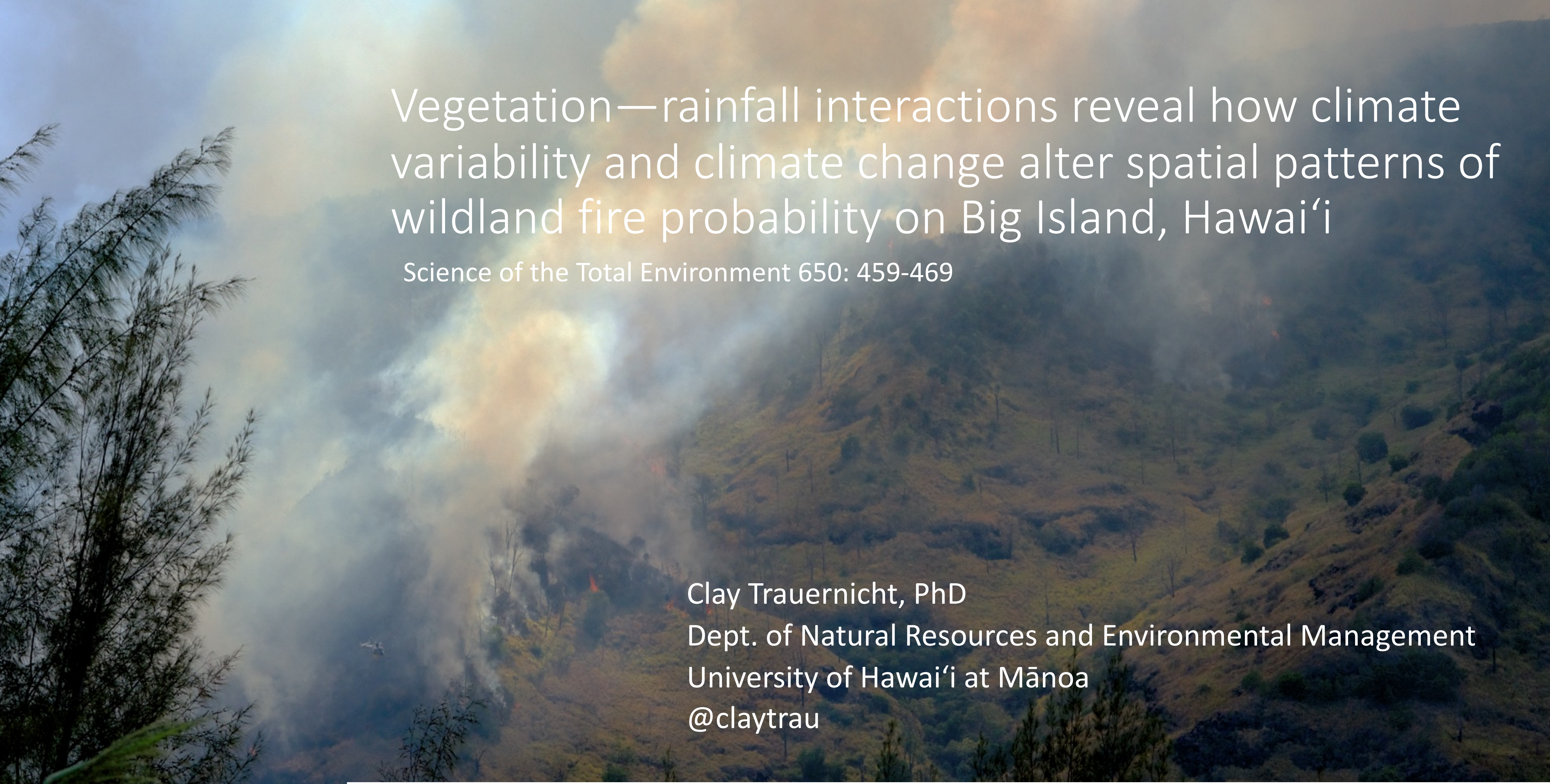

Vegetation—rainfall interactions reveal how climate variability and climate change alter spatial patterns of wildland fire probability on Big Island, Hawai‘i

Science of the Total Environment 650: 459-469

Clay Trauernicht, PhD
Dept. of Natural Resources and Environmental Management
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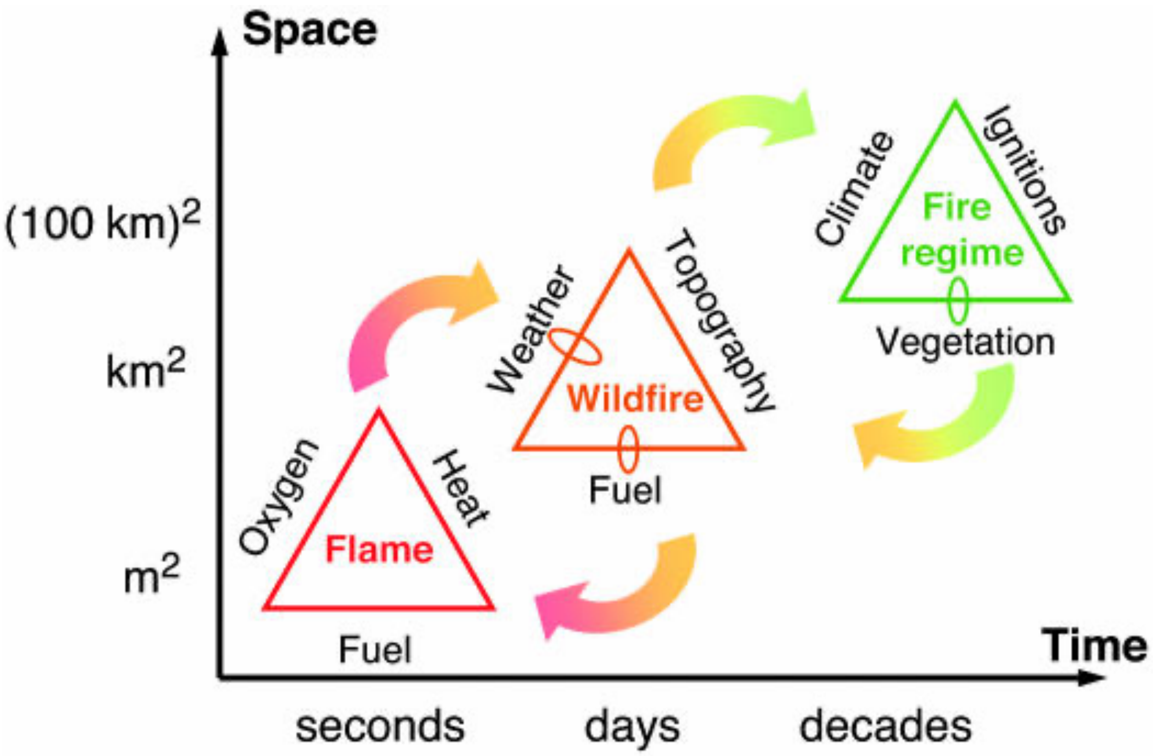
@claytrau

Cooperative Extension
University of Hawai‘i at Mānoa
College of Tropical Agriculture and Human Resources
PFX Pacific Fire Exchange
HWMO Hawaii Wildfire Management Organization
IPIF Institute of Pacific Islands Forestry

