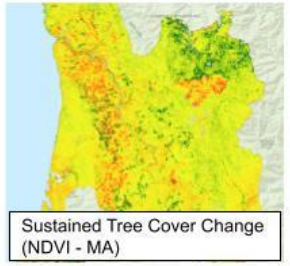
(Reid, 2019)

EVDT Framework pplied to the Yurok Tribe

(Courtesy of the Yurok Tribe)

Satellite Data

Satellite remote sensing data and field observations of forest and fire phenomena



Sustained Tree Cover Change (NDVI - MA)

Local socioeconomic data on land use and information on cultural value of resources

Policy Constraints & Opportunities such as funding and coordination with State and Federal agencies

(Courtesy of the Yurok Tribe)

Environment: *Tree cover and species analyses, modeling of carbon stocks and forest structure*

Environmental dynamics

Vulnerability: *Visualizations of socioeconomic data and environmental analyses*

Environmental dynamics and estimates of socio economic impact

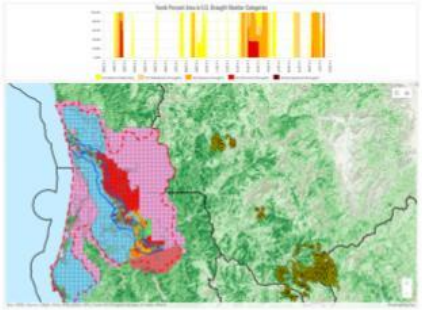
Decision-making: *Balancing revenue, resilience, and cultural values in forest management practices*

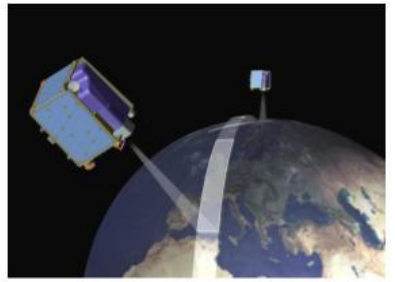
Policy actions related to forest management

Technology:
Development of Yurok Natural Resources Portal DSS

Decision support for improved forest management and fire response

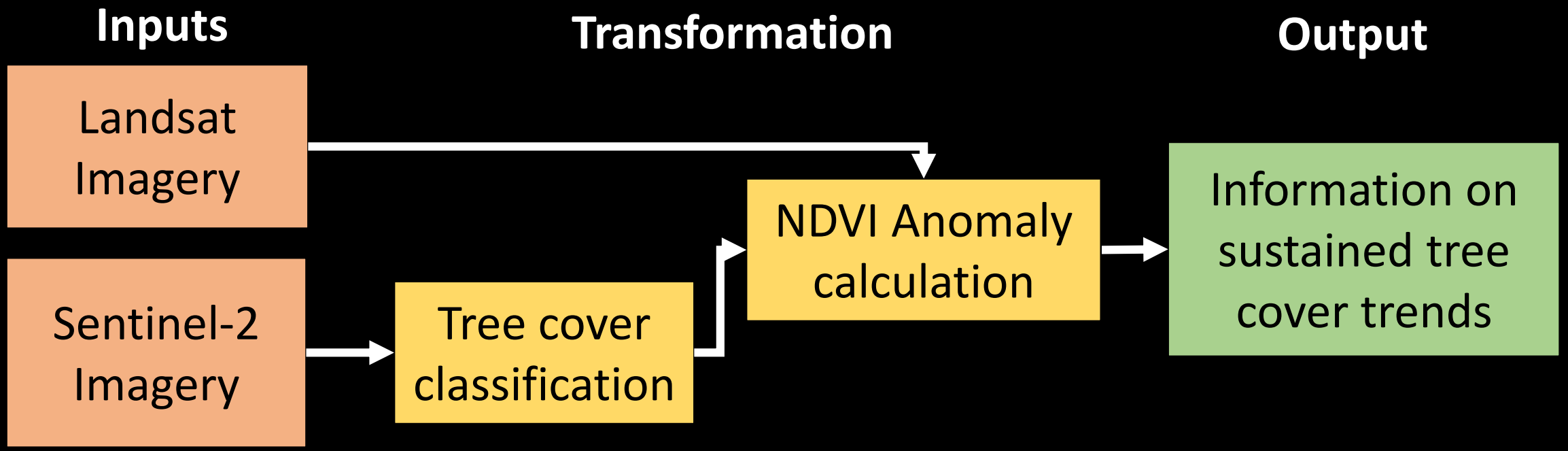
Additional data and insights for forest management and fire response





