

A Spatial Decision Support System and Open Knowledge Network for Fire-Risk Reduction in Santa Barbara County



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Conservation
Biology Institute

**ThinkSpatial Presentation, Department of Geography, University of California, Santa Barbara
December 3, 2021**

Key Links (Page added post-presentation)



The [Regional Priority Planning Website](#)

The [Wildfire Risk Reduction SDSS v1.0 Core Map](#) (Click on the  icon in the layers tab to open the GUI.)

The EEMS Explorers for [Wildfire Risk Reduction](#), [Open Space Wildfire Risk Reduction](#), [Prescribed Herbivory Priorities](#)

Gallo, John A., Zachary M. Canter, and Wayne D. Spencer. 2021. A Spatial Decision Support System for Wildfire Risk Reduction in Santa Barbara County, California. Conservation Biology Institute.

<https://doi.org/10.6084/m9.figshare.15175752>

Tutorial for how to use the tools, Zoom, Dec 9, 1:00 PM. [Register here](#).

The KgBase Explorer of the [People, Projects, and Expertise Knowledge Graph](#). To view an example query of a different Kg Base, [click here](#).

The [Projects on the Website](#), and their [google spreadsheet](#)

Gordon, Sean N., Philip J. Murphy, John A. Gallo, Patrick Huber, Allan Hollander, Ann Edwards and Piotr Jankowski. Accepted, in Proofreading. People, Projects, Organizations, and Products: Designing a Knowledge Graph to Support Multi-Stakeholder Environmental Planning and Design. International Journal of Geo-Information.

More about the Open Knowledge Network Project: <https://www.collaborativegeodecisions.net/>

Today's Context



- Overarching Research Goal:
 - Improved access to geospatial knowledge and data to support decision making
- Presentation
 - Part 1: A Spatial Decision Support System (SDSS) for Fire-Risk Reduction in Santa Barbara County
 - Part 2: An Open Knowledge Network (OKN) Framework and initial Application
- Future Research:
 - The Case Study is ripe for building operable links between SDSS and OKN

Partner Organizations



SANTA BARBARA COUNTY
CONSERVATION BLUEPRINT

Funders



Regional Priority Plan for Santa Barbara County

<https://www.sbcwildfireresilience.org/>

SBC Wildfire Resilience Priorities

[Home](#) [Process](#) [Partners](#) [Projects](#) [Permitting](#) [Matrix](#) [Maps](#)

[Contact](#)

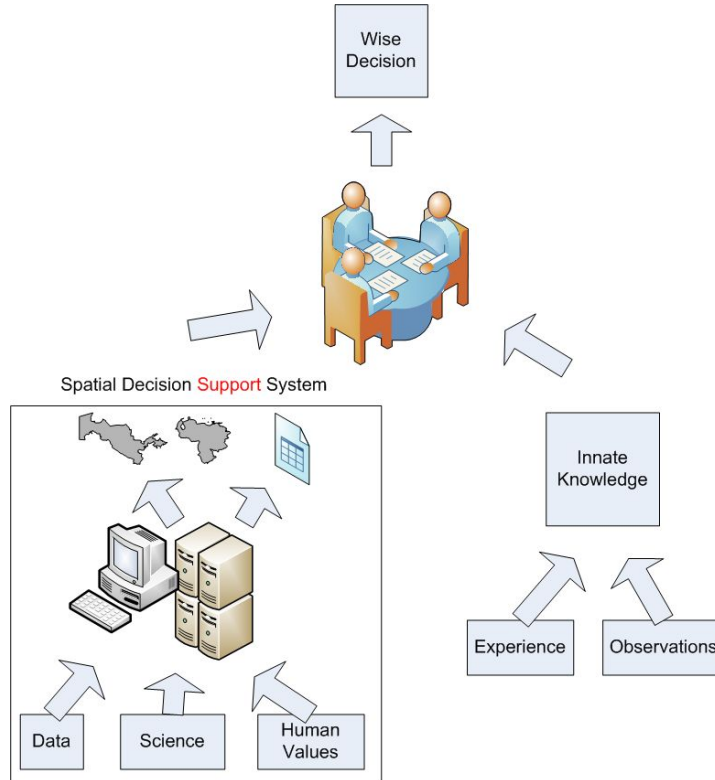
A large, intense wildfire with a fire truck in the foreground. The fire is massive, with bright orange and yellow flames and thick black smoke rising into the sky. In the foreground, a white fire truck with blue and red markings is visible, its headlights on. The scene is dark, suggesting it might be nighttime or in a very smoky environment.

Regional Priority Plan to Reduce Wildfire Risk and Improve Forest Health in Santa Barbara County

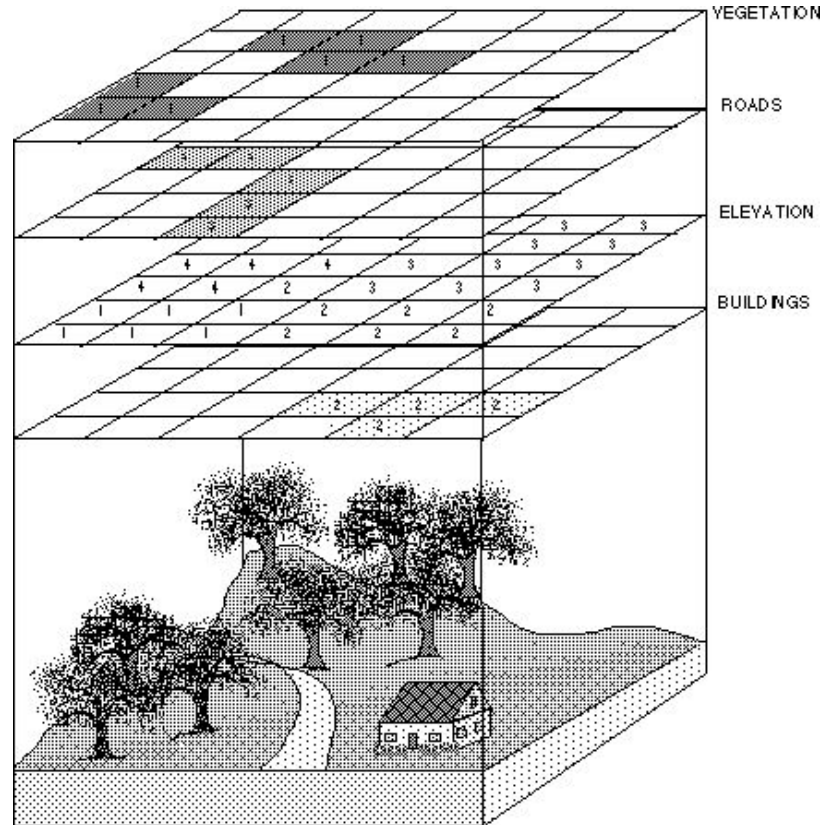
As Santa Barbara County becomes more vulnerable to the risks of large-scale fire events given the ever-increasing impacts of climate change and extreme heat and drought conditions, community leaders and frontline communities are increasingly focused on these challenges and finding opportunities to build resilience and reduce these risks. A number of efforts are underway to identify high-priority opportunities for meeting the challenges of addressing fire risk in a proactive manner.



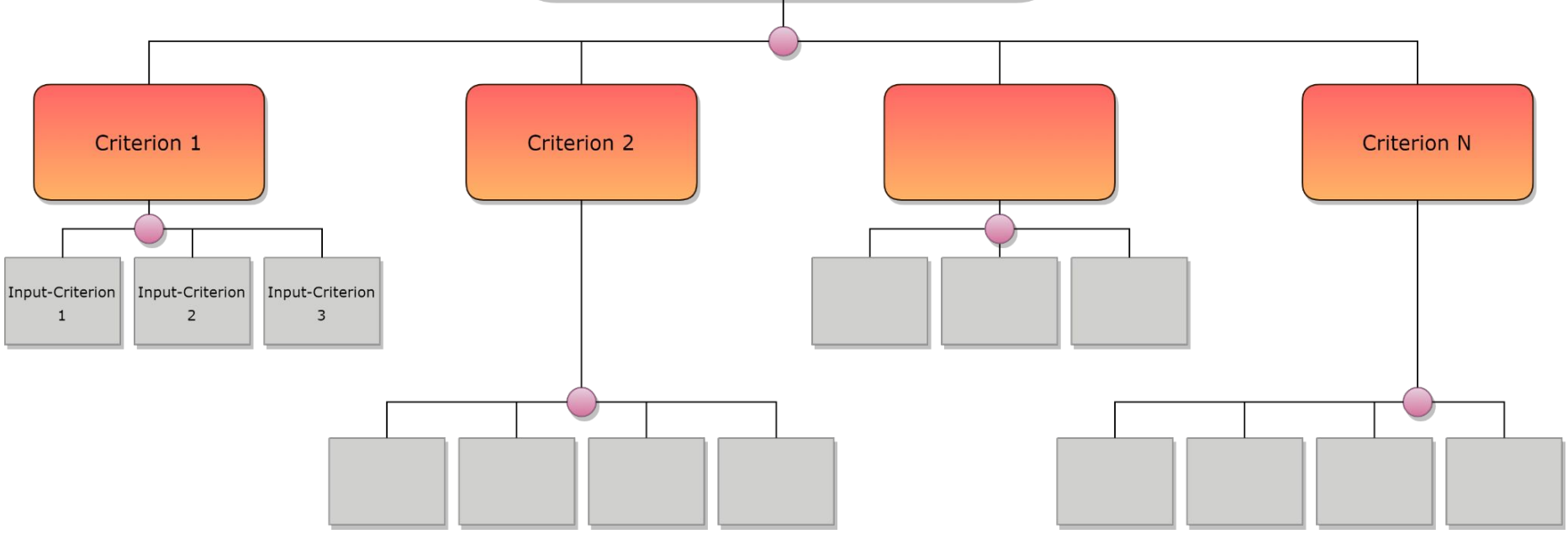
Spatial Decision Support System



Map Algebra of Criteria



Where are the suggested High Priority Sites for Wildfire Risk Reduction Treatments in SB County?