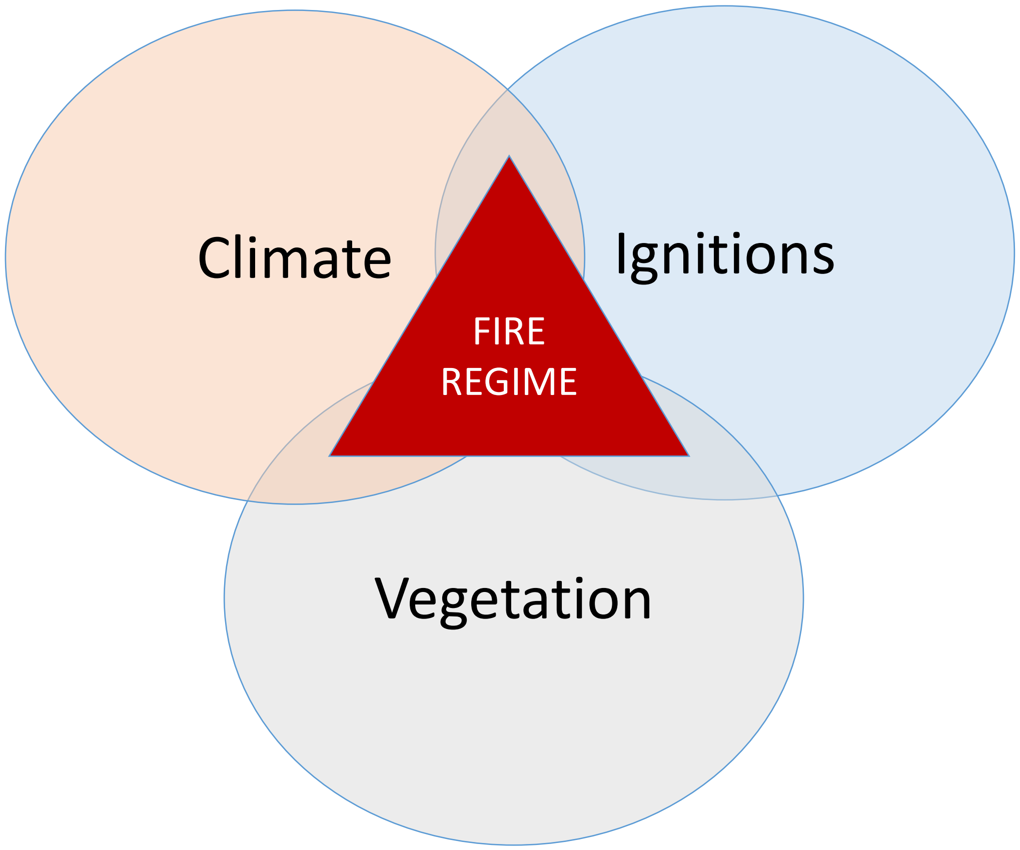
Fire regimes



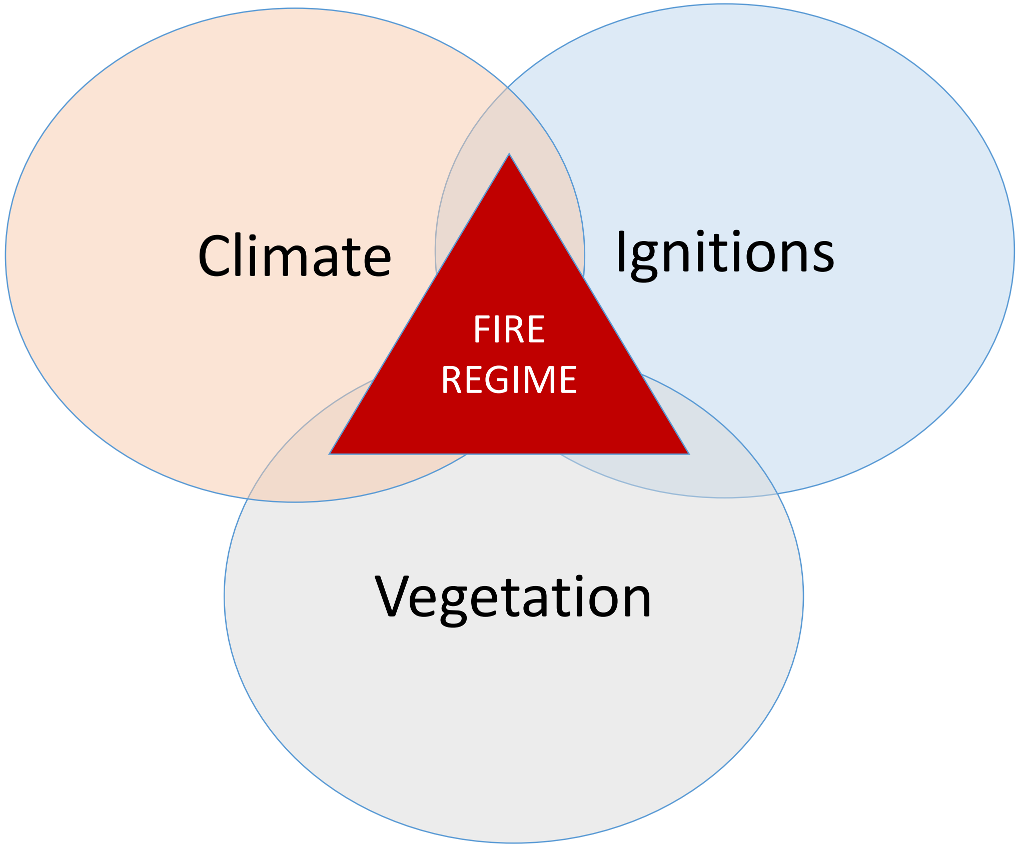
Moritz et al. 2005. PNAS

Makaha Valley, Oahu 2018

Changing fire regimes on Pacific Islands

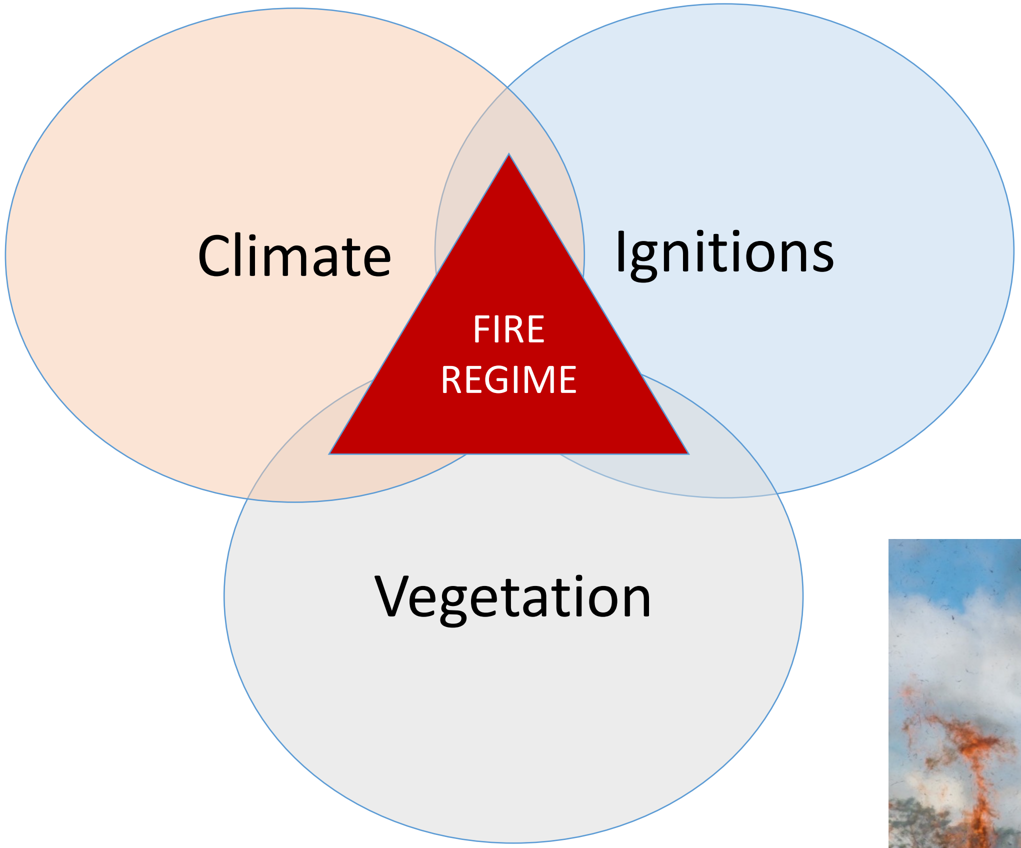


Changing fire regimes on Pacific Islands



Human-caused ignitions