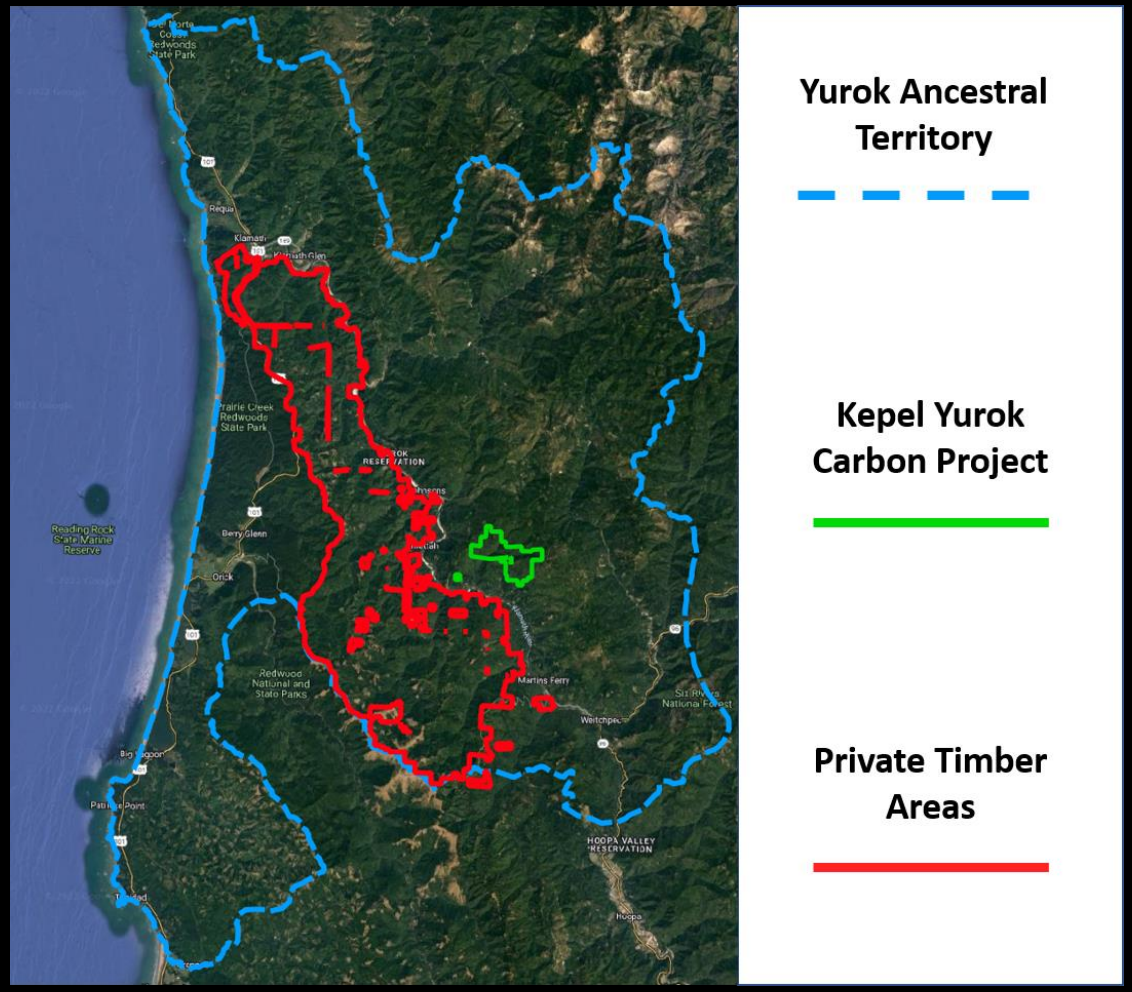
Satellite Data Analyses – Yurok Tribe

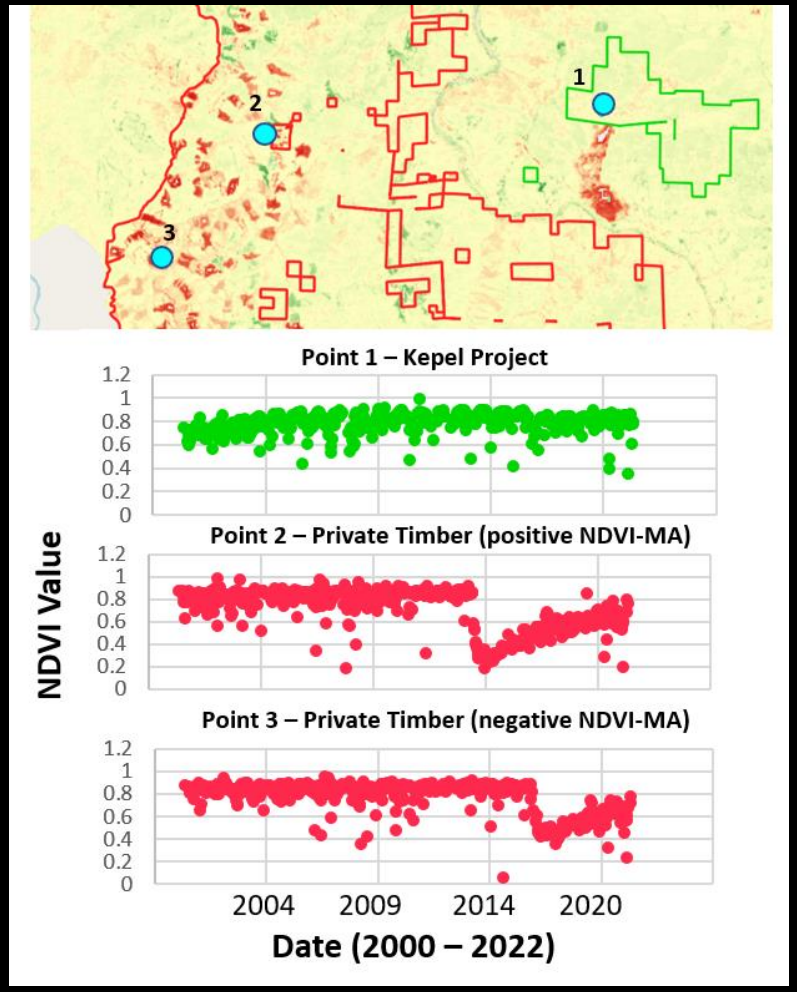
- Analysis of tree cover change used to gain insight into forest trends
- Utilized Sentinel-2 for tree cover classification in the present, and Landsat NDVI for analysis of trends over time in classified areas



Satellite Data Analyses – Yurok Tribe

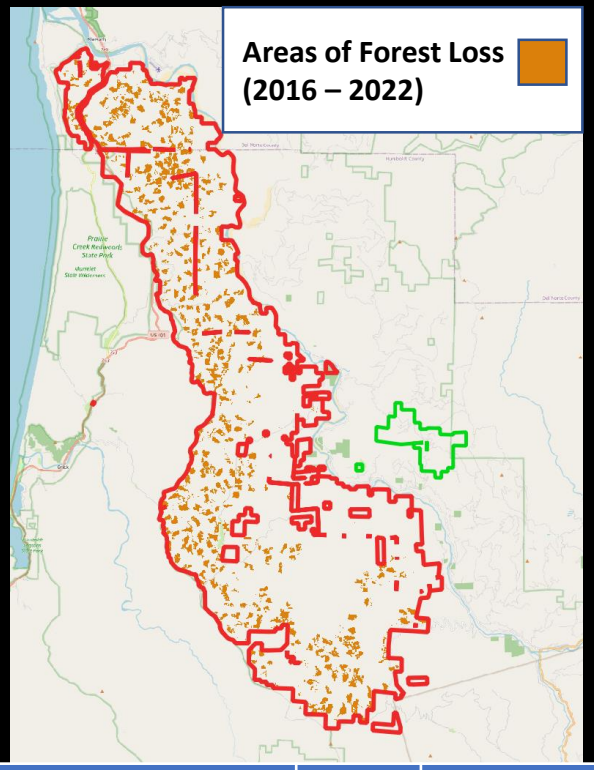
- Demonstrates NDVI analysis is useful for identifying forest trends in differently managed forest areas



