Developing usable CTSM model and experimental configurations for Klamath River Indigenous communities

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NCAR | RESEARCH APPLICATIONS LABORATORY

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Background

- ***Full Project: Centering climate adaptation science and policy in Indigenous ecocultural practice to restore floodplains and ecohydrological processes in the Klamath River basin, California***
- **Project Methods**
  - Fire effects - hydrological modeling in Klamath Basin
  - Targeting questions and downscaling models using Karuk knowledge
  - Reconstructing past landscapes using historical imagery and Karuk place names
  - Informing community-engaged research for floodplain reconnection and cultural fire planning

Photos from Cleo Wölfle Hazard

Project Process

- Iterative discussions - Project team spent most of the first year discussing:
  - Capabilities of Community Terrestrial Systems Model (CTSM, formerly CLM)
    - Vegetation/land cover
    - Hydrology
    - Fire
  - **How can the model serve community needs?**
  - Other topics
    - Climate variability in the Klamath
    - Observation availability from traditional and community sources

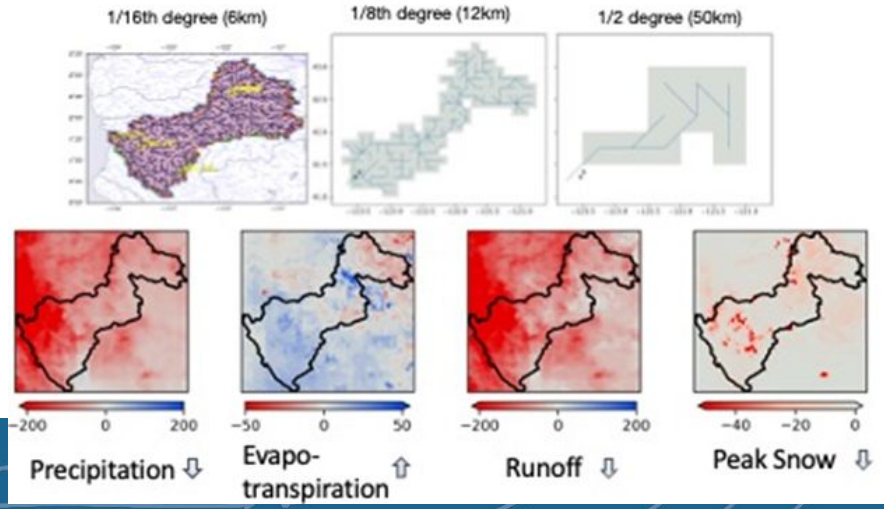


Photo from Cleo Wölfle Hazard, plots from NCAR

Project Process

- Iterative discussion - Community Partners
  - UW team has long-standing relationships with communities (**this is a key point!**)
  - Community workshop in June 2022, repeated community interactions over the course of the project
    - Led by UW and primarily performed by UW

Photo from Cleo Wölfle Hazard

Project Process

- Iterative discussion - Model Capabilities and Configuration
  - Spend a lot of effort here
  - Earth system models have many assumptions based on original use case
    - What are key assumptions, how to mitigate?
  - Project team decided a high-resolution grid was most appropriate for project goals
    - Need to resolve orography and land cover
    - What does high-res break?