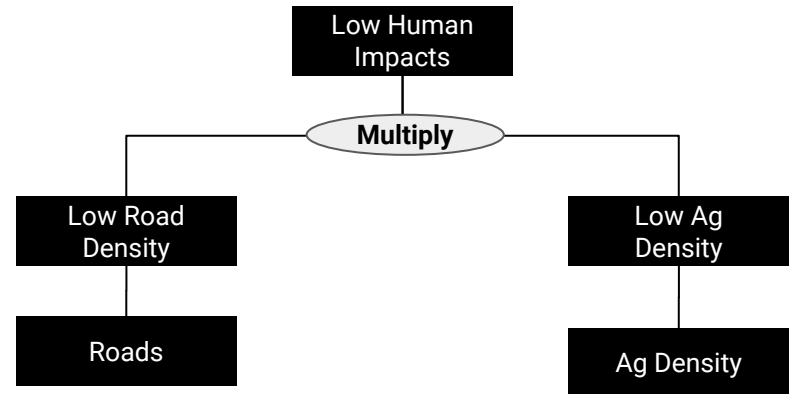
Building the SDSS

Use Environmental Evaluation Modeling System (EEMS)

- Open Source Software
- GUI in Data Basin

Models are Hierarchical.

1. Start with a primary question (e.g., *is there low human impact?*)
2. Build branches consisting of sub-questions
3. Combine using Math Operators (e.g. Multiply, Weighted Sum, etc)



Continuous Values of Criteria

Allows us to assign shades of gray to phenomena instead of just true/false

Example: High Road Density (Criterion)

- Traditional Logic = Binary value (True/False)
- Continuous Values = Values along a truth continuum, here from 0-1



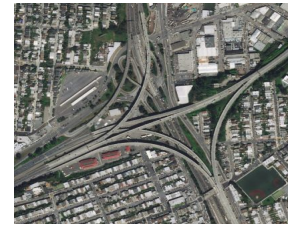
0 km/km²



8 km/km²

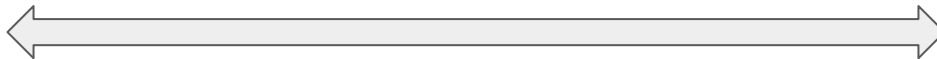


16 km/km²



25 km/km²

“High Road Density”
Totally False (0)

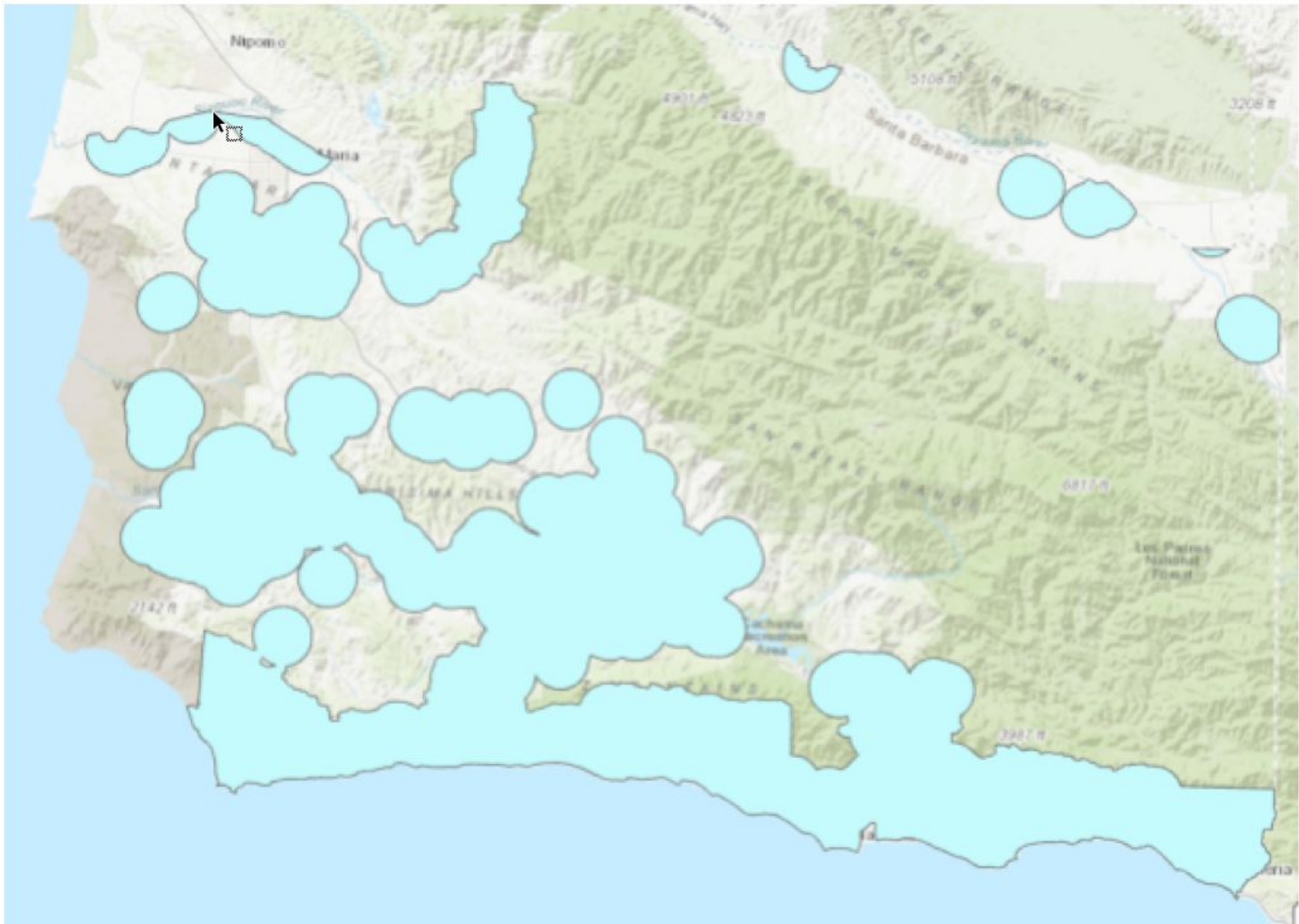


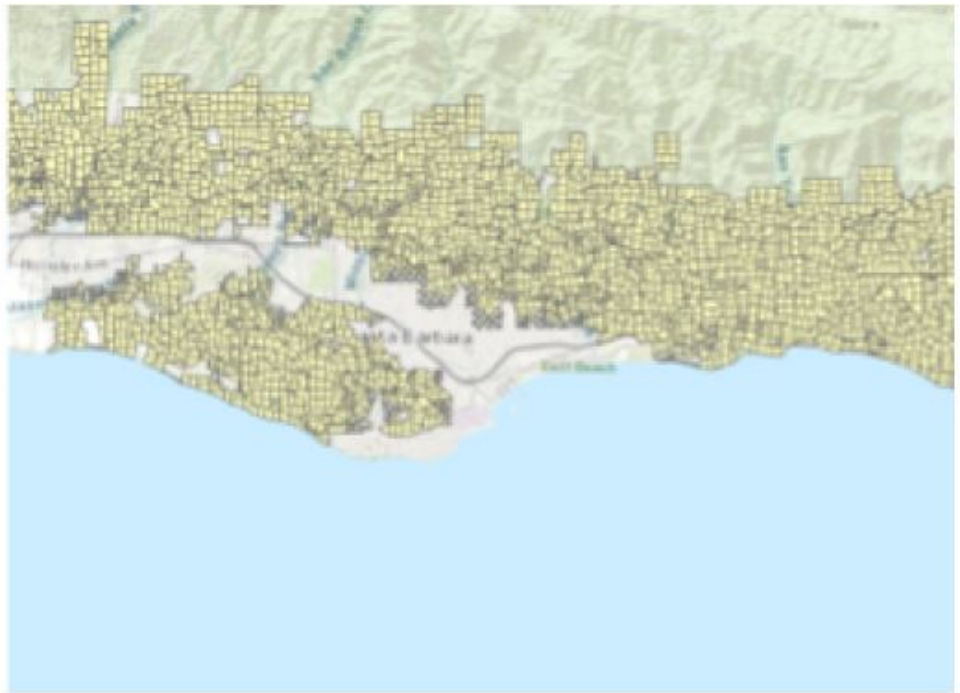
“High Road Density”
Totally True (+1)

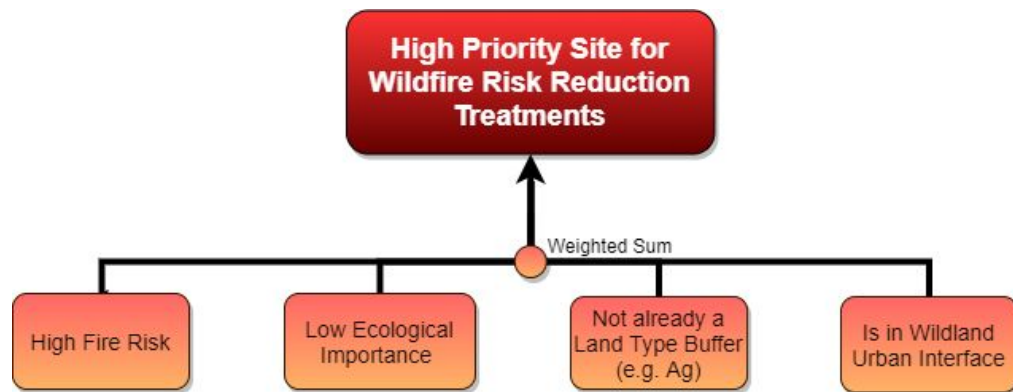
Expert Opinion Process

- 20+ Interviews
- CBI Strawman Logic Model
- RPP Planning Team Feedback
- Several Iterations









Two Graphical User Interfaces



- EEMSONline.org
- Data Basin
 - EEMS Explorer
- lets enter them via the RPP Website.