Changing fire regimes on Pacific Islands

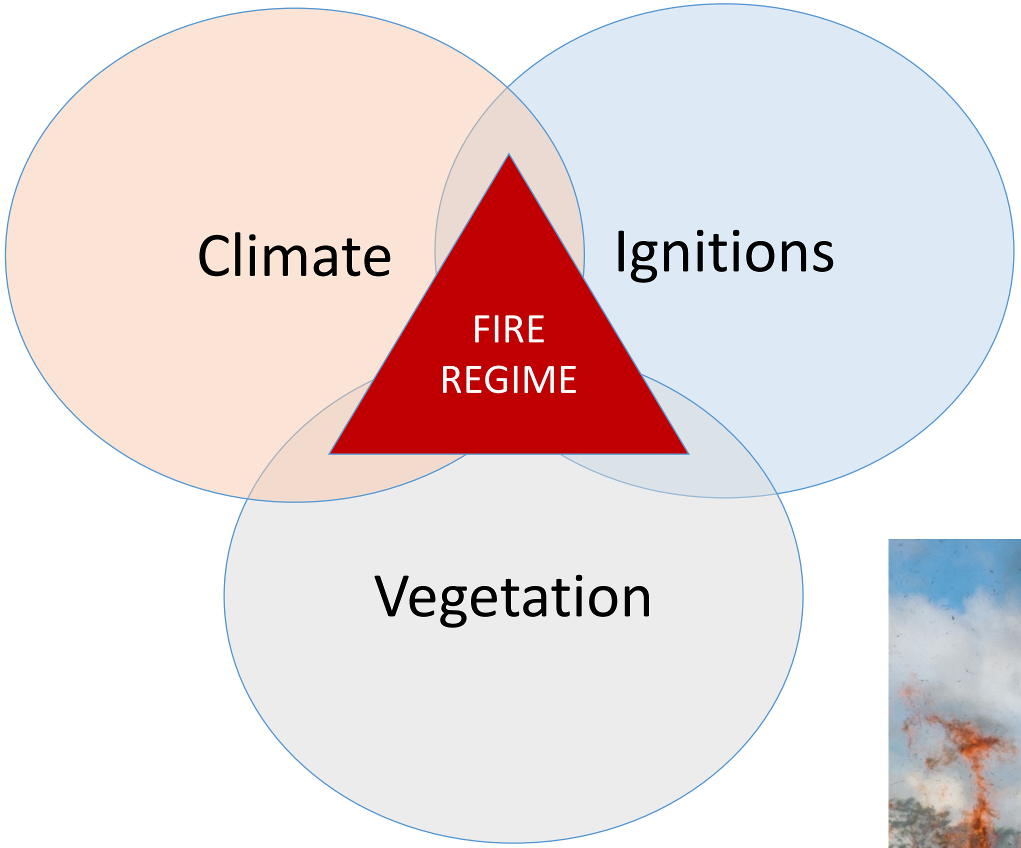


Grassland/savanna expansion

Human-caused ignitions

Changing fire regimes on Pacific Islands

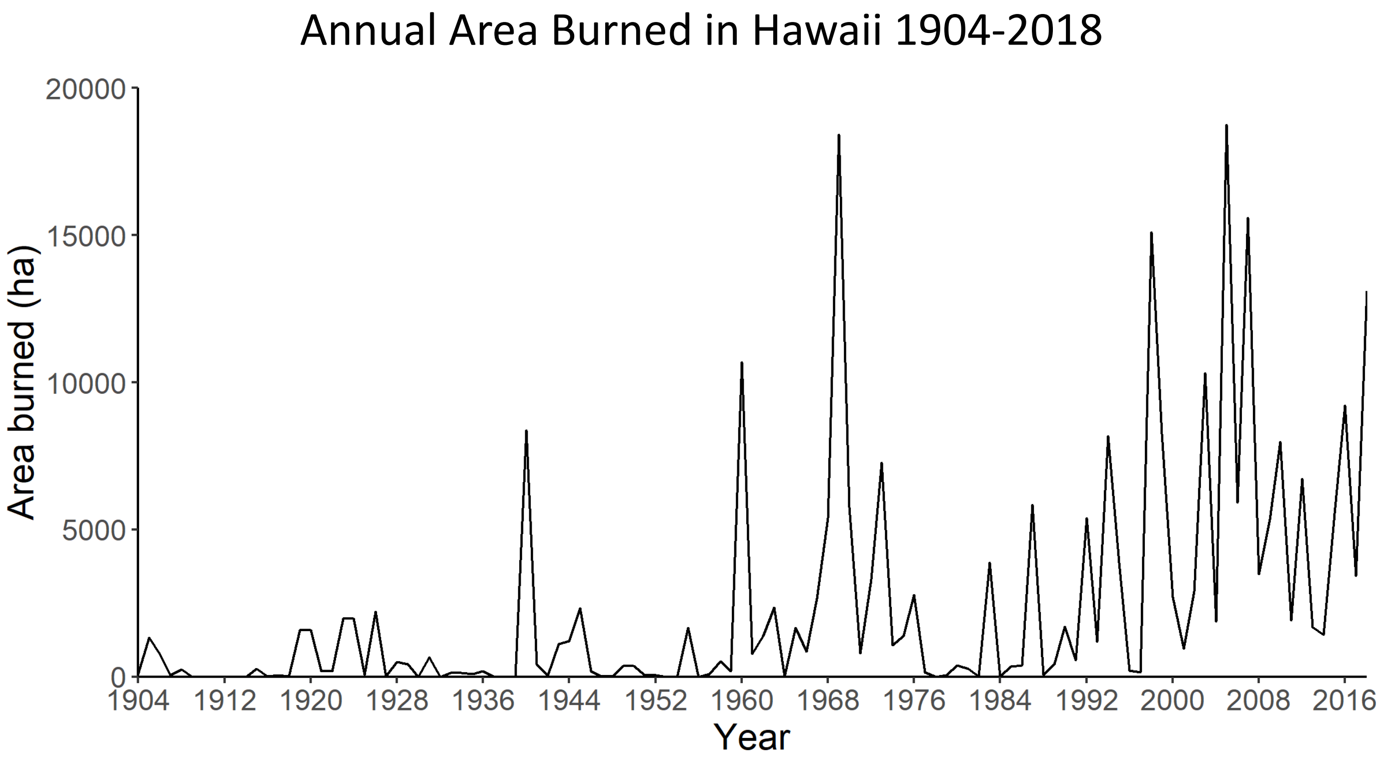
Drought

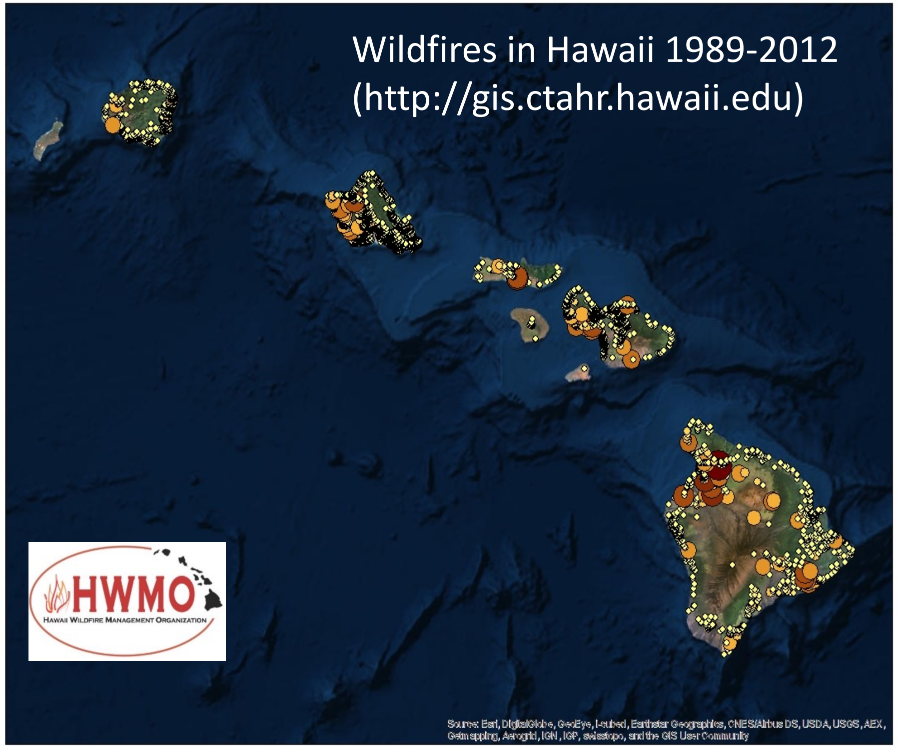


Grassland/savanna expansion

Human-caused ignitions