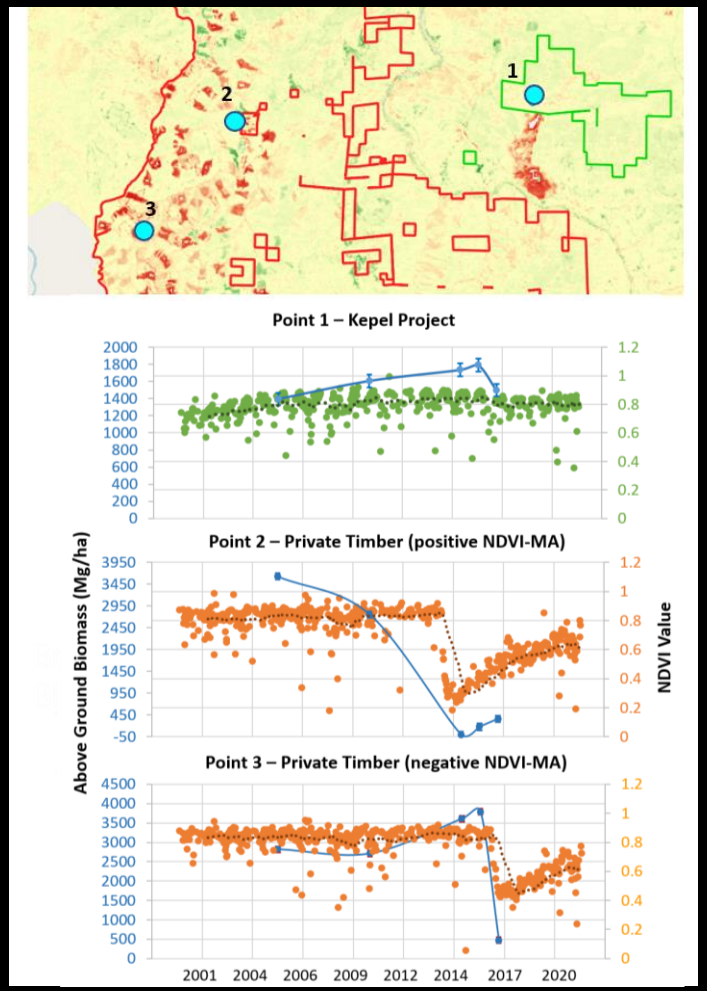


Satellite Data Analyses – Yurok Tribe

- Comparison of analysis to Hansen (2013) tree cover change builds confidence in trends identifying tree cover loss
- Comparison to biomass dataset (Yu *et al.*, 2022) shows dip in biomass corresponding to tree cover loss, but slower recovery than NDVI