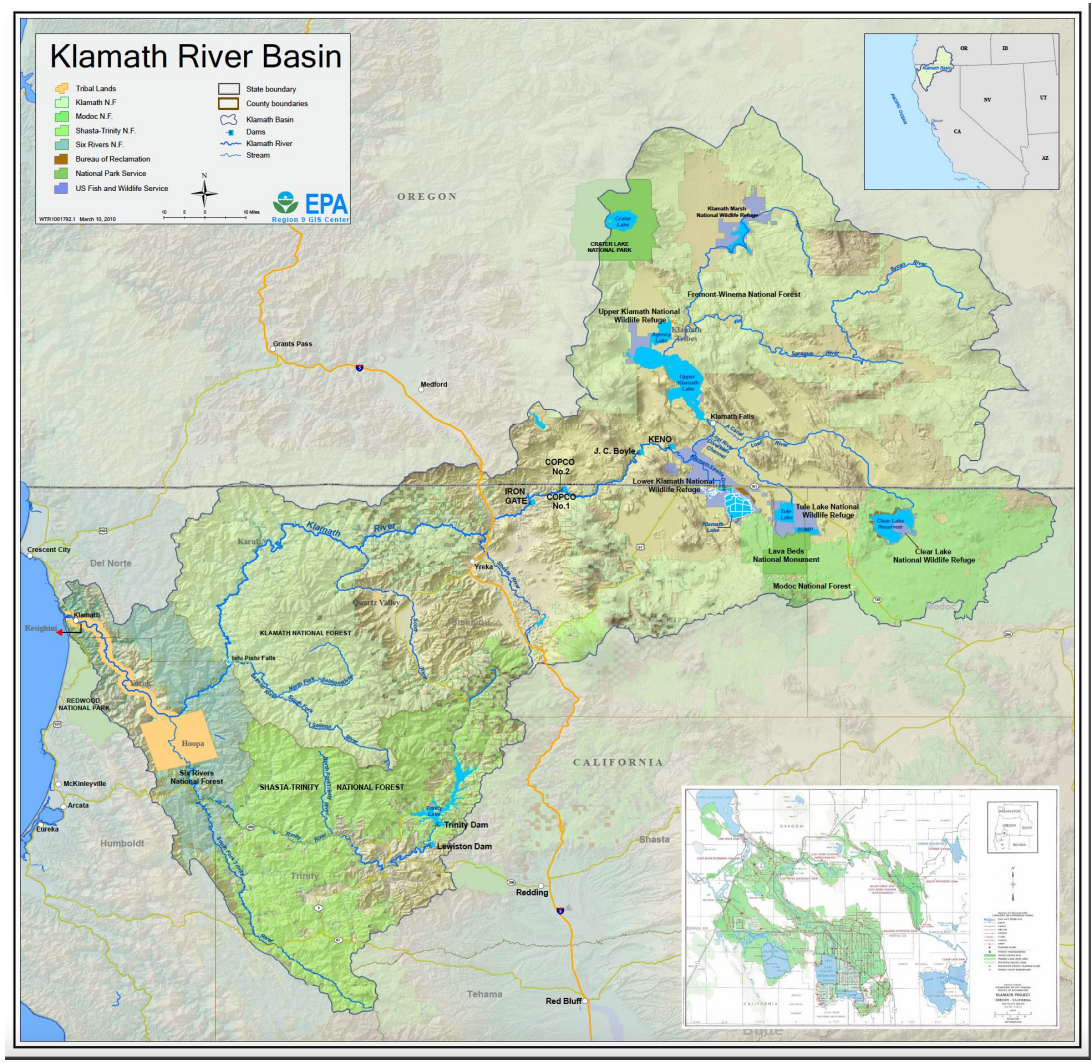