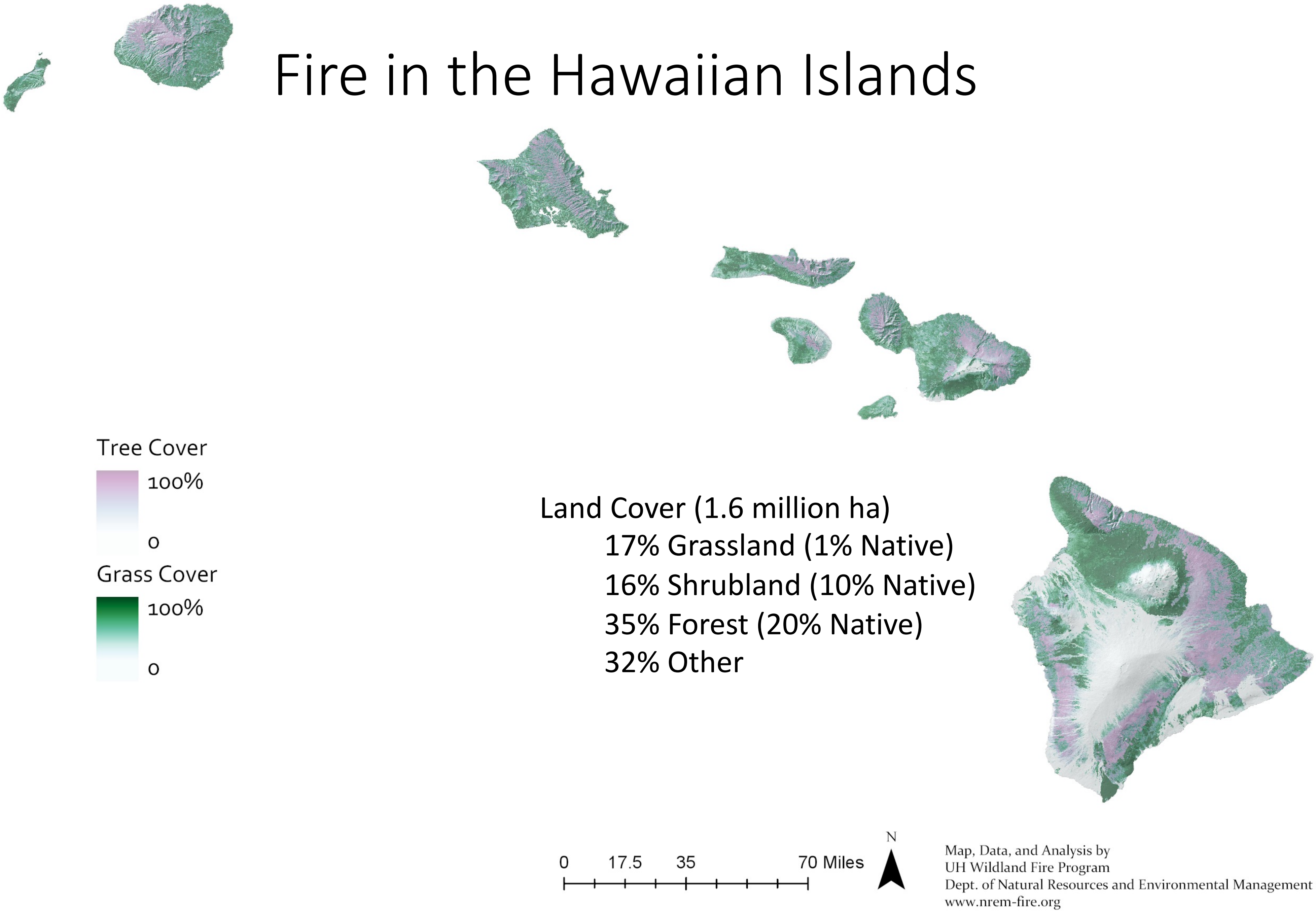
Fire in the Hawaiian Islands





Trauernicht et al. 2015 Pacific Science

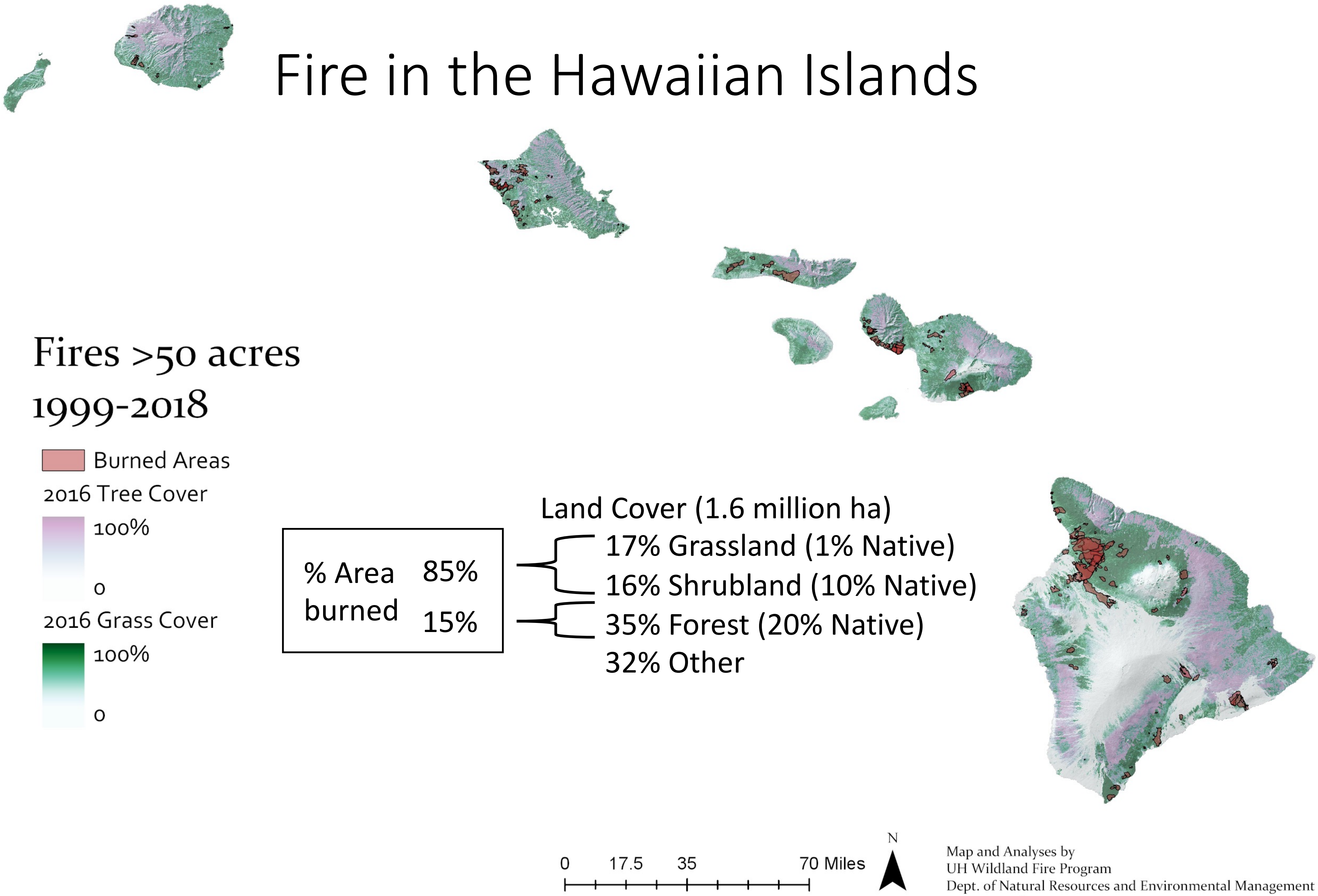
Fire in the Hawaiian Islands



Land Cover (1.6 million ha)

- 17% Grassland (1% Native)
- 16% Shrubland (10% Native)
- 35% Forest (20% Native)
- 32% Other