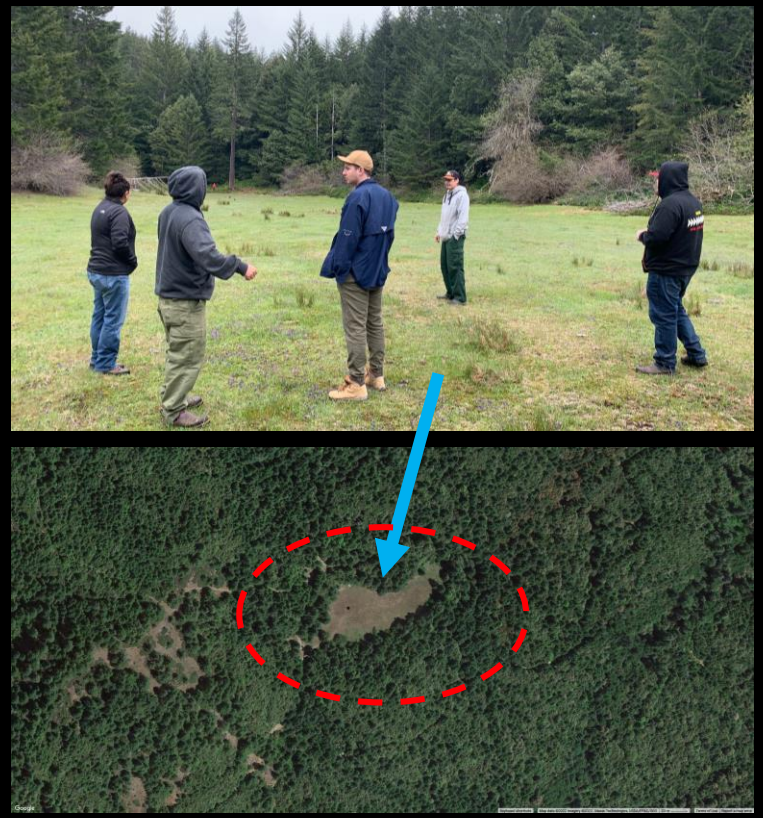


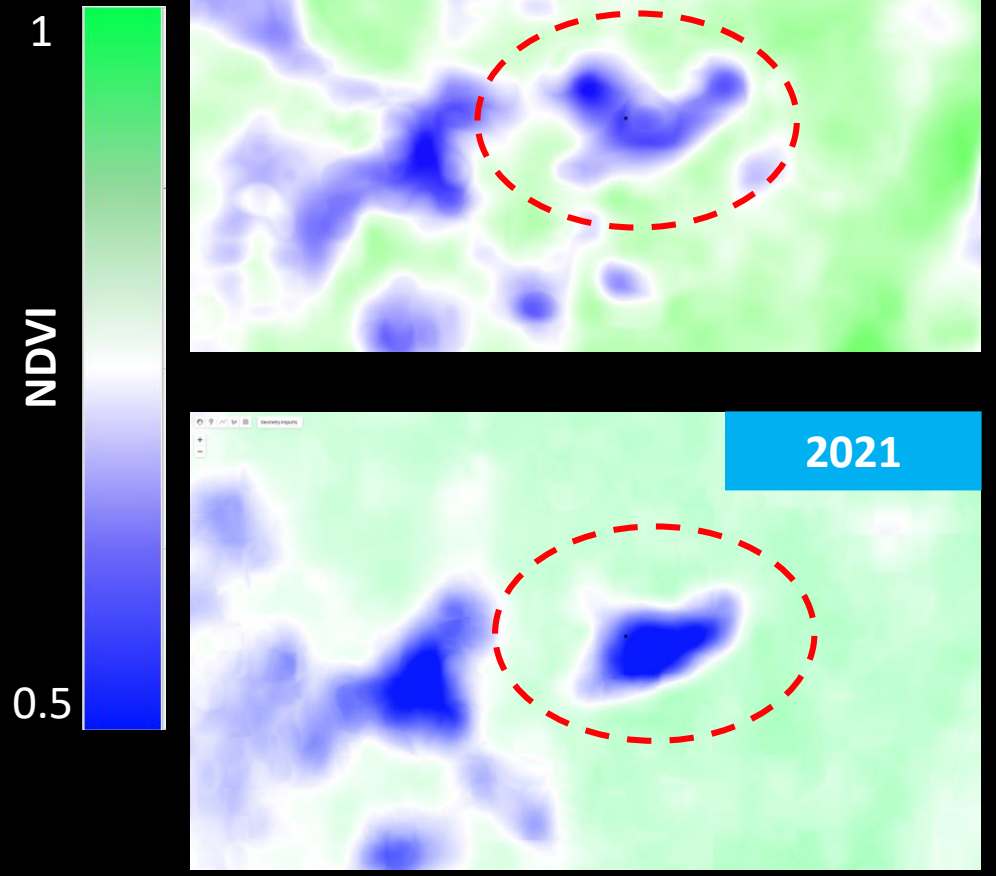
	Kepel Area	Private Timber Areas
Percentage of total area experiencing "stand-replacement disturbance"	0.05%	12.3%



EVDT Principles – Data Integration

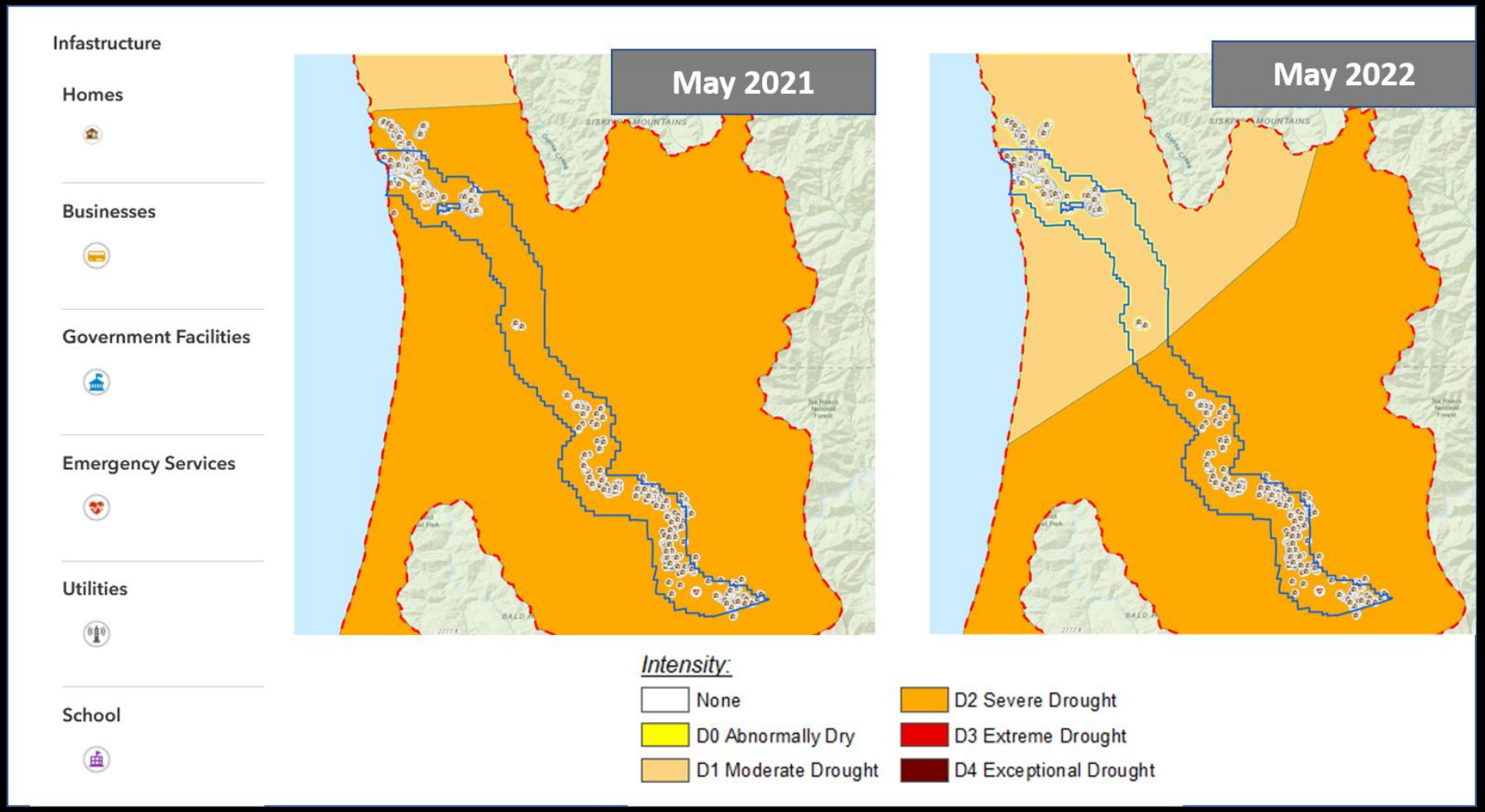
- Satellite and ground data were combined to analyze conifer encroachment on culturally-important prairies