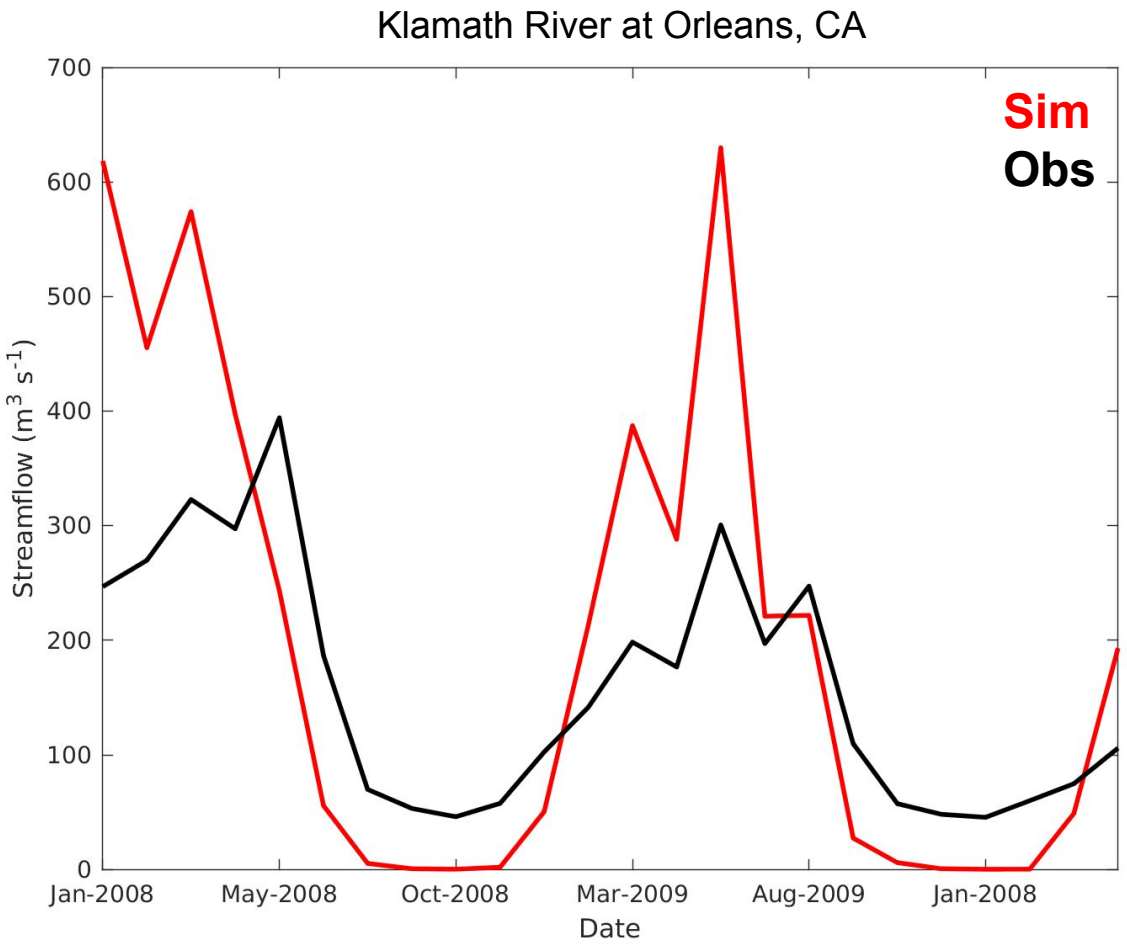


