Project description and impact

The frequency and size of wildfires have been increasing since the 1950's (Weber and Yadav 2020). Furthermore, the incidence of fires impacting an expanding wildland urban interface (WUI)[1] is becoming more prominent (Chen et al 2024, Tang et al 2024). These factors – particularly when coupled with diminishing land management budgets and uncertain climate change impacts – make the need for proactive wildfire mitigation essential. One step toward this end is the application of spatial data science (e.g., Geographic Information Systems (GIS) and satellite remote sensing) to identify areas with high wildfire susceptibility, hazard, and risk. The results of these models then need to be communicated to decision makers to aid in the prioritization of mitigation strategies, such as fuel load reduction prescriptions.

This one-year project, titled Spatial Analysis Research and Course development (SPARC), is planned in three distinct phases aligned with the 2026-2027 school year at Idaho State University. During the summer of 2026, phase one will be completed. In this phase, the selected graduate or undergraduate student – mentored by PI Weber – will use various satellite imagery and GIS datasets (**Table 1**) for parts of Bannock County, Idaho (**Figure 1**) to develop a wildfire susceptibility model. A susceptibility model is the foundational data layer describing the intrinsic characteristics of a landscape that make it more or less prone to a wildfire. Factors include fuel load (derived from various vegetation indices (e.g., NDVI and MSAVI2) calculated from the satellite imagery, fuel continuity (calculated using bare ground indices), the presence/absence of ladder fuels (calculated from lidar data[2] (Kramer et al 2016, Casper and Weber 2026 in review), as well as slope and aspect (calculated from lidar data). The susceptibility model will be advanced into a hazard model, which takes into account the likelihood of fire ignition. This will be estimated using past fire events (Weber 2026) and lightning pattern analysis (Boccippio et al. 2001, Weber 2024). Finally, the hazard model will be advanced into a risk model, which takes into account the presence of homes, structures, and infrastructure (e.g., electric transmission lines and substations).

Table 1*. Spatial data to be used by the SPARC project (note: these data have already been acquired/purchased by the GIS TREC at ISU)*

Name	Data Type	Spatial Resolution
NASA/USGS Landsat 9	Satellite imagery	30 meters per pixel
EU Sentinel 2	Satellite imagery	10 meters per pixel
EU SPOT 6	Commercial satellite imagery[1]	1.5 meters per pixel
WorldView 3	Commercial satellite imagery	1.2 meters per pixel

[1] The wildland urban interface can be thought of as suburban and rural areas where private property adjoins undeveloped rangelands and forests which are often public lands managed by state and federal agencies.

[2] Lidar is an acronym for light detection and ranging. It is a spatial data technology to map elevation of not only the ground but tree heights above ground as well. Resulting lidar data products are highly spatially resolved (1 meter per pixel)

WorldView Legion	Commercial satellite imagery	0.3 meters per pixel
USDA NAIP[2]	Aerial imagery	0.3 meters per pixel
Digital Terrain Model	Lidar-derived imagery	1.0 meters per pixel

1. Pan-sharpened imagery based on original 6 meter per pixel source data
2. NAIP is an acronym for National Agricultural Imagery Program. Imagery collected in both 2023 and 2025 is available for the SPARC study area