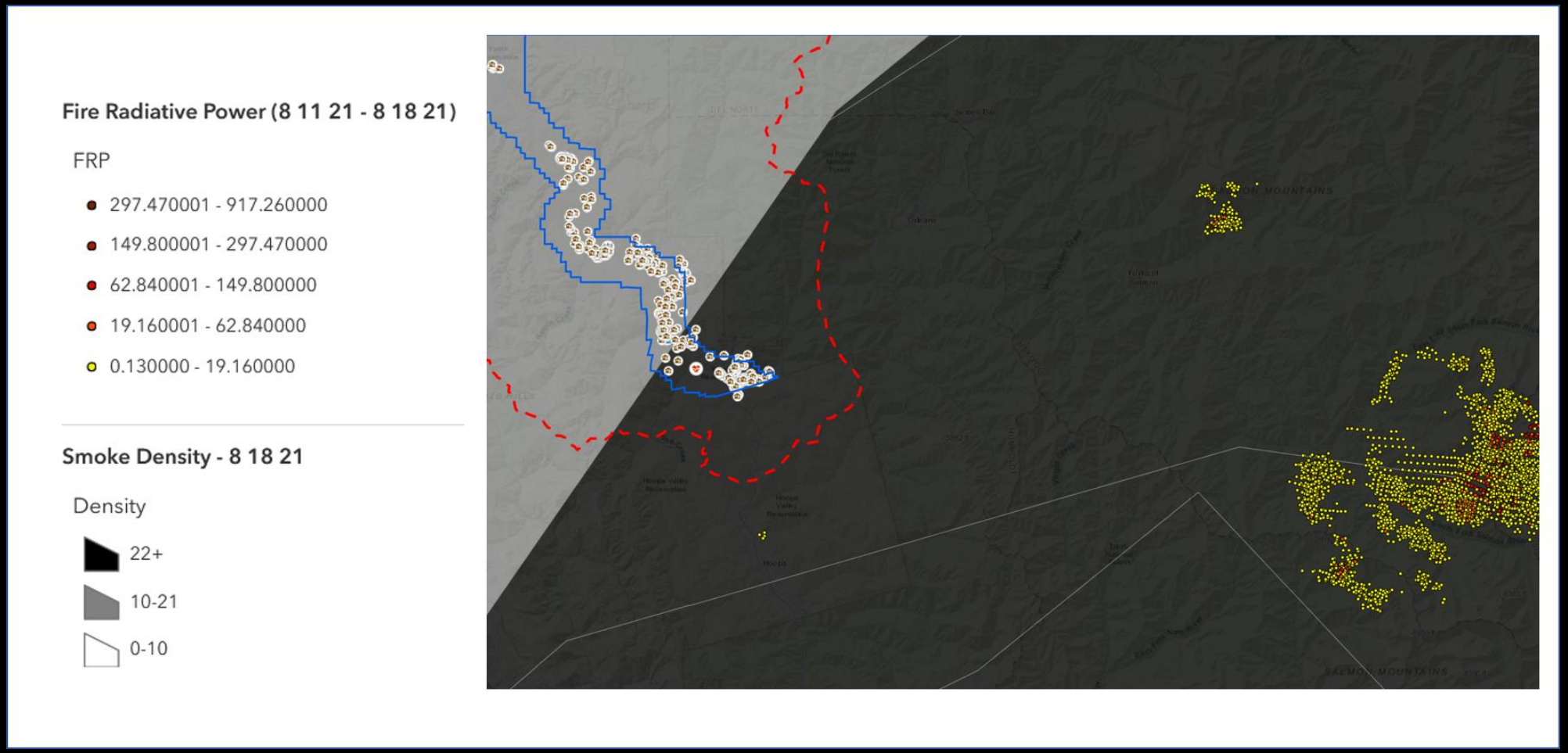
EVDT Principles – Data Integration

- Integration of existing SRS drought products and Yurok infrastructure information facilitates identification of threatened areas