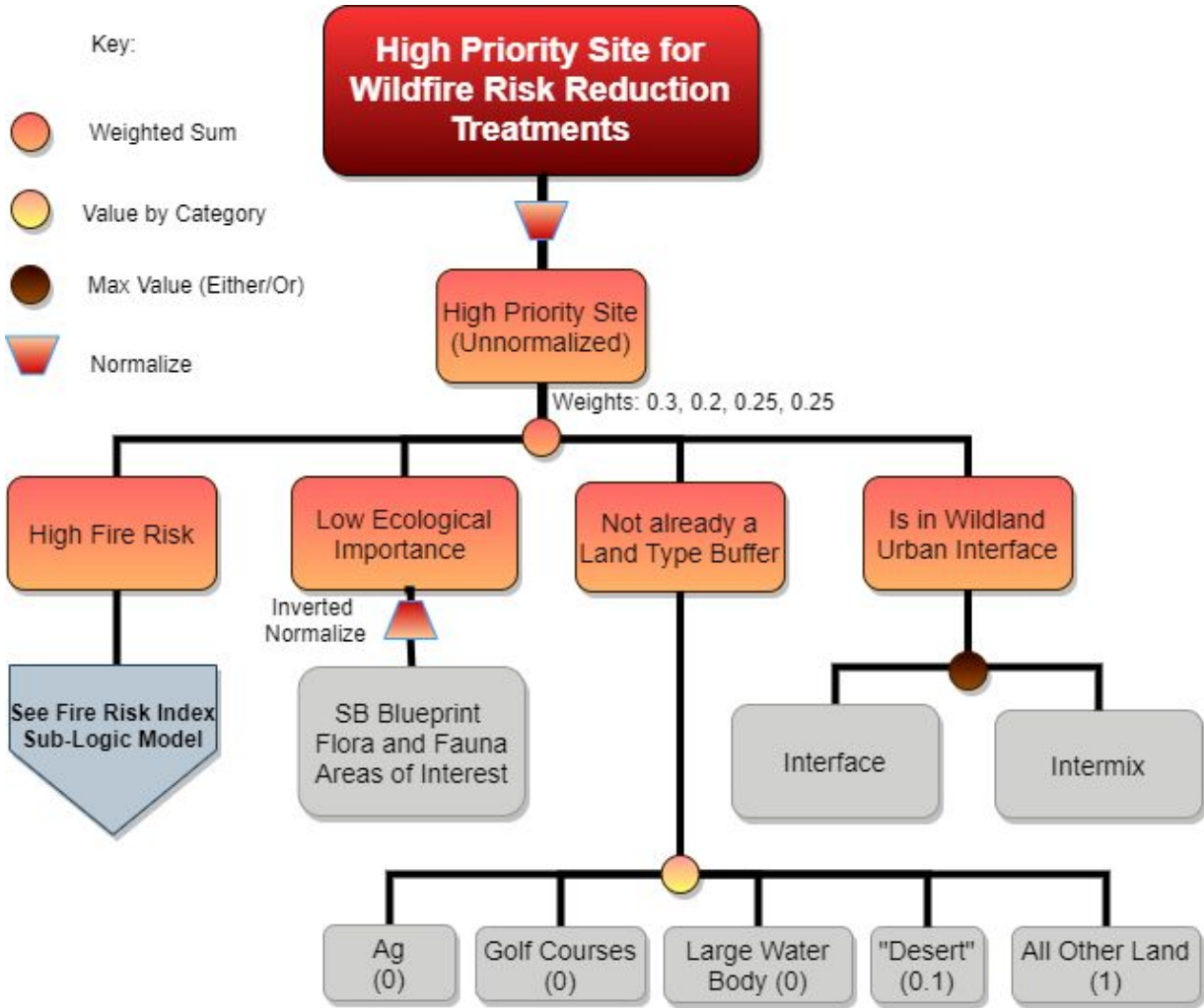
DEMO



High Priority Site for Wildfire Risk Reduction Treatments

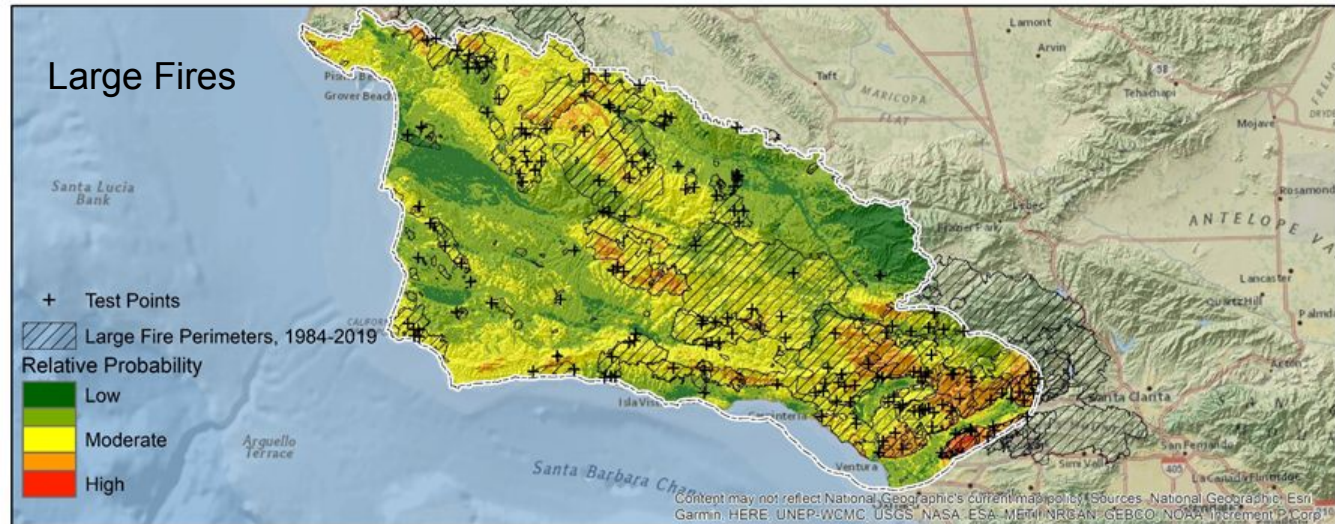
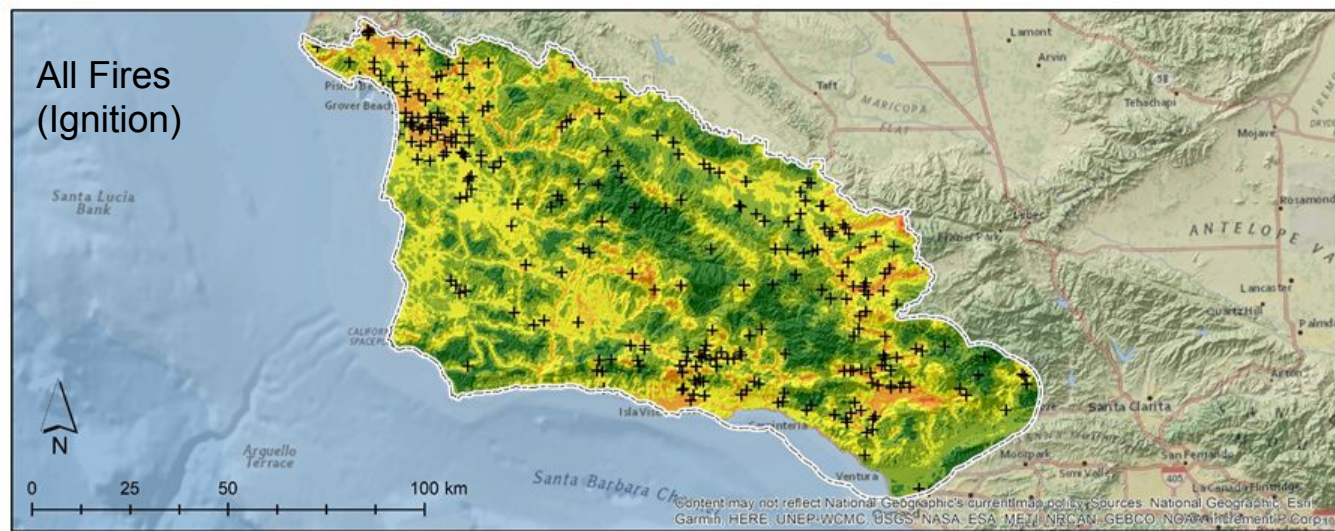
Key:

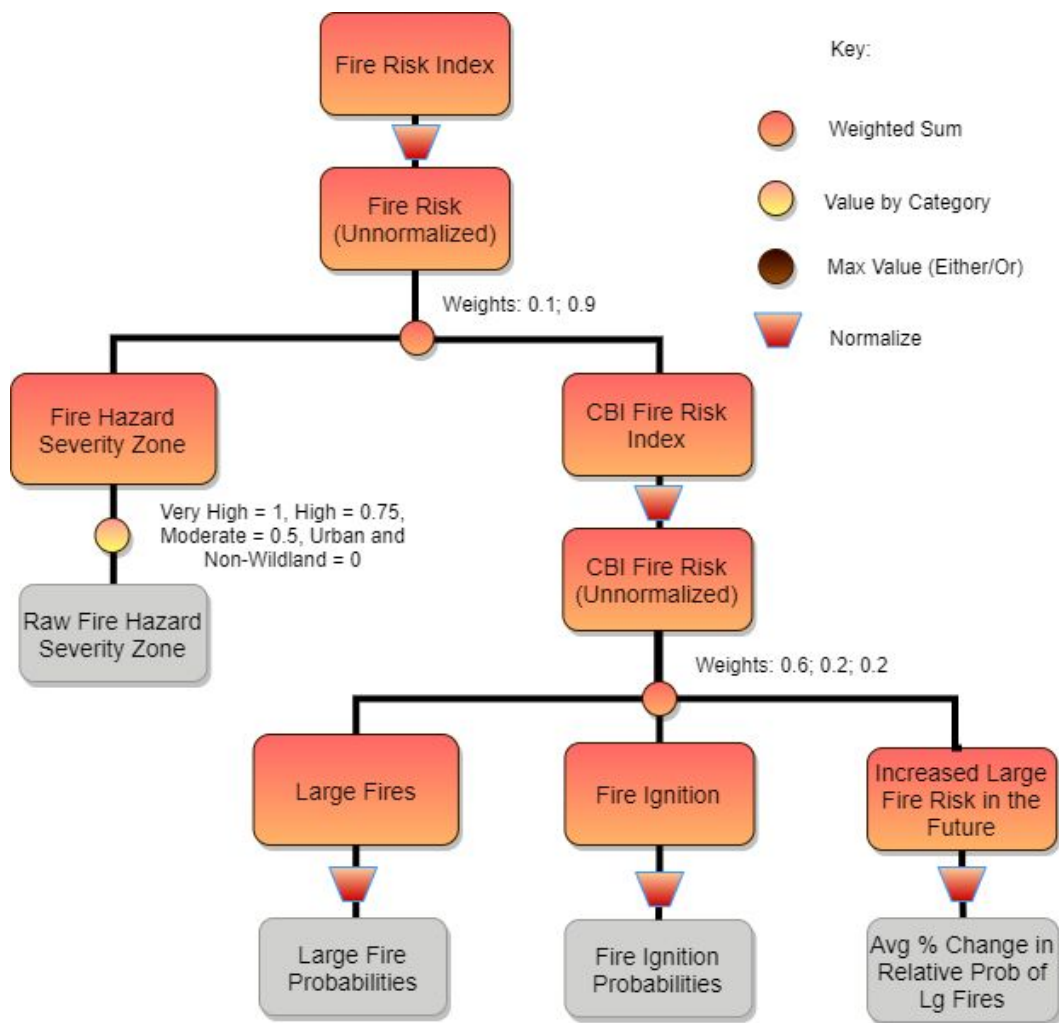
- Weighted Sum
- Value by Category
- Max Value (Either/Or)
- Normalize