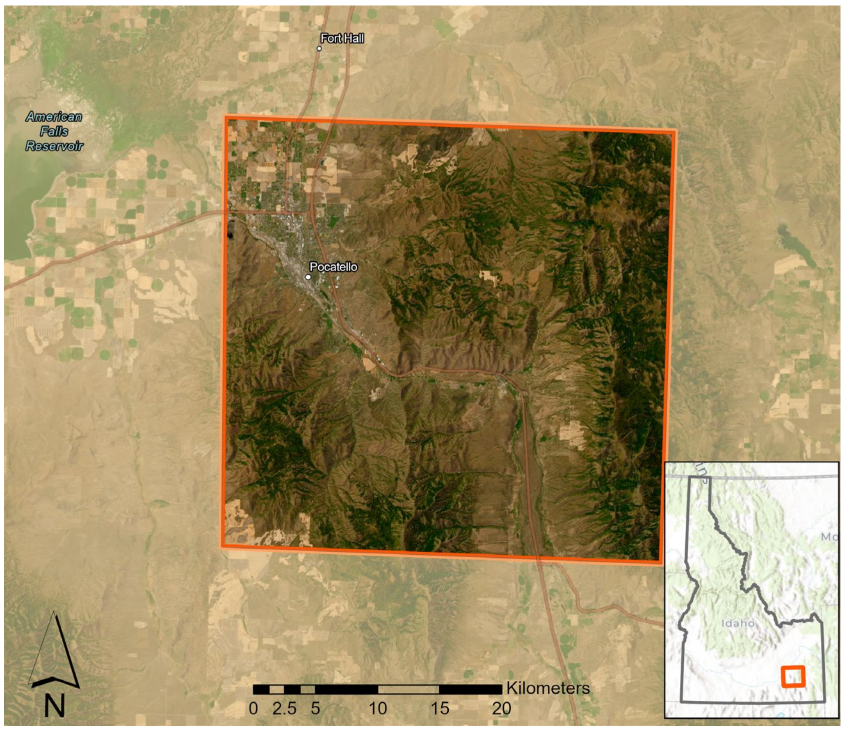

***Figure 1**. The southeast Idaho study area for the SPARC project includes the cities of Pocatello and Chubbuck as well as parts of Fort Hall in Bannock County.*

The output models alone may be quite useful to emergency managers, but SPARC proposes to develop even more advanced spatial information. Artificial intelligence, machine learning, and deep learning techniques will be implemented to extract features (e.g., structure footprints and utility poles) from high spatial resolution aerial and satellite imagery. Furthermore, the imagery will be used to delineate areas lacking defensible space within the WUI. All these data, taken together, will result in a conflagration risk model (Bankoff et al 2012). By the end of the summer 2026, these models and the research completed will be communicated and shared with emergency managers (e.g, Wes Jones, Bannock County Emergency Director).

Phase two of SPARC will be completed throughout the fall semester. In this part of the project, the *impact* of the spatial data science completed in phase one will be greatly expanded by developing course material, website content[3], and presentations. The goal of phase two is to

[3] The SPARC project website will look very similar to a previous ISGC project website https://giscenter.isu.edu/research/Techpg/NASA_ISGC/index.htm

empower the student with the communication skills necessary to transform the spatial data into actionable information (Weber 2021). By the end of the fall semester, numerous PowerPoint presentations and hands-on exercise tutorials will be completed to allow other students to learn and better understand wildfire from both an ecological and policy perspective, and obtain spatial data science skills that can be applied to numerous other regions or problem scenarios.

Examples of the materials developed throughout phase two of the SPARC project include a syllabus with guest lecture invitations, literature review, PowerPoint presentations, discussion topics, questions, and moderation guidelines, as well as detailed computer laboratory exercises.

In phase three, a *Special Topics: Wildfire and Spatial Data Science* course will be taught during the spring semester 2027. This phase will be led by PI Weber with some assistance from the student who will help supervise computer lab sessions. An estimated 12-15 undergraduate and/or graduate students are expected to participate in this course and will complete the same geoprocessing steps used to develop the models throughout phase one of the SPARC project with the potential to improve the models by implementing experimental geoprocessing techniques taught during the course. The students will be introduced to high-performance computing (HPC), which is used to process and analyze the extremely large lidar point cloud data required to prepare input datasets used for ladder fuel modeling. An important section of this course will be a guest lecture by Dr. Shin Kue Ryu (ISU), which will focus on the implications and effects of policy on wildfire. Another highlight section of the course will focus on forecasting and alternative futures modeling. Here climate models for Idaho developed by PI Weber as part of the NSF EPSCoR I-CREWS study[4] (Weber 2025) will be explored and used to develop possible future wildfire risks based on existing trends in precipitation, snow pack, ambient temperature, and atmospheric vapor pressure. Improved models will be shared with emergency managers.

Upon successful completion of *Special Topics: Wildfire and Spatial Data Science*, the student will be able to (1) complete spatial data science workflows using data engineering skills to prepare remotely sensed data for use in classification analyses, (2) transform spatial and non-spatial data into actionable information, (3) Integrate policy constraints into spatial models, and (4) apply critical thinking to research questions

The Special Topics course developed by the SPARC project will be offered in spring semesters beginning in 2027 and offered again in 2028, etc.

PI Weber will prepare final reports and necessary deliverables by the end of the project award period of performance.

SPARC has the potential to have substantial impact in two of four STEM fields, namely science and technology with arguably some impact toward advancing our student's skills in mathematics through imagery calculations and map algebra. First, numerous students at Idaho State University will be positively impacted by learning advanced spatial analysis and remote

[4] https://idahocrews.org/