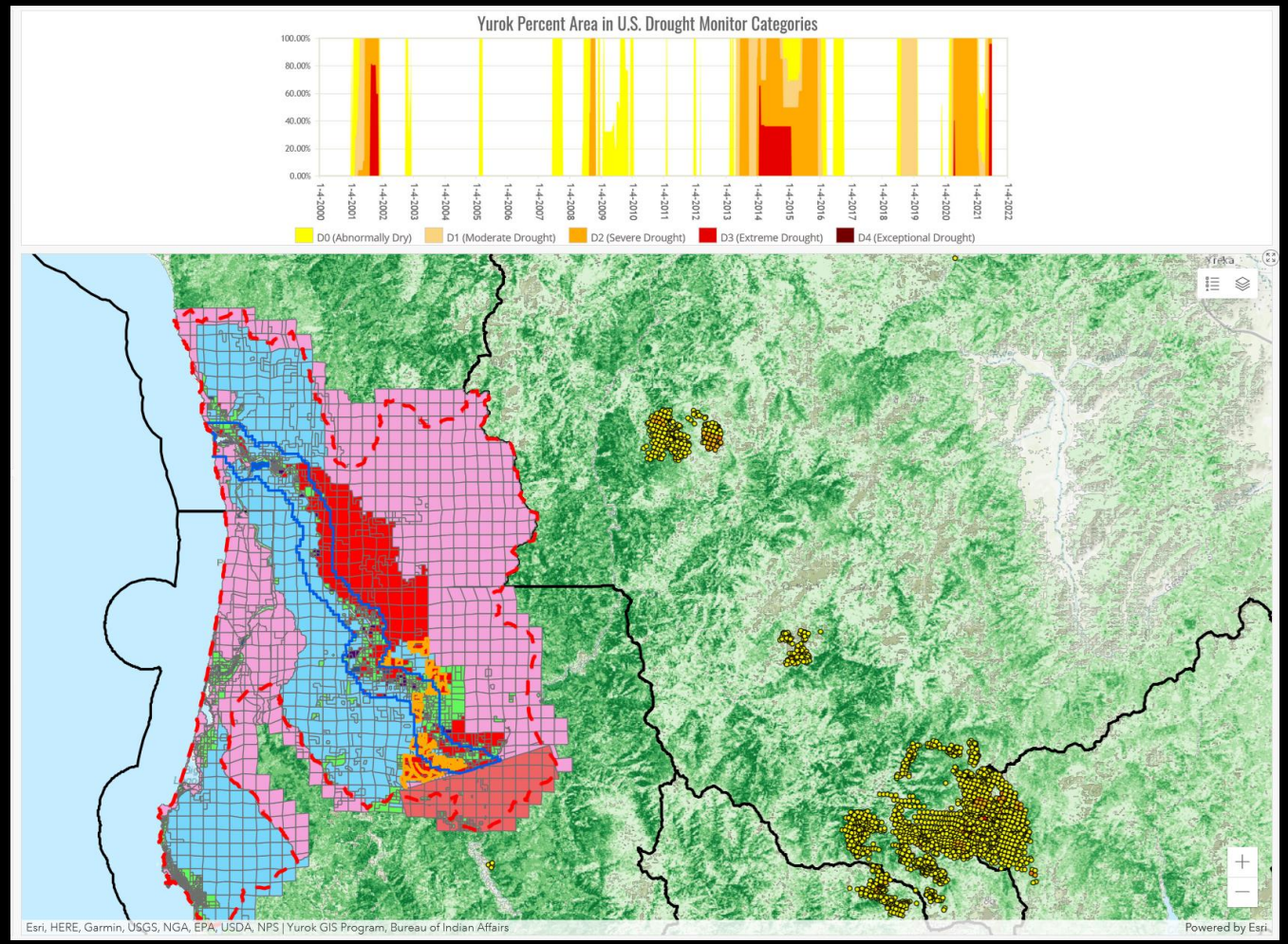
EVDT Principles – Data Integration

- Integration of existing SRS fire and smoke products and Yurok Tribe residence and infrastructure identifies affected homes and facilities