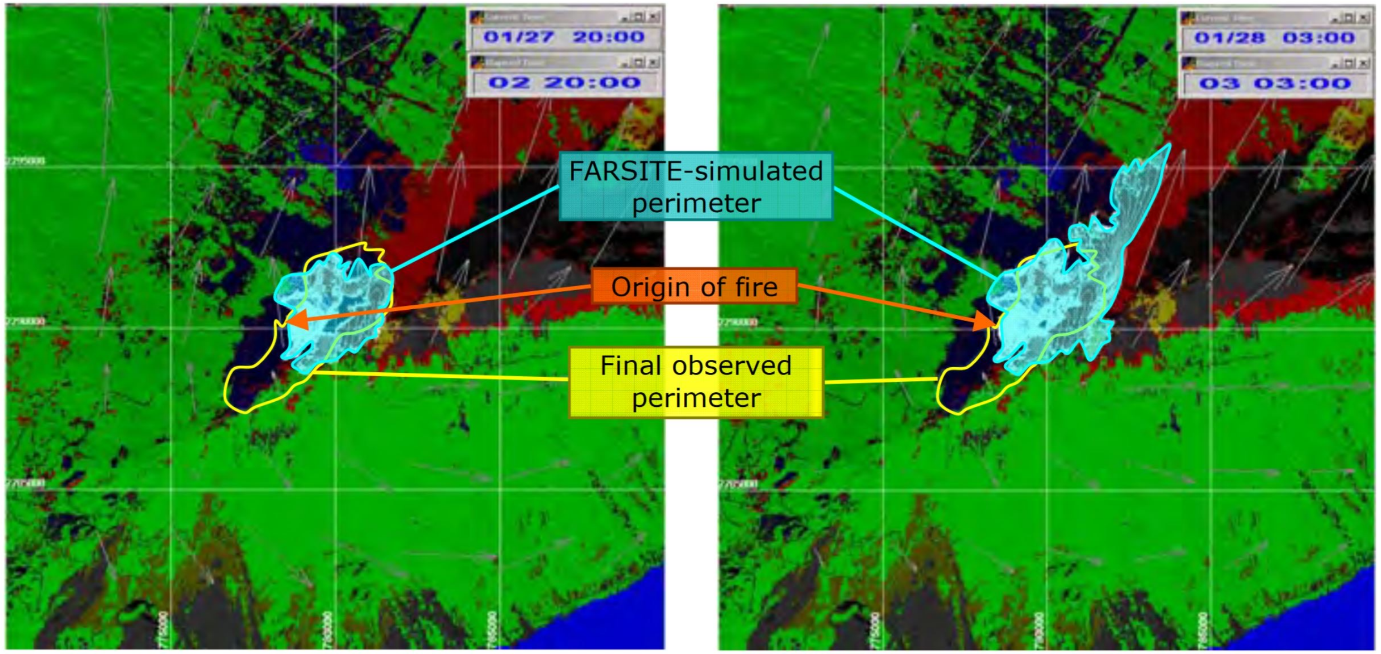
Fire in the Hawaiian Islands

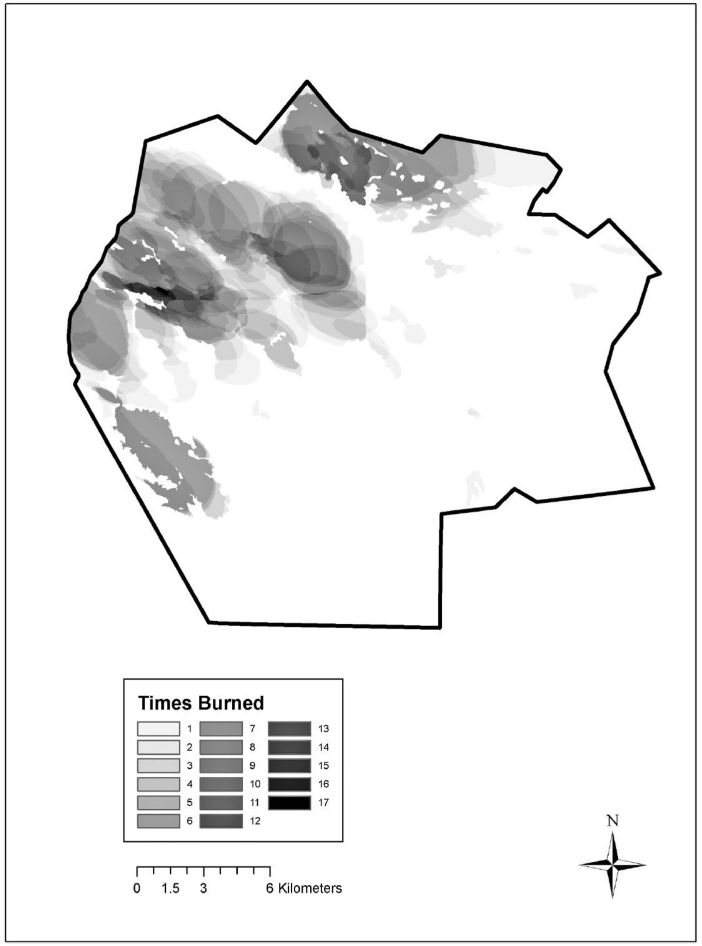


Map and Analyses by
UH Wildland Fire Program
Dept. of Natural Resources and Environmental Management
www.nrem-fire.org

The Problem

"Conventional" fire models perform poorly in Hawaii



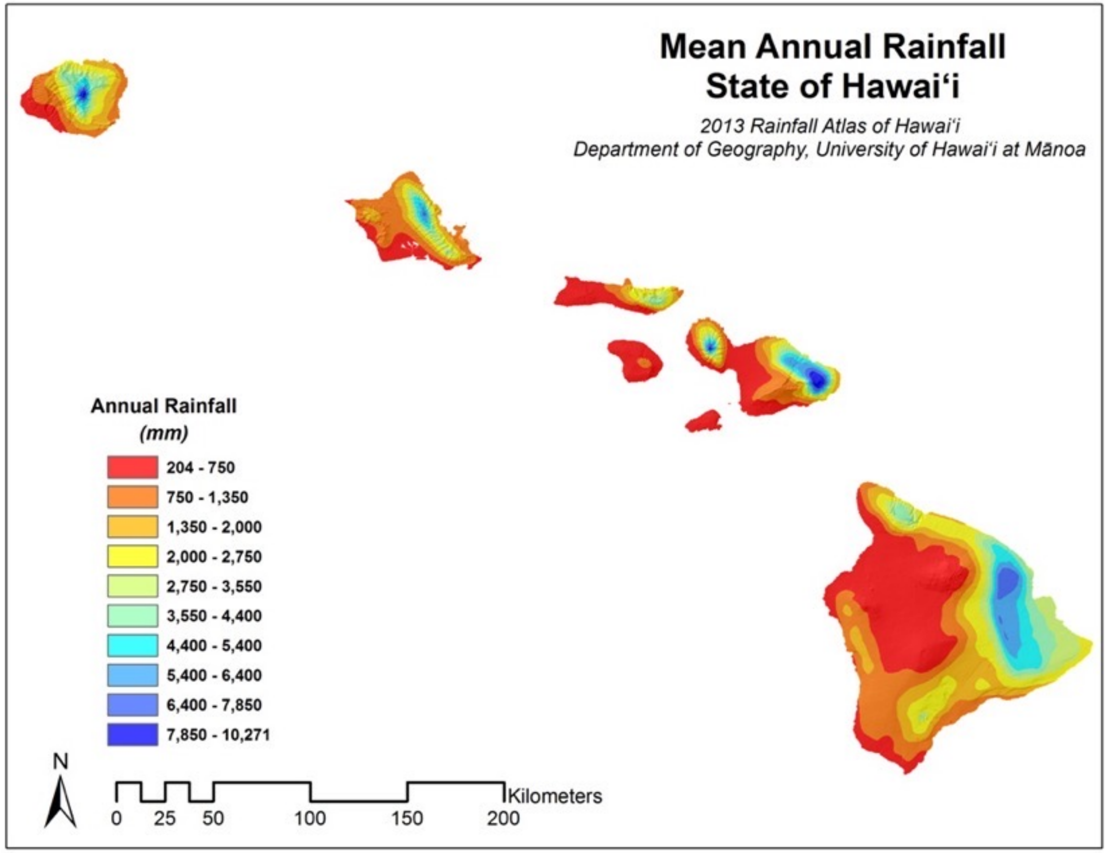


Benoit, J., Fujioka, F., Weise, D., 2009. Modeling fire behavior on Tropical Islands With High-resolution Weather Data, USDA Forest Service, PSW-GTR-227, pages 321-330

Weise, D.R. et al., 2010. Estimation of fire danger in Hawai'i using limited weather data and simulation. Pac. Sci. 64, 199–220.

The Problem

How do we assess fire risk in Hawaii?



A Fire Danger Rating System for Hawaii

ROBERT E. BURGAN, FRANCIS M. FUJIOKA,
and GEORGE H. HIRATA

Extremes in rainfall on the Hawaiian Islands make it difficult to judge forest fire danger conditions. The use of an automatic data collection and computer processing system helps to monitor the problem.