Fire Risk Modeling

- **Countywide**
- **Statistical Analysis**
 - Past Fires
 - 18 Predictor Variables
- **Maxent Analysis**
 - Correlations
- **Put into Larger Model**
- **Link with Open Knowledge Network**





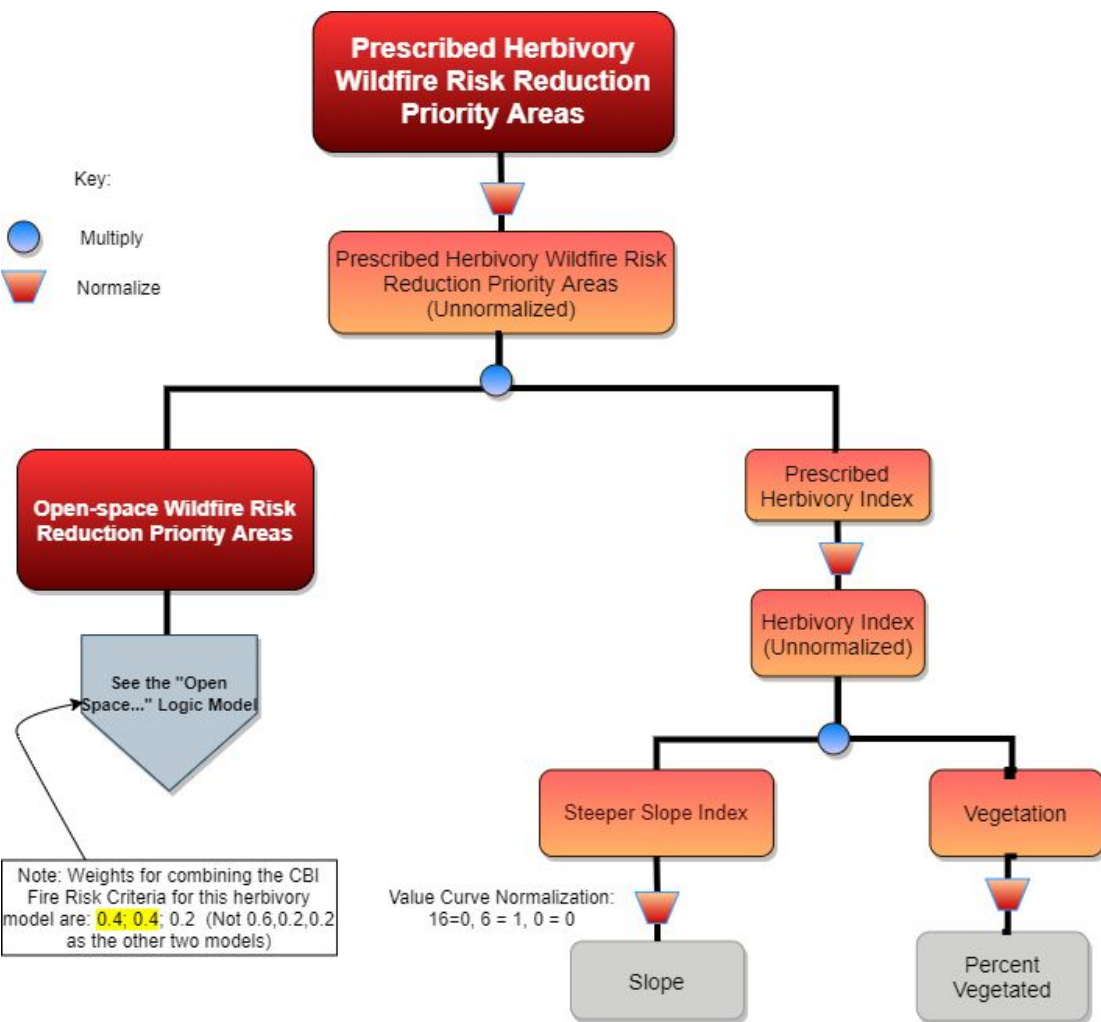
**Open-space Wildfire Risk
Reduction Priority Areas**

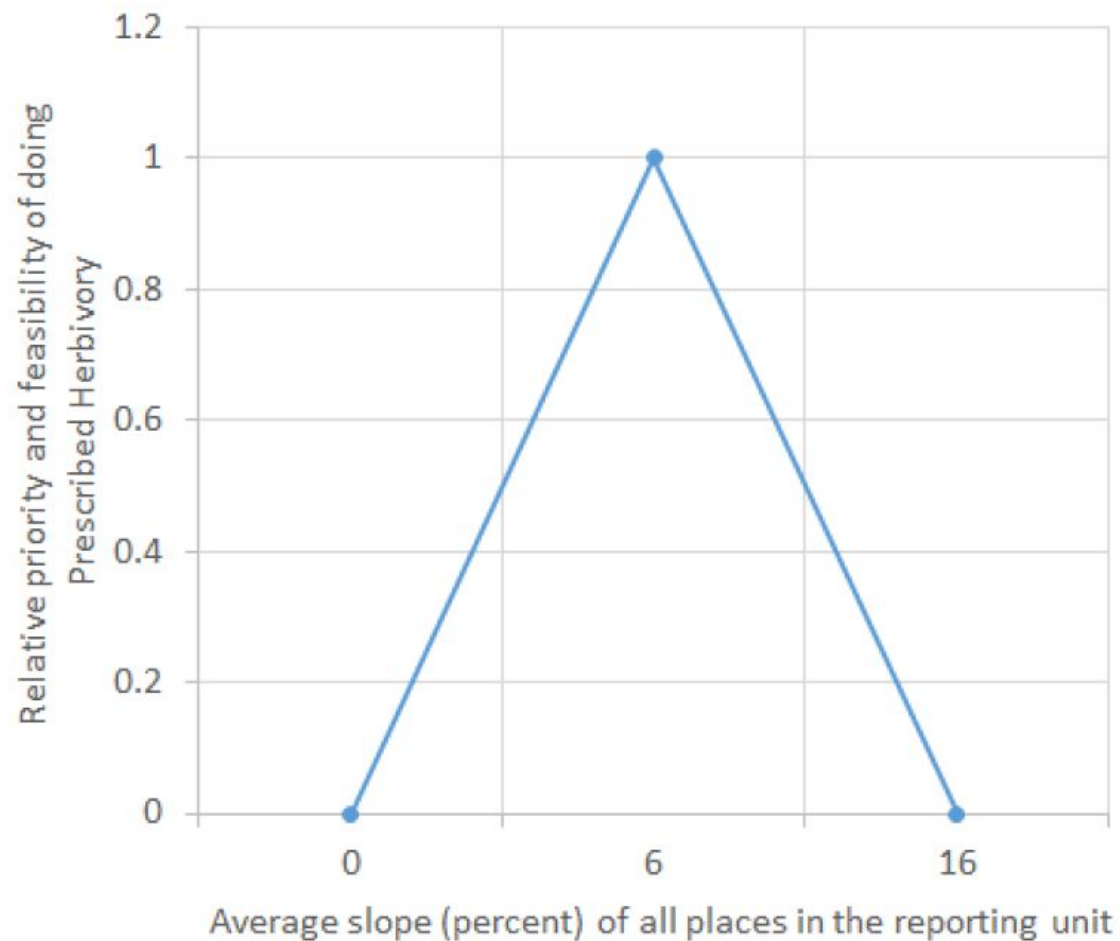
Multiply

**High Priority Site for
Wildfire Risk
Reduction Treatments**

Undevelopment
Index

See the "High
Priority Site..."
Logic Model





SANTA BARBARA COUNTY CONSERVATION BLUEPRINT ATLAS

Search by keyword or location

powered by DATA BASIN

ABOUT

EXPLORE

CREATE

COLLABORATE

WORKSPACE

The Atlas is a platform for community members to easily access high-quality maps, datasets, and information about land use and resources in Santa Barbara County.



What is the Santa Barbara County Conservation Blueprint Atlas?

What is the Santa Barbara County Conservation Blueprint?

How do I start exploring?

What else can I do?

Let us know your thoughts on the Blueprint Atlas

[Take Our Brief Survey](#)

Explore by theme



Water Resources



Climate



Ag and Ranch Lands



Community and the Land



Flora and Fauna



General



Fire

Explore by watershed

Click on a watershed in the map below to access



<https://sbcblueprint.databasin.org/>

Fire & RPP Portal on Conservation Blueprint

- Project 'Homepage'
- Links to Data Gallery



Fire Portal and Regional Priority Planning Project

By SB Atlas Admin

Jul 9, 2020 (Last modified Oct 30, 2020)

Manage... Add to...

Purpose and Description

Vision:

There are a multitude of agencies in SB County involved in fire management, and each has their own subset of relevant GIS data. They would all benefit from having the sum of all these data layers available to them, but this takes time to gather. The vision of this Fire Portal is to provide a data sharing hub, so people can share their data, view and interact with it and other people's data online, and download other data to their local systems.

Purpose

This portal has been developed in partnership with one of the Blueprint's Flagship Projects, the Cachuma Resource Conservation District's Regional Priority Plan (RPP) project. This is funded through the California Coastal Conservancy with the goal of fostering partnerships and projects to reduce wildfire risk and improve forest health in Santa Barbara County. This portal aims to help meet this goal by fulfilling the above Vision and also gathering data that will be synthesized in the RPP's spatial decision support system (SDSS) for helping prioritize projects.

Data:

Under the "Explore related items..." section you'll find maps on Santa Barbara County's:

- Fire History Time Series
- Fire Treatment Boundaries
- Wildland Urban Interface Boundaries
- Building Footprints
- Fire Risk Model Outputs

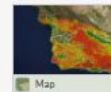
Each of these maps has a variety of data layers you can interact with. When you open these maps please pay close attention to the data layers that you can click on in the left tab. Keep in mind that each of these maps has a small subset of data layers that are available for fire resources. The full list of data layers for this theme can be found within the Fire in Santa Barbara Gallery, which we welcome you to explore. We will continue to add layers to this gallery as we receive them.



Explore related items...