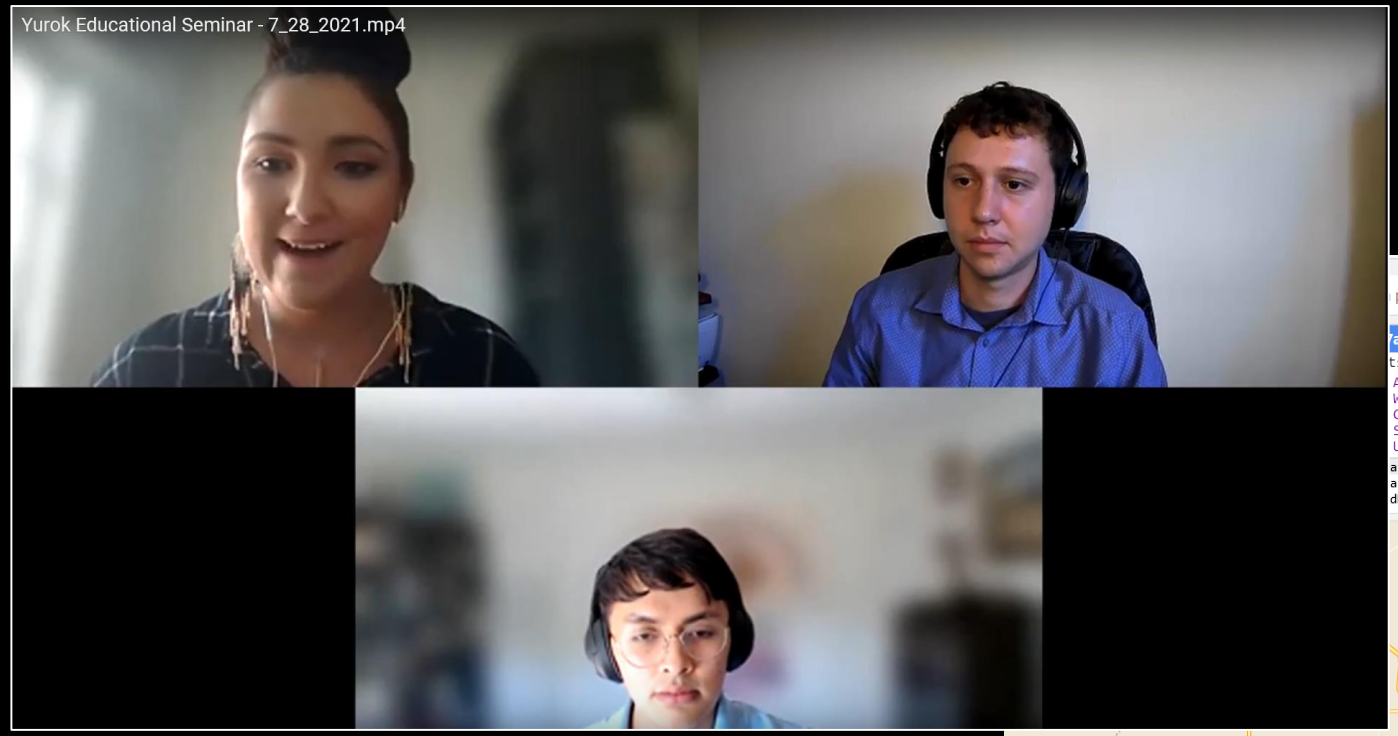
DSS Prototype

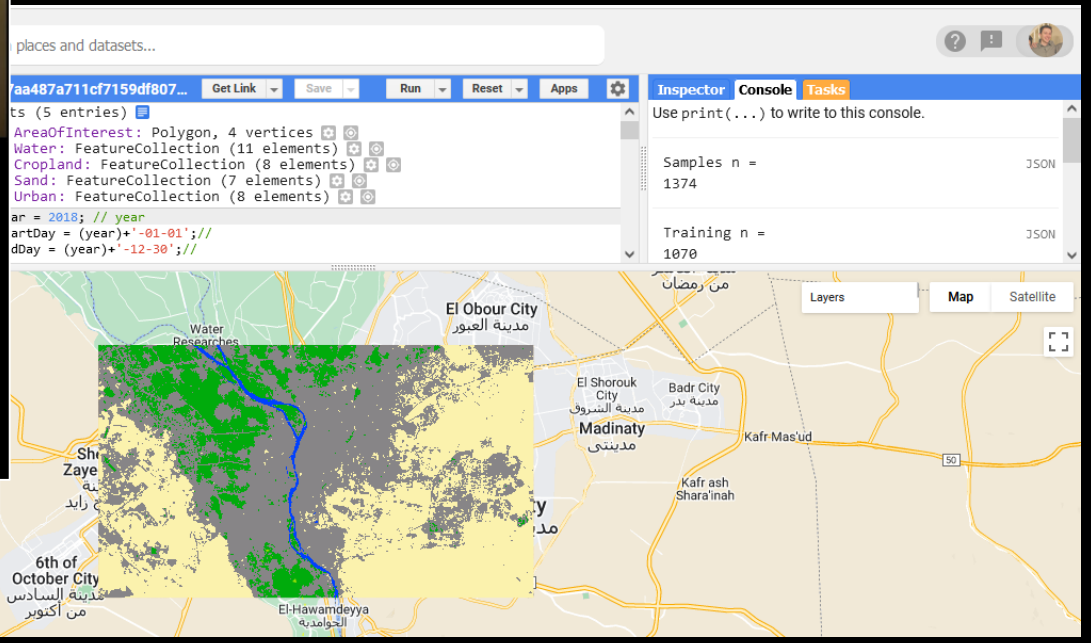
- Create web-based software where Yurok decision makers can interact with data to support decision making



Capacity Building – Yurok Tribe

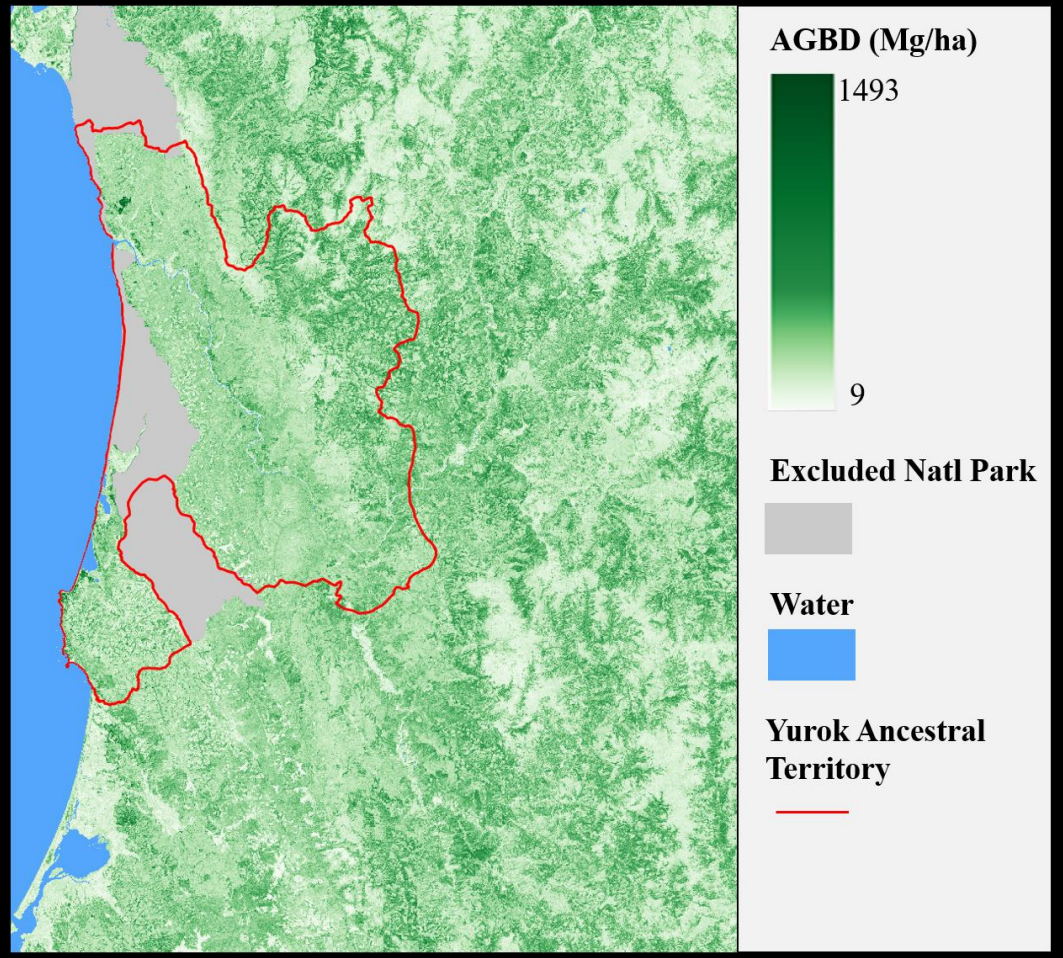
- Conducting educational outreach and GEE trainings to build STEM capacity among Yurok students and others in northern CA