1974

Fire Probability

(vs fire spread)

Logistic regression (GLM/GAM)

CSIRO PUBLISHING

www.publish.csiro.au/journals/ijwf *International Journal of Wildland Fire*, 2004, **13**, 133–142

Probability based models for estimation of wildfire risk*

Haiganoush K. Preisler[A], *David R. Brillinger*[B], *Robert E. Burgan*[C] *and J. W. Benoit*[D]

Risk Assessment: a Forest Fire Example

David R. Brillinger, Haiganoush K. Preisler, and John W. Benoit

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APPLIED GEOGRAPHY

The environmental envelope of fires in the Colombian Caribbean

CrossMark

N. Hoyos [a,*], A. Correa-Metrio [b], A. Sisa [c], M.A. Ramos-Fabiel [d], J.M. Espinosa [a], J.C. Restrepo [e], J. Escobar [c,f]

Habitat distribution models (MaxEnt)

CSIRO PUBLISHING

International Journal of Wildland Fire **2012**, *21*, 313–327
http://dx.doi.org/10.1071/WF11044

Spatial variability in wildfire probability across the western United States

Marc-André Parisien[A,B,G], *Susan Snetsinger*[C], *Jonathan A. Greenberg*[D], *Cara R. Nelson*[C], *Tania Schoennagel*[E], *Solomon Z. Dobrowski*[F] *and Max A. Moritz*[B]

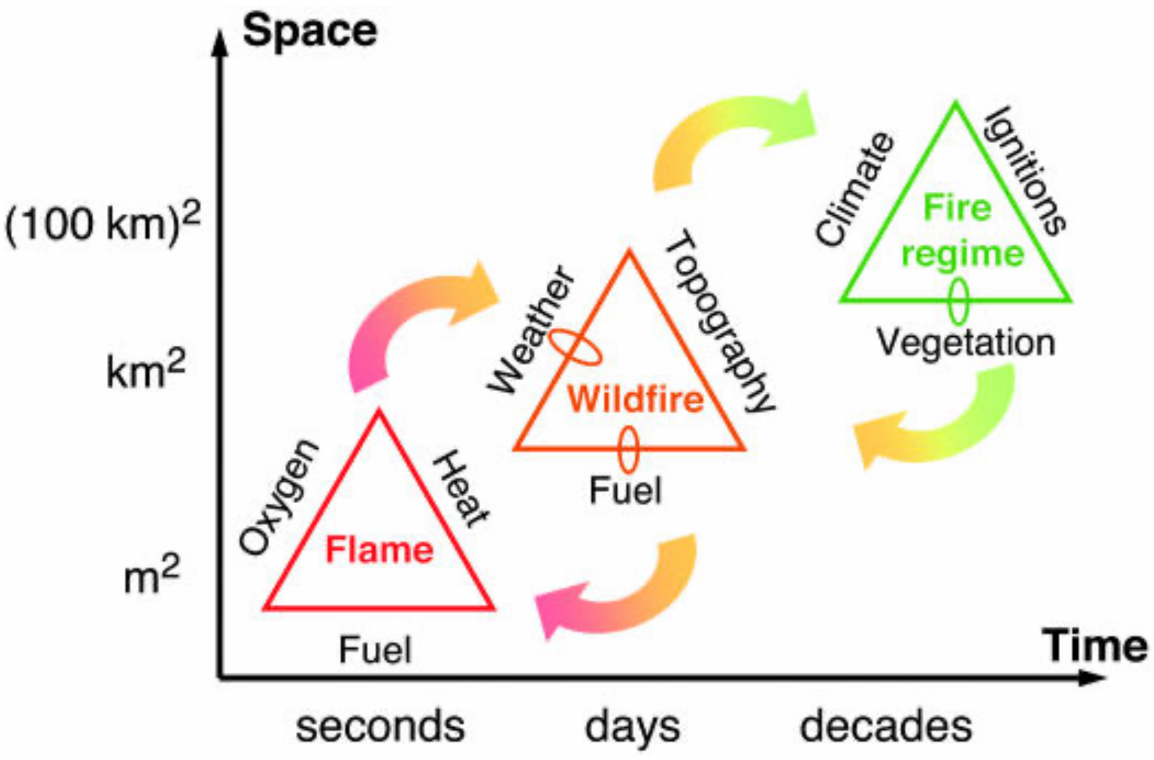
esa ECOSPHERE

Habitat distribution modeling reveals vegetation flammability and land use as drivers of wildfire in SW Patagonia

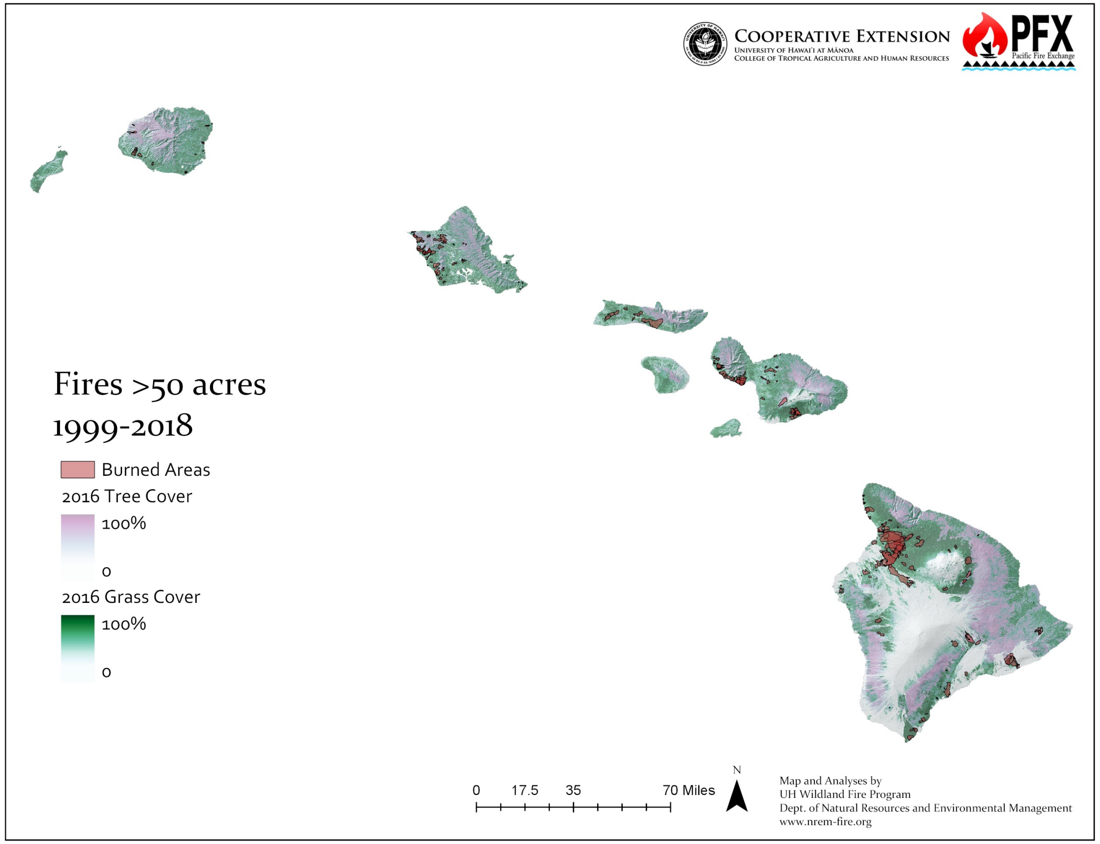
Juan Paritsis,[1,4,†] Andrés Holz,[1,5] Thomas T. Veblen,[1] and Thomas Kitzberger[2,3]

Fire Probability

(vs fire spread)

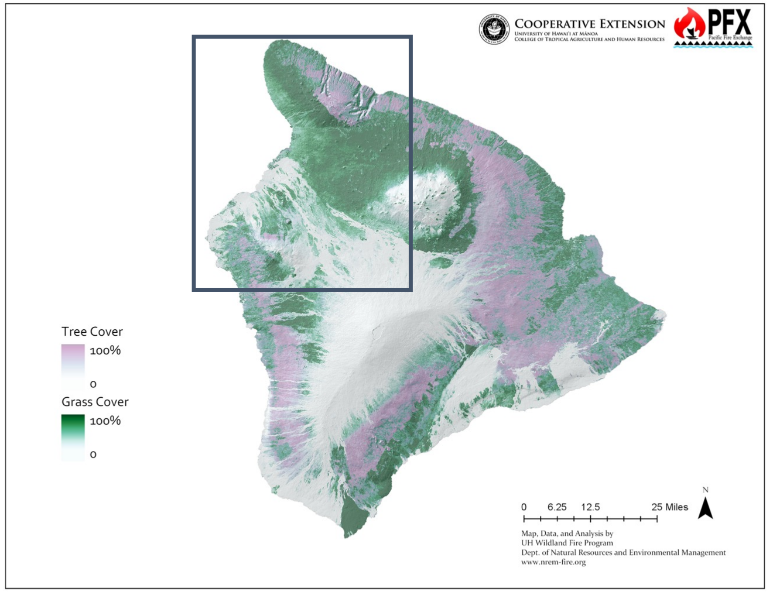


Moritz et al. 2005. Proc. Natl. Acad. Sci.