Image from EPA

Project Process

- Iterative discussion - Model Capabilities and Configuration
  - A few points from our project
    - CTSM hydrology is regionally poor
      - Discuss base CTSM capability
      - What are important flow factors?
      - Optimize CTSM hydrological performance



Project Process

- Iterative discussion - Model Capabilities and Configuration
  - Communities very interested in fire intensity and spread
  - CTSM fire models are probabilistic – essentially burned area across large-grid cell with no spread across grid cells
  - Moving to high-resolution invalidates fire model use, and still doesn't meet community needs

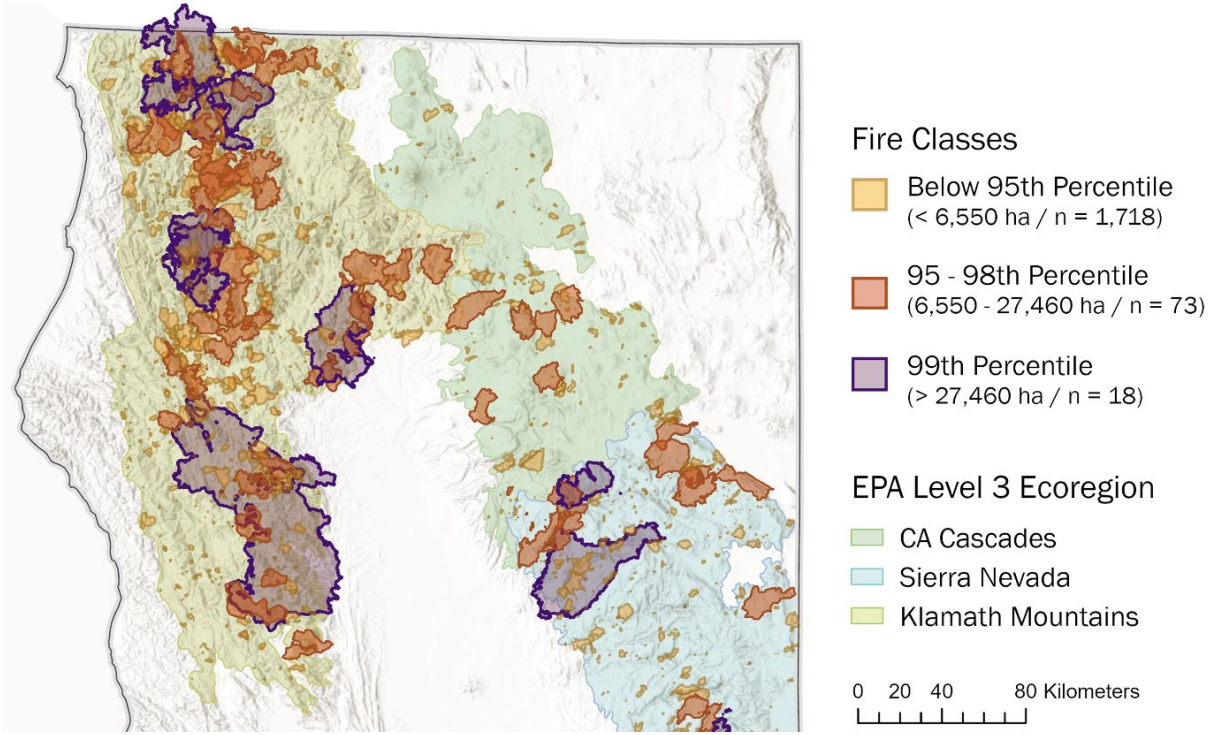
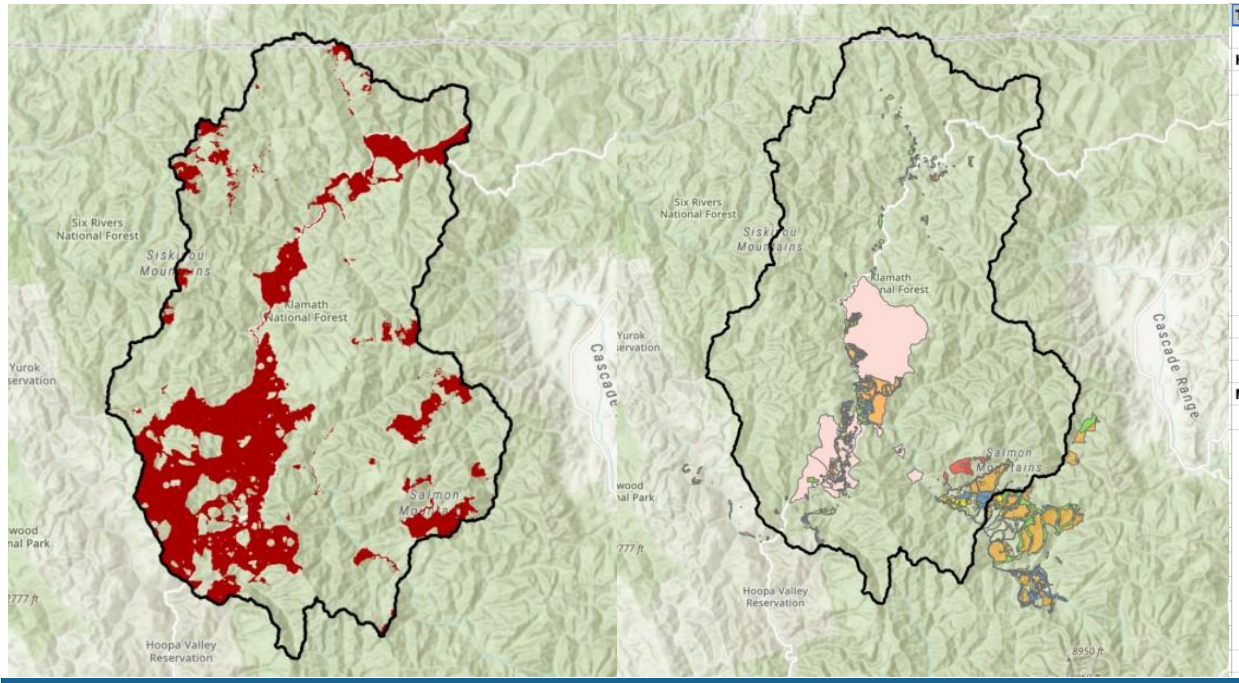