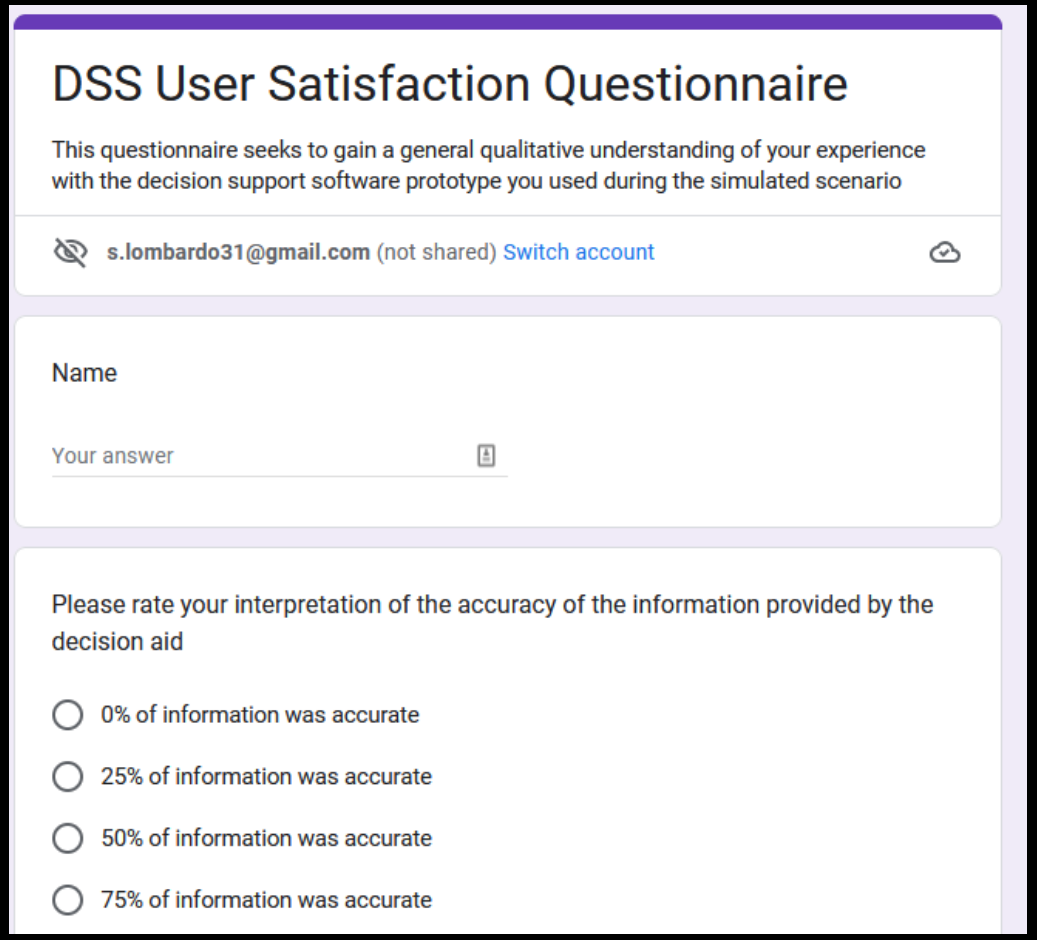
Next Steps - Satellite Data Analyses

- Ongoing analyses of above ground biomass for carbon sequestration projects



Next Steps: DSS Evaluation

- Survey evaluation of prototype DSS to get stakeholder feedback



DSS User Satisfaction Questionnaire

This questionnaire seeks to gain a general qualitative understanding of your experience with the decision support software prototype you used during the simulated scenario

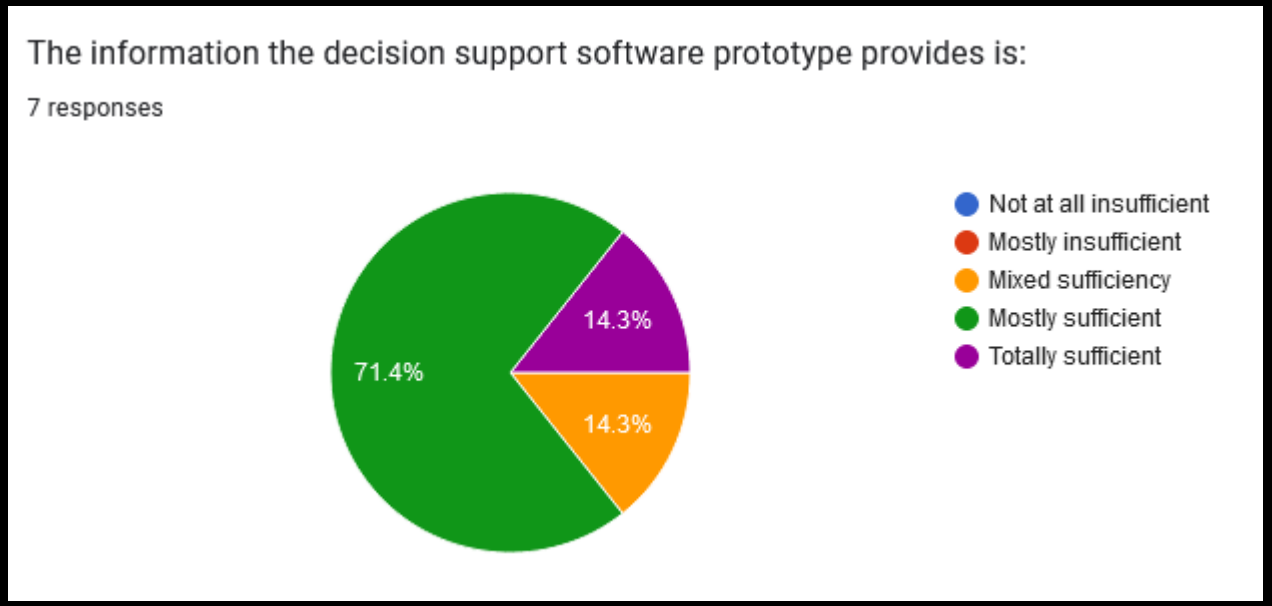
s.lombardo31@gmail.com (not shared) Switch account

Name

Your answer

Please rate your interpretation of the accuracy of the information provided by the decision aid

- 0% of information was accurate
- 25% of information was accurate
- 50% of information was accurate
- 75% of information was accurate



Conclusions

- Engaging stakeholders in every stage of DSS development process
  - New datasets and context revealed by stakeholders
  - DSS strives to meet objectives

- Use of EVDT integrated modeling framework promotes integration of environmental and socioeconomic data to help understand complex system for Yurok Tribe

- Satellite data spatial and temporal coverage provides useful supplement to decision making for Yurok Tribe

- The scientific and technological collaboration between MIT and the Yurok Tribe support nation building actions and strategic planning to address climate change and its impacts for the Yurok Tribe on and off their ancestral territory

Acknowledgments

- The funding for this work came in part from the Draper Scholar program.
- We would also like to thank our Yurok Tribe collaborators led by Javier Kinney, Amanda Ammon, David (DJ) Bandrowski, Dawn Blake, Dawn Baum, Alexandra Mojado, Shaonna Chase and Elaina O’Rourke and Tim Hayden.
- Yurok Tribe images were obtained courtesy of the Yurok Tribe.

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