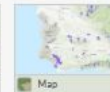
Debris Flow - Climate Impacts



Fire Probability - Climate Impacts



WUI Intermix, Interface, and Influence Zones, Santa Barbara



Multiagency Fuel Treatments, Santa Barbara County



Santa Barbara County Building Footprints



Fire Probability (2026-2050)



Fire History - Santa Barbara County



2017 Fires and Trails and Protected Lands, Santa Barbara



Fire Vulnerability - CEC Powerpoint



Fire - Vegetation Recovery Map



Local Fire Data, Santa Barbara County

Go to Data Basin



Part 2 of Presentation



- Part 1: A Spatial Decision Support System for Fire-Risk Reduction in Santa Barbara County
- **Part 2: An Open Knowledge Network**

Article in Press:

Article

People, Projects, Organizations, and Products: Designing a Knowledge Graph to Support Multi-Stakeholder Environmental Planning and Design

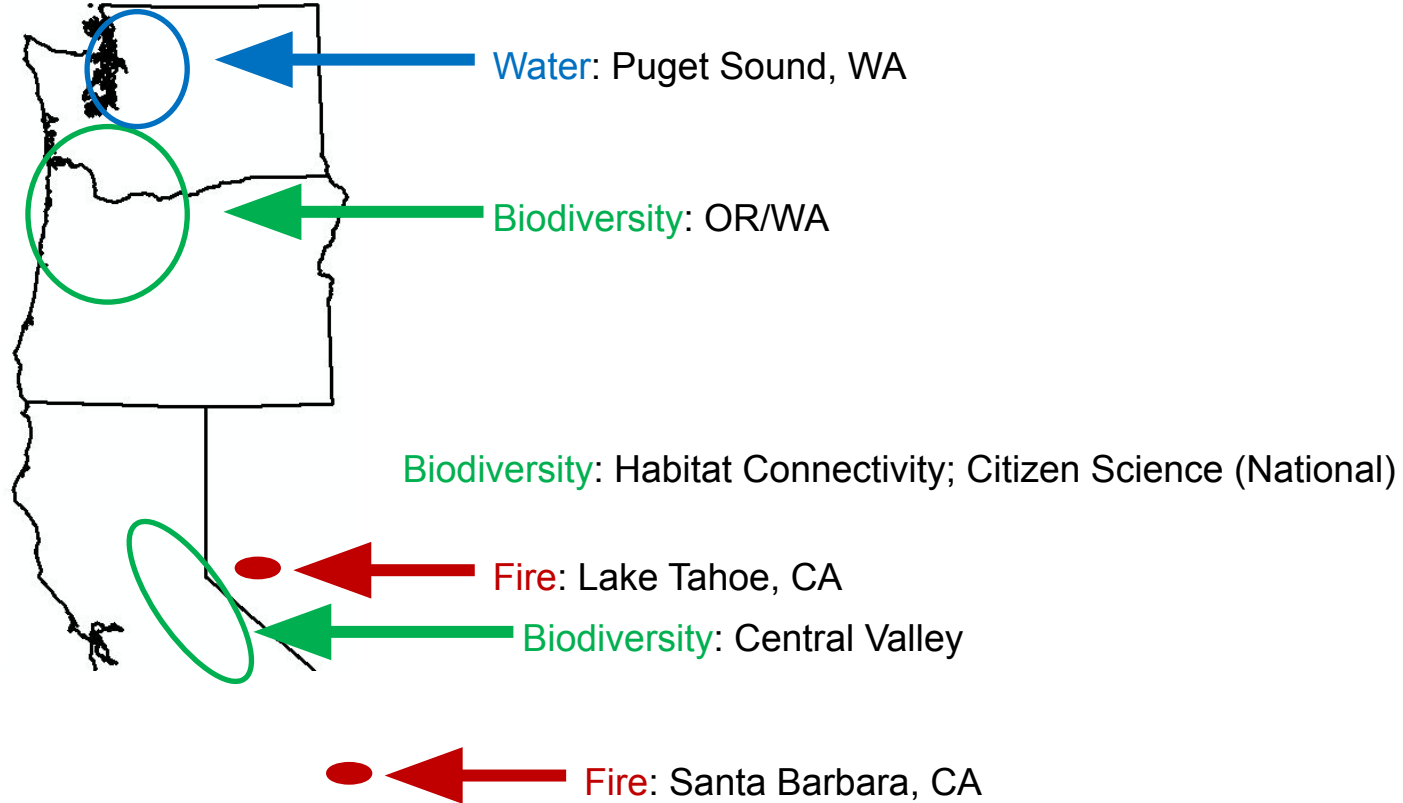
Sean N. Gordon ^{1,*}, Philip J. Murphy ², John A. Gallo ³, Patrick Huber ⁴, Allan Hollander ⁴, Ann Edwards ⁵
and Piotr Jankowski ^{6,7}



Open Knowledge Network

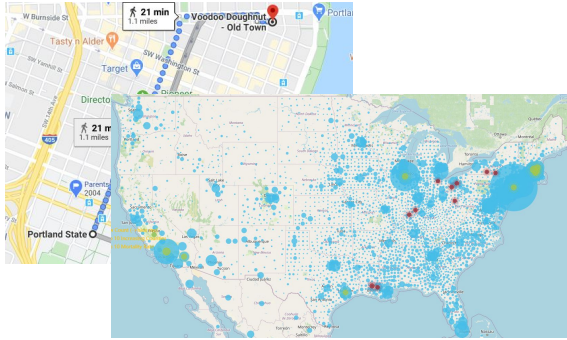
- Part of Web 3.0
 - Web 1.0 was static web pages
 - Web 2.0 was interactive data and much user produced content like social media
 - Web 3.0 is Linked Open Data
- What is Linked Open Data?
 - See up to 1:18 of <https://www.youtube.com/watch?v=uju4wT9uBIA>
 - Also called the Semantic Web
- How do they Link?
 - Using “Triples” in Knowledge Graphs
 - Subject
 - Relationship
 - Object
 - Example:
 - Subject = Person = “John”
 - Relationship = HasExpertise
 - Object= Knowledge Domain = “Geography”
 - Result
 - John has expertise in Geography
 - All in a machine readable format...

Use Cases

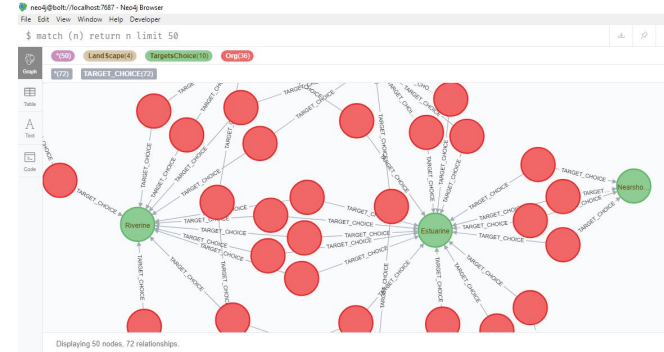


Potential of SDS + Open Knowledge Networking

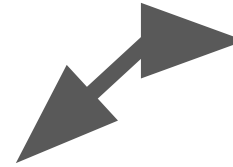
Spatial Decision Support



Knowledge Graphs



Collaboration Tools & Techniques



1. What is the structure of the multi-stakeholder network and the problem they are addressing?
2. What are their knowledge discovery, sharing, and usage needs, particularly convergent ones across scales/sectors/roles/disciplines (we refer to these as “need-to-know questions and concerns” or NTKQC)?

Water

Puget Sound Partnership, WA



Wildfire

Santa Barbara County, CA



Phase I Multi-sector Stakeholder Case Studies

Biodiversity

Cascades to Coast

Landscape Collaborative, OR/WA



Table 1. High-level information needs from the case studies.

Information Needs				
Case Study	People and Organizations	Indicators	Priority Areas for Work	Strategies, Methodologies, and Tools
Water quality in the Puget Sound	✓	✓		
Wildfire management in Santa Barbara	✓		✓	✓
Biodiversity in Cascades to Coast	✓		✓	✓

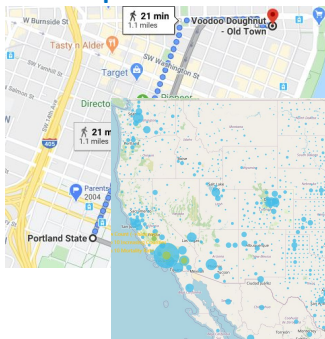
Wildfire	Need to make the system of actors more readily visible and understandable	Information on who	
Wildfire	Need to measure levels of connectivity, communication, coordination, and collaboration between and amongst key actors in the system and track changes over time	Communication within/between roles	
Wildfire	Need tools to help guide risk reduction efforts and direct resource investments to particular places	Information on where/what	
Wildfire	Need methods to connect the people data with the environmental data (e.g., the network of people and organizations that should be involved for actions on any particular parcel)	Information on who	Information on where/what

Table 3. List of conceptual entities needed for the knowledge graph.

Class	Description
Person	An individual person with important links to organizational entities, products, and domain expertise
Organization	A group of people with a commitment to a shared structure and purpose
Program	An organizational structure for the resourcing and organizing of ongoing work
Project	A temporary organizational structure for accomplishing a particular objective
Report	A document describing the results of some investigation or effort
Tool	A codified technique for accomplishing a particular objective
Dataset	A named collection of data, usually containing only one type of data
Indicator	A piece of information designed to be a measure of the state of some phenomenon
Region	A particular spatial area
Knowledge Domain	A category for describing a body of related information

Potential of SDS + Open Knowledge Networking

Spatial Decisio



SDS Consortium

specific

Organization

member of

Person

specific

Philip Murphy

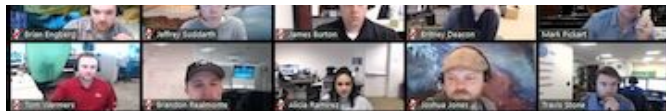
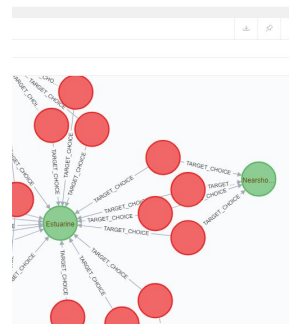
works on