Fig. 1 - Cova et al. 2022, Forest Ecology and Management

Project Process

- Iterative discussion – Experimental design
  - Communities very interested in fire intensity and spread
  - How can we make progress with current tools and outline development needs?



Treatment type	Veg change matrix									
High Treatment: Oak/Savannah		Old State								
		0. Bare ground:	1. Needleleaf ev	5. Broadleaf eve	7. Broadleaf dec	9. Broadleaf eve	10. Broadleaf de	13. C3 grass: GC	14. C4 grass: GC	15. Unmanaged
New state	0. Bare ground: Bare	1	0	0	0	0	0	0	0	0
	1. Needleleaf evergreen tree tempe	0	0.05	0	0	0	0	0	0	0
	5. Broadleaf evergreen tree temper	0	0.1	0.99	0	0	0	0	0	0
	7. Broadleaf deciduous tree tembe	0	0.25	0	0.95	0	0	0	0	0
	9. Broadleaf evergreen shrub temp	0	0.1	0	0	0.8	0	0	0	0
	10. Broadleaf deciduous shrub tem	0	0.1	0	0	0	0.8	0	0	0
	13. C3 grass: GC3	0	0.4	0.01	0.05	0.2	0.2	1	0	0
	14. C4 grass: GC4	0	0	0	0	0	0	0	1	0
	15. Unmanaged C3 crop: Crop	0	0	0	0	0	0	0	0	1
	Sum:	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Moderate Treatment: Mixed Conifer		Old State								
		0. Bare ground:	1. Needleleaf ev	5. Broadleaf eve	7. Broadleaf dec	9. Broadleaf eve	10. Broadleaf de	13. C3 grass: GC	14. C4 grass: GC	15. Unmanaged
New state	0. Bare ground: Bare	1	0	0	0	0	0	0	0	0
	1. Needleleaf evergreen tree tempe	0	0.25	0	0	0	0	0	0	0
	5. Broadleaf evergreen tree temper	0	0.3	0.99	0	0	0	0	0	0
	7. Broadleaf deciduous tree tembe	0	0.1	0	0.9	0	0	0	0	0
	9. Broadleaf evergreen shrub temp	0	0.05	0	0	0.8	0	0	0	0
	10. Broadleaf deciduous shrub tem	0	0.05	0	0	0	0.8	0	0	0
	13. C3 grass: GC3	0	0.25	0.01	0.1	0.2	0.2	1	0	0
	14. C4 grass: GC4	0	0	0	0	0	0	0	1	0
	15. Unmanaged C3 crop: Crop	0	0	0	0	0	0	0	0	1
	Sum:	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Images and table courtesy of Hannah King, UW

Summary/Recommendations

- Lay the foundation for successful work
  - ‘Go slow to go fast’
- Open, honest discussion on model capabilities
  - What are critical assumptions that need to be known and potentially mitigated?
  - Is ‘your’ preferred model even the most appropriate option?
- Discussion needs to be followed by action
- There are lots of potential exciting model development – application co-produced projects out there