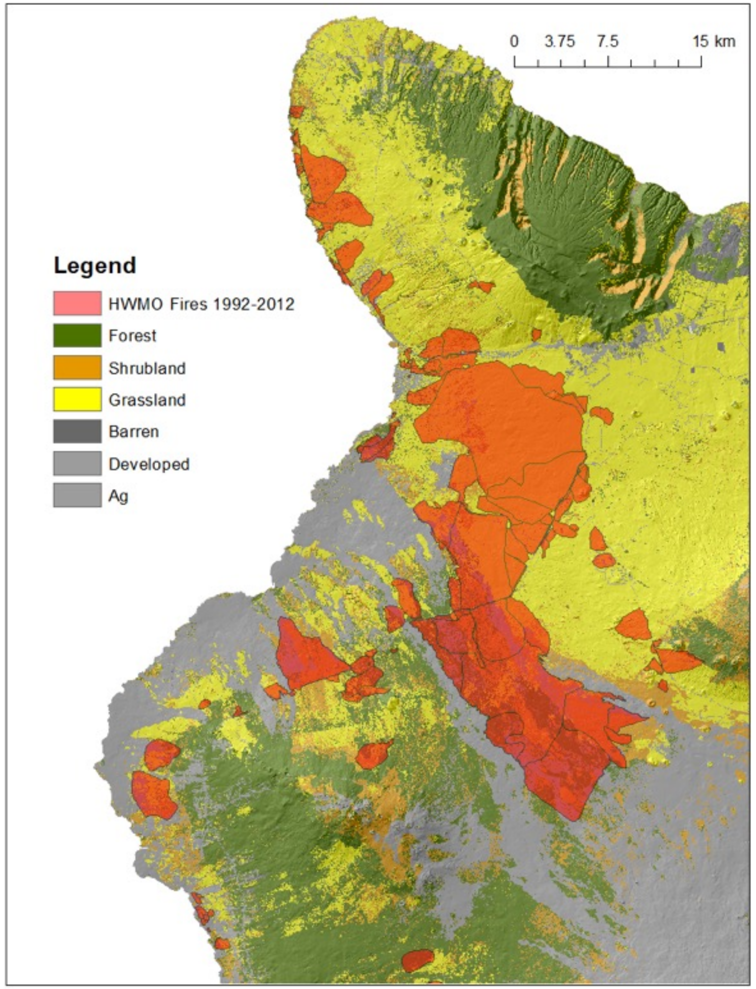


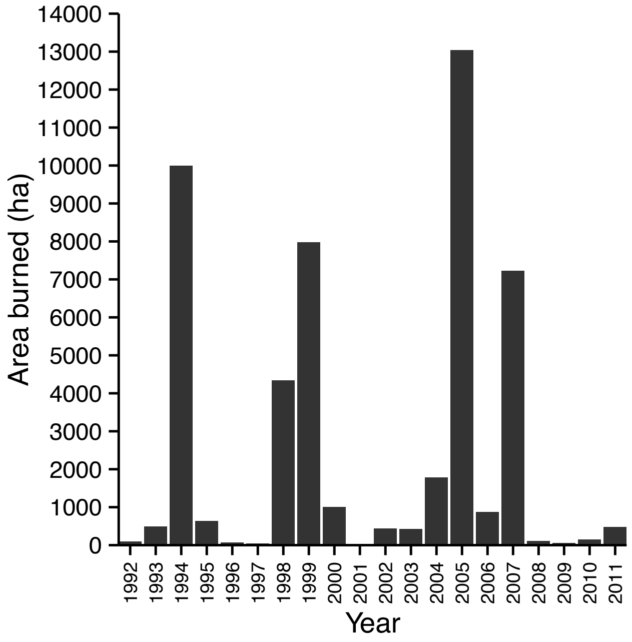
Northwest Hawaii Island

HWMO
HAWAII WILDFIRE MANAGEMENT ORGANIZATION



NW Hawaii Island fires 1992-2011

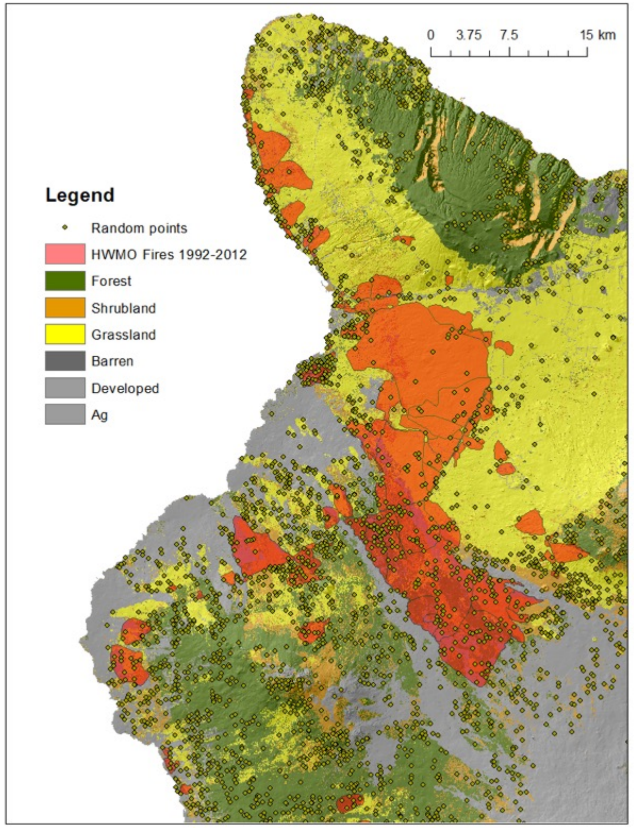




Model Fitting

Binary Response:

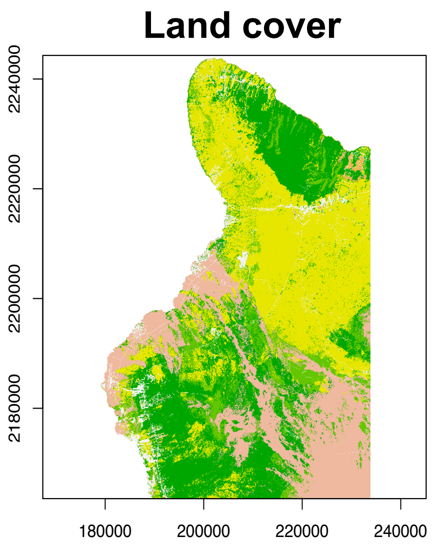
20 year fire history
1000 random points per year
Classified as burned/unburned

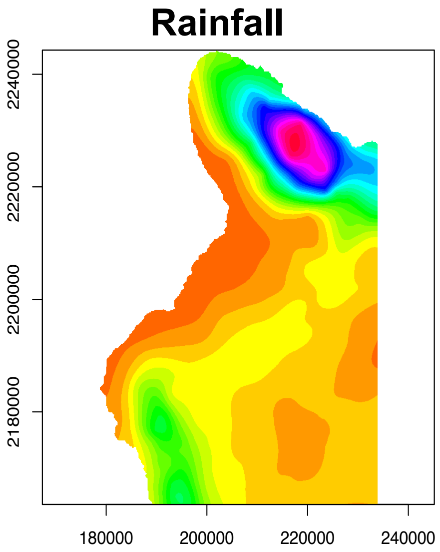


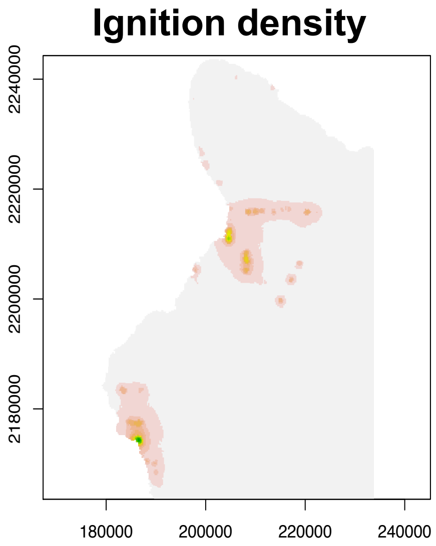
Predictors:

Simplified vegetation – LANDFIRE; 30m
Mean annual rainfall
Mean annual temperature
Annual rainfall – year of fire
Annual rainfall – year prior
Ignition density – point-based dataset; 250m

(Mean annual rainfall, mean annual temperature, annual rainfall – year of fire, annual rainfall – year prior:) Climate of Hawaii, 250m
Giambelluca et al.; Frazier et al.