Project

SDS OKN

specific

Graphs





A1 fx Data Dictionary for Class

	A	B	C	D	E	F	G	H	I	J
1	Data Dictionary for Class	Person	This sheet describes each field on the Person sheet							
2										
3	KG Class: Person	http://xmlns.com/foaf/0.1/Person	Person	Data Type	Description					
4		http://purl.org/dc/terms/identifier	identifier	'xsd:string'	This identifier is unique in the KG					
5		http://www.w3.org/2000/01/rdf-label	'rdf:label'	'xsd:string'	This label is created by the macros and is unique for the OKN knowledge Graph					
6		http://xmlns.com/foaf/0.1/first-name	'has first name'	'xsd:string'	Person's first name					
7		http://xmlns.com/foaf/0.1/last-name	'has last name'	'xsd:string'	Person's last name					
8		http://www.sdsconsortium.org	'works at'	'Organization'	identifier to organization in the Organization Class					
9		http://www.sdsconsortium.org	'works in department'	'Department'	Department within Organization (read from Organization Sheet entry)					
10		http://www.sdsconsortium.org	'works in division'	'Division'	Division within organization (Read from Organization Sheet entry)					
11		http://www.sdsconsortium.org	'holds job title'	'Job title'	from Job Title look up					
12		http://www.w3.org/ns/org#reports-to	'reports to'	'Person'	who this person reports to in their organization - Person Class					
13		http://xmlns.com/foaf/0.1/mail	'personal mail'	'xsd:string'	email					
14			'sourced from list'		Will NOT be included in KG, but can be maintained in these Google sheet					
15			'connected by'		Will NOT be included in KG, but can be maintained in these Google sheet - Used in a limited way in GoogleSheet - the member of the SB F					
16		http://purl.org/dc/terms/description	'has description'	'xsd:string'	brief description of who this person is					
17		http://www.sdsconsortium.org	'has authority'	'Decision domain'	Could be an organization - e.g. a CEO has (decision) authority for their company, could be jurisdictional - a governor has (decision) authority					
18		http://www.ic-foods.org/ontology	'has expertise'	'Knowledge domain'	They are an expert in Knowledge Domain (dropdown)					
19		http://www.sdsconsortium.org	'has stake in'	'Interest domain'	Domains they have a stake in - e.g. commercial fisherman in salmon recovery -- ?? Policy/program dropdown??					
20		http://www.w3.org/2000/01/rdf-comment	'comment'	'xsd:string'	Any comment about the data entered for this person -- e.g., could not find their title					
21		http://purl.obolibrary.org/obo/	'member of'	'Organization'	Instance of an organization that they are a member in - e.g. Union of Concerned Scientists, Board of a company , but NOT an organization					
22		http://www.sdsconsortium.org	'works on'	'Project'	Instances of Project that they are (or have) working on					
23		http://www.sdsconsortium.org	'works on'	'Model'	Instances of Model they are (or have) working on					
24			'contributes to'	'Dataset'	This person contributes in some way to a Dataset					
25		http://www.sdsconsortium.org	'directs'	'Program'	Instance of a Program that they direct					
26		http://www.sdsconsortium.org	'directs'	'Project'	Instance of a Project that they lead direct					
27		http://www.sdsconsortium.org	'has research area'	'Need to know topic'	need to know topic (dropdown) that they are researching					
28		http://xmlns.com/foaf/0.1/homepage	'foaf:homepage'	'xsd:string'	URL to a page describing this person - e.g., linked-in profile					
29		http://www.w3.org/2003/01/coords	'has location'	'xsd:string'	The WGS84 longitude, latitude of a SpatialThing (both decimal degrees, comma separated) -- e.g., 34.482884, -119.920496					
30										
31		http://xmlns.com/foaf/0.1/phone-number	'phone number'	'xsd:string'	Not in KG					
32		https://www.w3.org/2006/vcard	'street address'	'xsd:string'	NOT IN KG					



8 Dataset

2 Interview

2 Model

Report

DD Person

DD Project

DD Organization

DD Dataset

DD Region

2

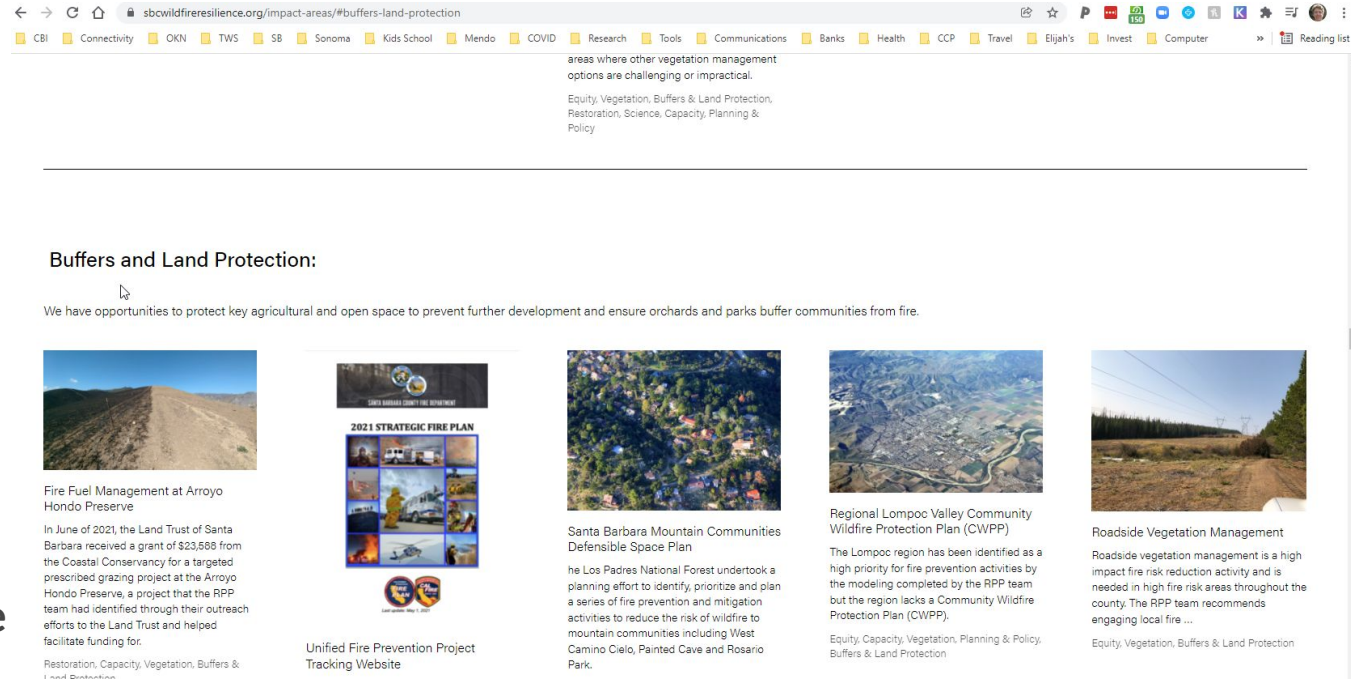


OKN Split into Two Products

- **Product Set #1: Projects Database and Webpages**
- **Product Set #2: People, Organizations, and Expertise Knowledge Graph and Webpages**

RPP: Projects Database

- 51 projects
- Open Access Spreadsheet:
 - Project Descriptions
 - 10 Impact Areas
 - 7 Readiness Factors
 - Priority
 - Relative Cost
 - Notes
- On Website Queryable by Priority, Impact Area, or “Featured”



sbwildfiresilience.org/impact-areas/#buffers-land-protection


CBII Connectivity OKN TWS SB Sonoma Kids School Mendo COVID Research Tools Communications Banks Health CCP Travel Eljah's Invest Computer Reading list

areas where other vegetation management options are challenging or impractical.

Equity, Vegetation, Buffers & Land Protection, Restoration, Science, Capacity, Planning & Policy

Buffers and Land Protection:


We have opportunities to protect key agricultural and open space to prevent further development and ensure orchards and parks buffer communities from fire.



Fire Fuel Management at Arroyo Hondo Preserve


In June of 2021, the Land Trust of Santa Barbara received a grant of \$23,588 from the Coastal Conservancy for a targeted prescribed grazing project at the Arroyo Hondo Preserve, a project that the RPP team had identified through their outreach efforts to the Land Trust and helped facilitate funding for.

Restoration, Capacity, Vegetation, Buffers & Land Protection




2021 STRATEGIC FIRE PLAN

Unified Fire Prevention Project Tracking Website



Santa Barbara Mountain Communities Defensible Space Plan


he Los Padres National Forest undertook a planning effort to identify, prioritize and plan a series of fire prevention and mitigation activities to reduce the risk of wildfire to mountain communities including West Camino Cielo, Painted Cave and Rosario Park.



Regional Lompoc Valley Community Wildfire Protection Plan (CWPP)

The Lompoc region has been identified as a high priority for fire prevention activities by the modeling completed by the RPP team but the region lacks a Community Wildfire Protection Plan (CWPP).

Equity, Capacity, Vegetation, Planning & Policy, Buffers & Land Protection



Roadside Vegetation Management

Roadside vegetation management is a high impact fire risk reduction activity and is needed in high fire risk areas throughout the county. The RPP team recommends engaging local fire...

Equity, Vegetation, Buffers & Land Protection

https://www.sbcwildfireresilience.org/matrix

		Impact Areas													Readiness Factors					Notes	
Community Identified Projects	Project Descriptions	Priority	Cost	Equity	Neighborhood Organizing	Restoration	Capacity Building	Education & Engagement	Population Management	Planning & Policy	Insurance	Resilience & Land Protection	Resilience & Policy	Accessibility	Partners	Capacity	Permitting	Designation	Funding Sources	Status	Notes
		3	Addressing WUI wildfire buffer gaps	1. Very High	\$\$\$																
4	Tequesquet Canyon Vegetation Management Program	1. Very High	\$\$																		<p>Tequesquet Canyon includes underserved communities and low income migrant workers, making this a high priority area from an equity perspective. The proposed vegetation management program would involve multiple components, with some prescribed fire, lots of roadside hand crew work, a few fuel breaks, and possibly some prescribed grazing. Santa Barbara County Fire Department is actively seeking funding. All portions of this project are within SB County jurisdiction, however, there is great potential and need to bridge the area into the LPNF. The LPNF completed the Bioscience Prescribed Fire Project between 2004 and 2009, which were found to be successful in the containment of the 2009 La Brea Fire.</p>
5	Campfire fire buffers on Paradise Road and other recreational areas throughout the County	1. Very High	\$\$																		<p>Paradise Road and other public land recreation areas throughout the County are highly visited community resources utilized by all income levels. These areas often include fire pits, grills and picnic areas where visitors bring stoves and other cooking equipment that can present fire risks. In earlier decades, buffer strips were created and maintained by county or forest service hand crews around such areas, but currently this effort lacks the funding and staffing capacity needed. The RPP team recommends inventorying all public recreation areas with such risks and developing a plan to build the capacity for annual fire prevention work into grants and annual budgets. This presents opportunities for the County Fire Department, the Los Padres National Forest, State Parks and other land managers to coordinate on the necessary inventory, planning, fundraising and implementation.</p>
6	Carpinteria Summerland Fire Hazard Fuel Reduction	1. Very	€																		<p>In June 2021, the Carpinteria Summerland Fire Protection District received funding from the State Coastal Conservancy to conduct a multi-pronged fuel reduction treatment program in the southeastern foothills of Santa Barbara County. The project includes continuous, year-round community-wide education, resource technicians, and mechanical maintenance of wildfire resources fuel breaks.</p>

RPP Project Impact Areas

Impact Areas

Equity - Centering equity and under-resourced communities is critical to resilience. Community resilience requires protecting our most vulnerable from the severe impacts of the climate crisis

Neighborhood Organizing - The roundtables and RPP outreach made it clear that fire resilience requires organized neighborhoods working together for preparation and prevention.

Restoration - Intact ecological communities are critical for wildfire resilience, and an array of restoration projects offer high impact opportunities to mitigate fire risk including removal of non-native and invasive vegetation and the reintroduction of herbivory and fire where needed.

Capacity Building - The projects identified below will require us to build new capacity to collaborate, secure funding, facilitate partnerships and build networks.

Education & Engagement - Education will be critical to building wildfire literacy, informing decision making, and advancing preparation and prevention initiatives.

Vegetation Management - Ecologically-informed vegetation management is needed to mitigate fire risk including prescribed herbivory, prescribed fire, roadside mowing and chipping programs

Planning & Policy - Wildfire resilience will require integration of ecologically-informed policy and investment in all of our public agencies and planning processes.

Insurance - Innovative solutions to the looming insurance crisis must be addressed where insurance, key to community resilience, may soon be impossible to acquire for many homeowners in the wildland urban interface area or WUI.

Buffers & Land Protection - We have opportunities to protect key agricultural and open space to prevent further development and ensure orchards and parks buffer communities from wildfire.

Research & Analysis - Projects that address a needed research topic to further guide and inform scientific knowledge were noted in this column.

Project Schema Data Transform

Query

Complex

Custom

▼ Display

 Projects Persons Topic

▼ Focus

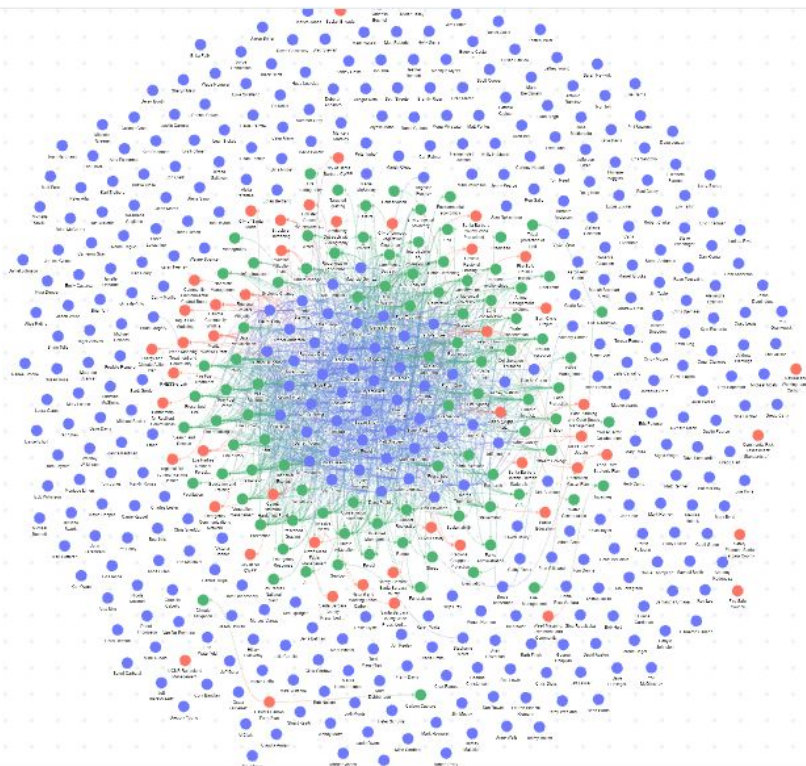
Double-click on a node in the graph and select
"Focus on node", or search here:

› Filters

▼ Configuration

Layout Default ▼

Nodes

Sizing Dynamic Fixed

Query Complex Custom

Display

- Projects
- Persons
- Topic

Focus

Double-click on a node in the graph and select "Focus on node", or search here:

Search for a node

Filters

Configuration

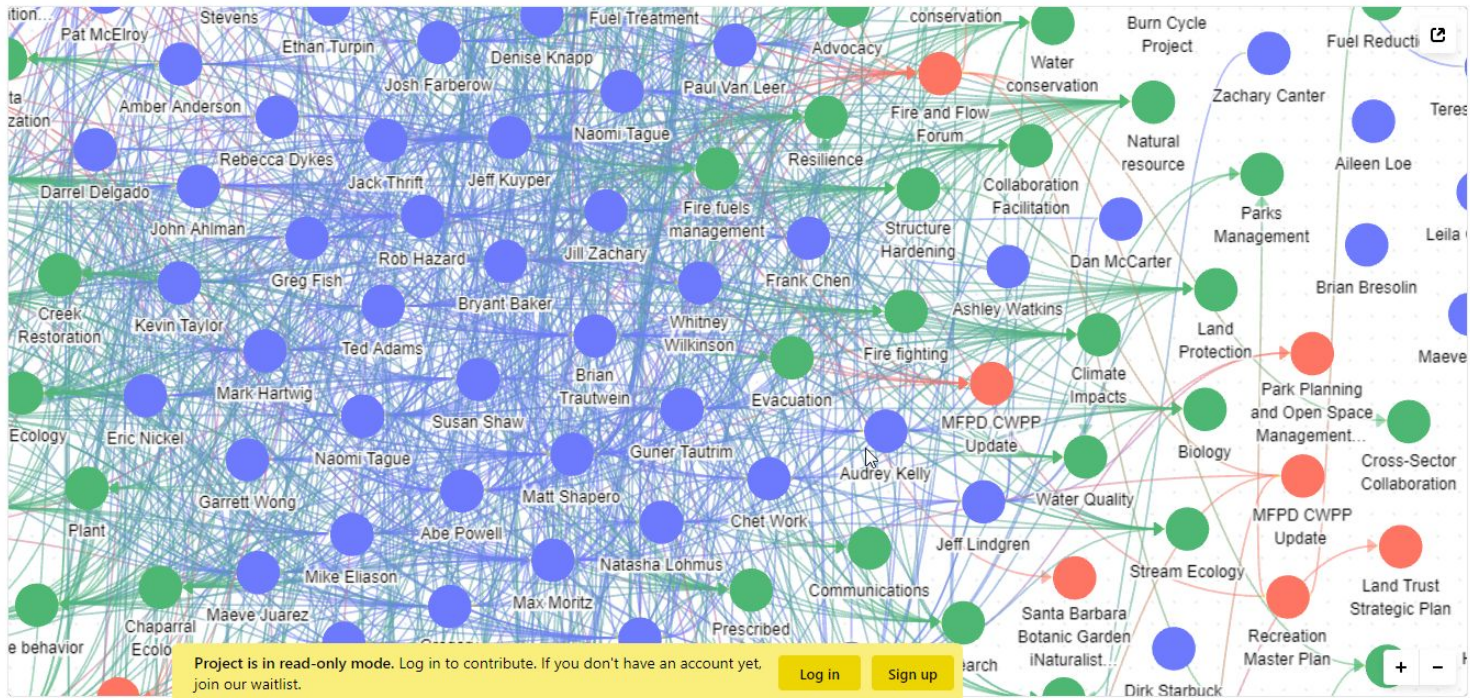
Layout Default

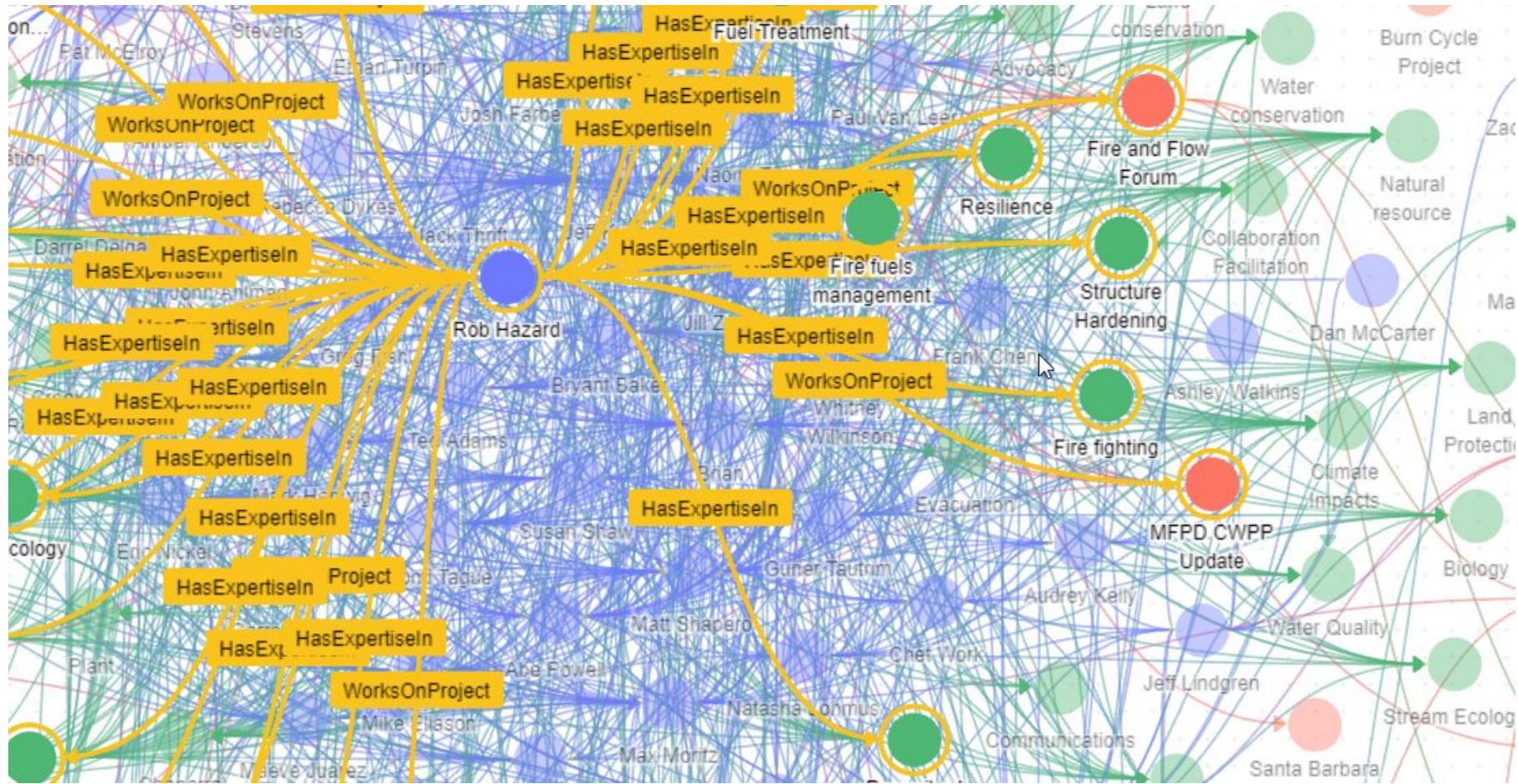
Nodes

Sizing Dynamic Fixed

Visibility Show images

Advanced configuration





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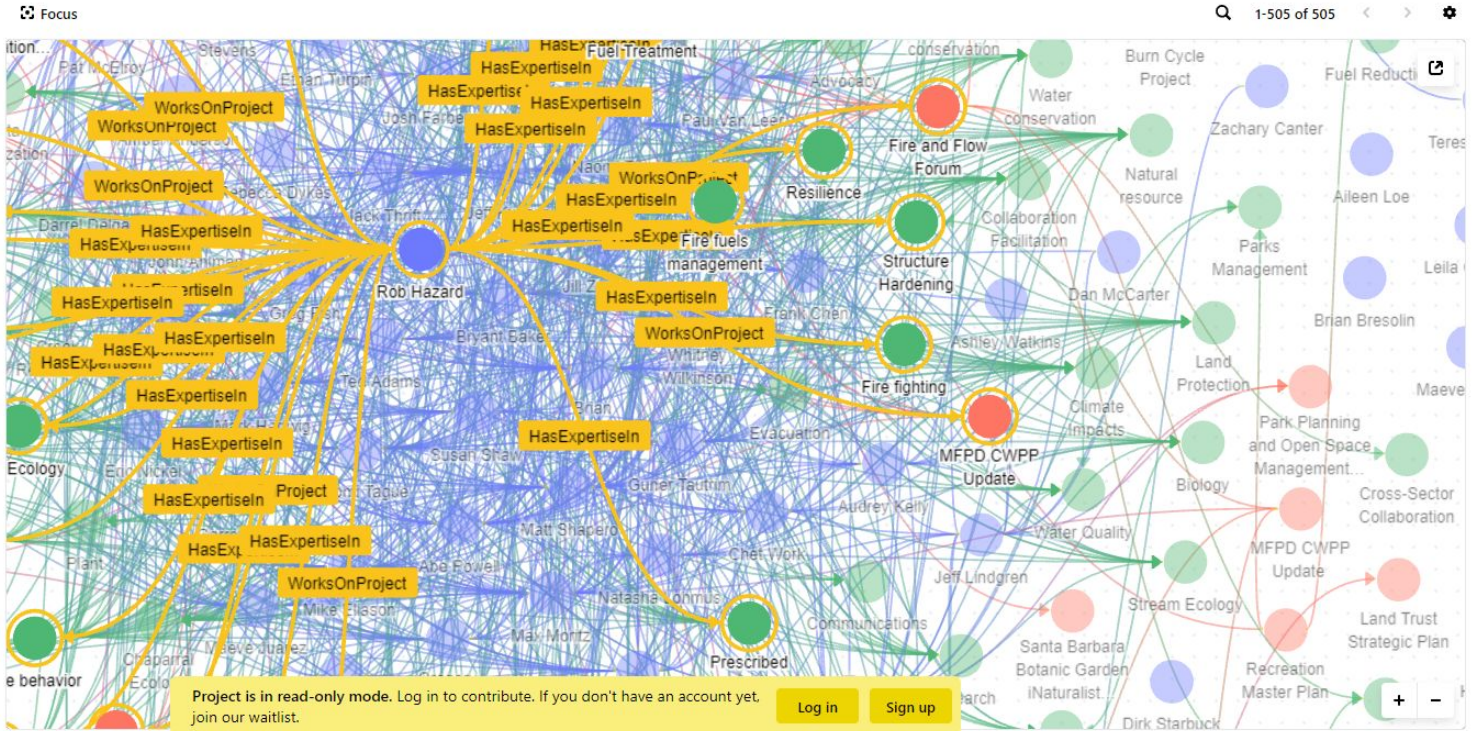
Layout Default

Nodes

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▼ Focus

● Rob Hazard ✕

› Filters

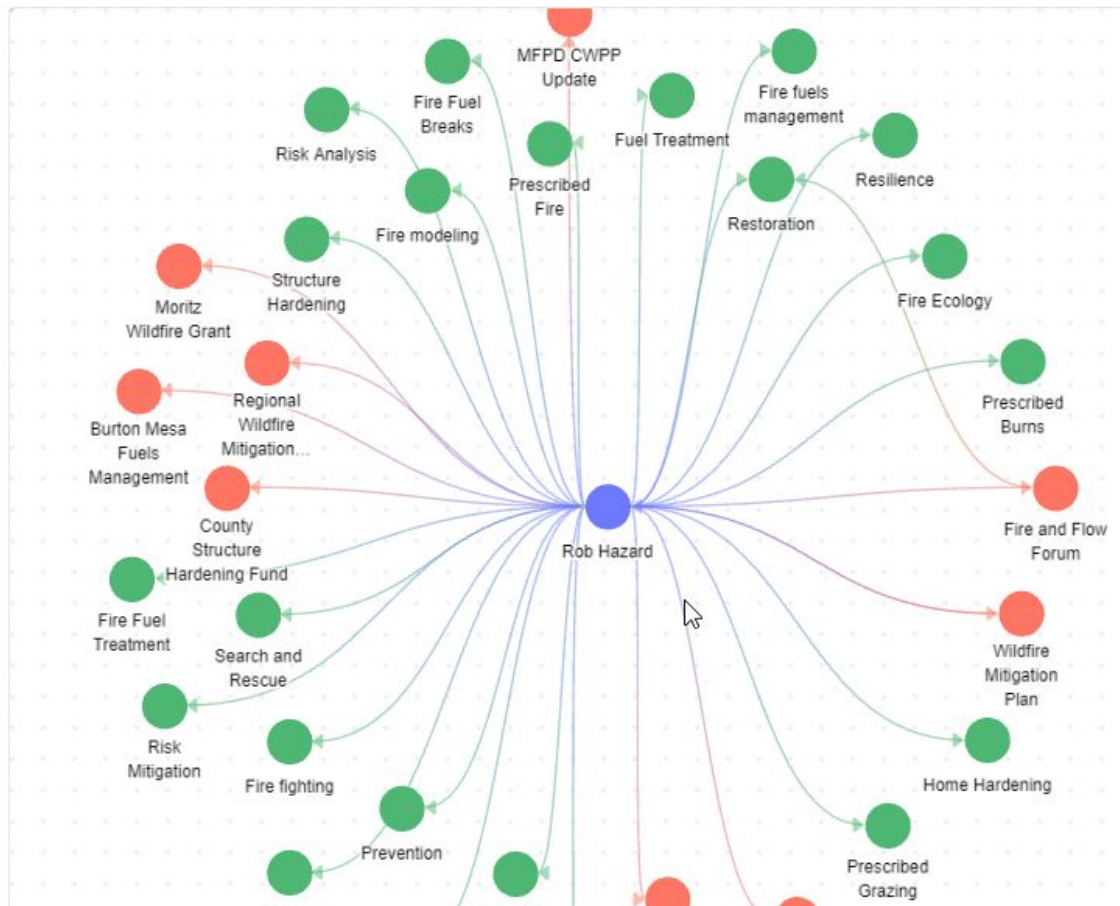
▼ Configuration

Layout Default

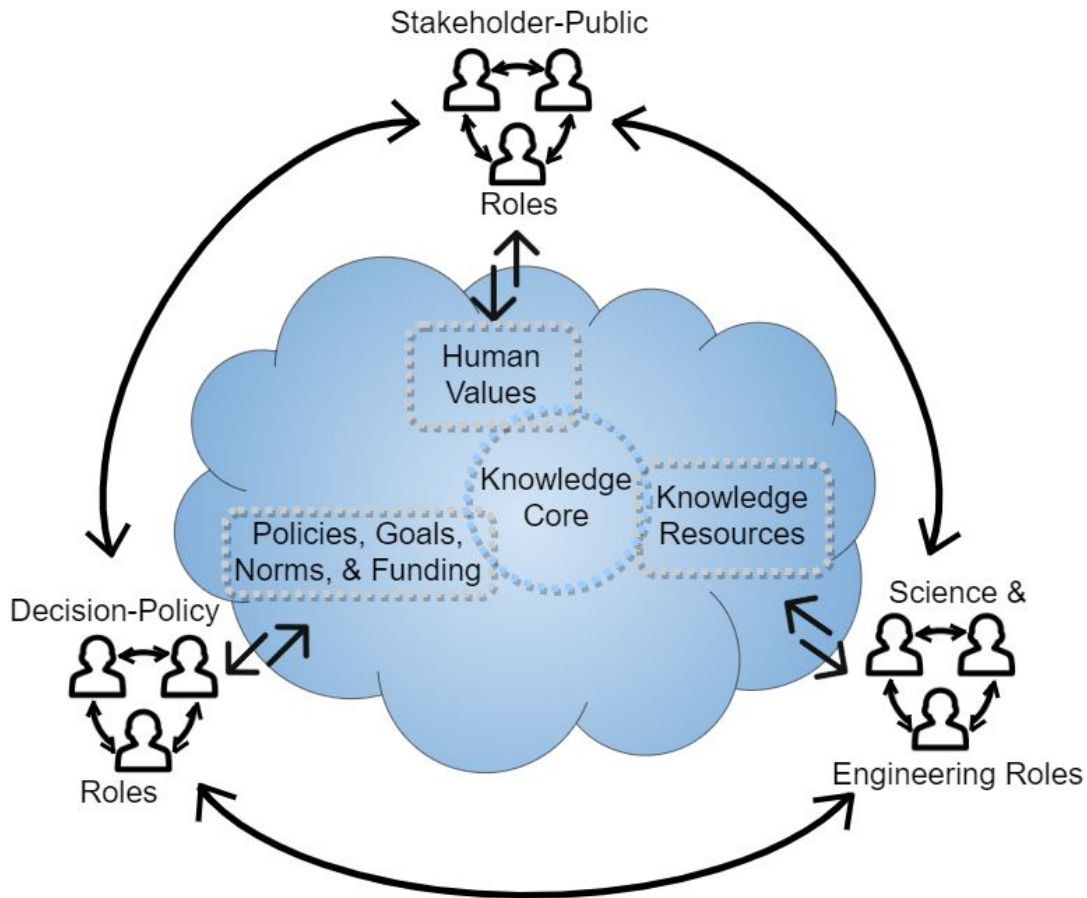
Nodes

Sizing Dynamic Fixed

✖ Clear focus



Open Knowledge Networking for Spatial Decision Support



Thank You!

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