Model Fitting and Prediction

Fitting: Generalized additive models and multi-model selection (AICc)

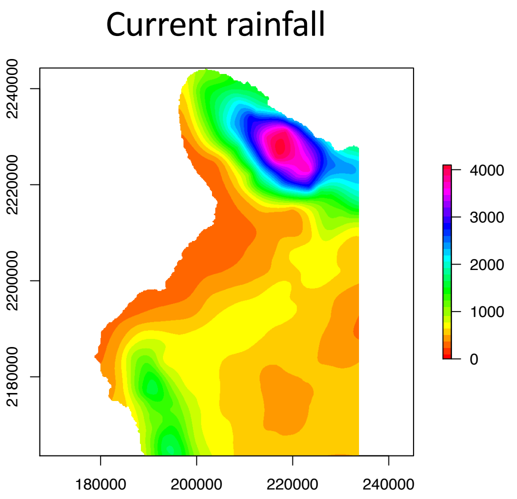
P_{FIRE} ~ veg type * mean annual rainfall + veg type* year of fire rainfall +
veg type*prior year rainfall + mean annual temp +
ignition density + sample year (as random effect)

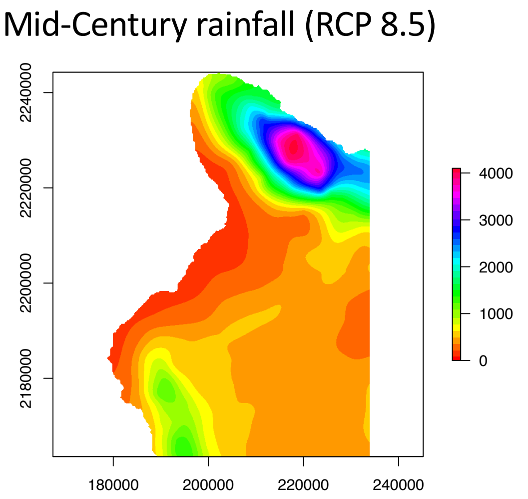
[Additional model set fit with spatial term: + s(lon, lat)]

Prediction: Sampling, model fitting, and prediction bootstrapped 100x for:

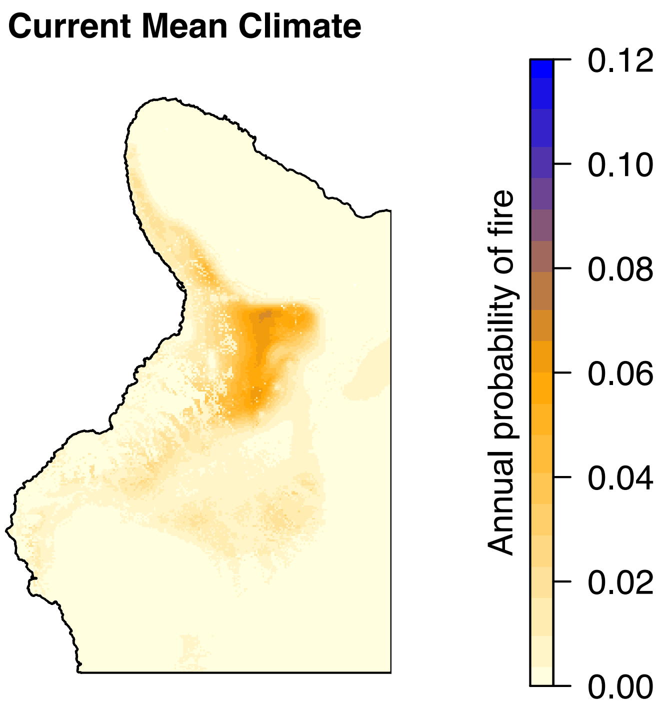
Current, mean climate (rainfall/temp)
Annual rainfall anomalies (+/- 1 SD)
Mid-century climate (RCP 8.5)
Late-century climate (RCP 8.5)

(Ellison Timm et al. 2015; Zhang et al. 2017)





Results

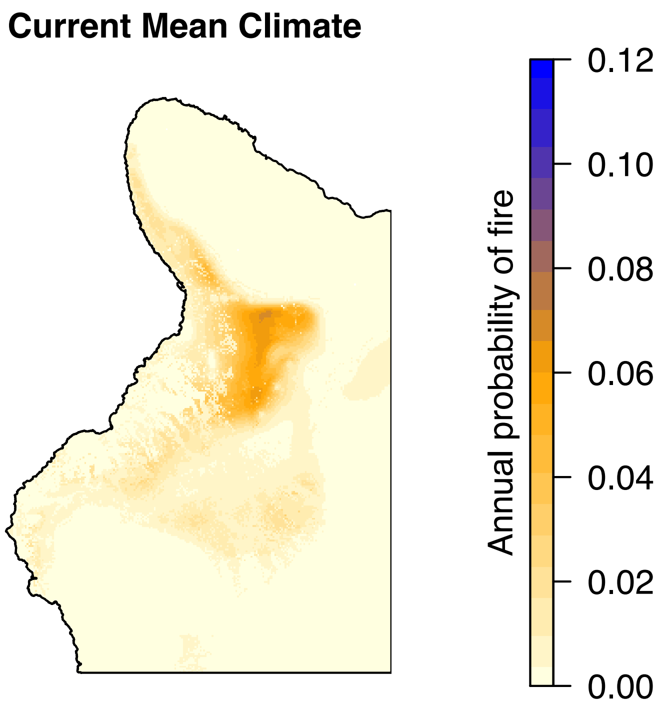


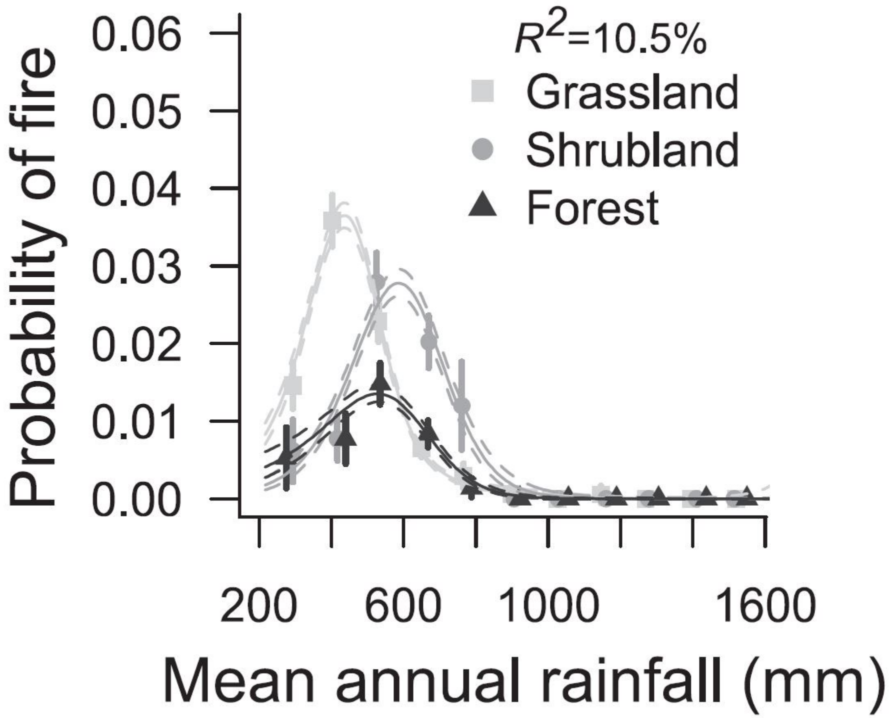
Global GAM was best supported

Akaike Weight > 0.99

Explained Deviance = 34.7%

Results – drivers of fire risk





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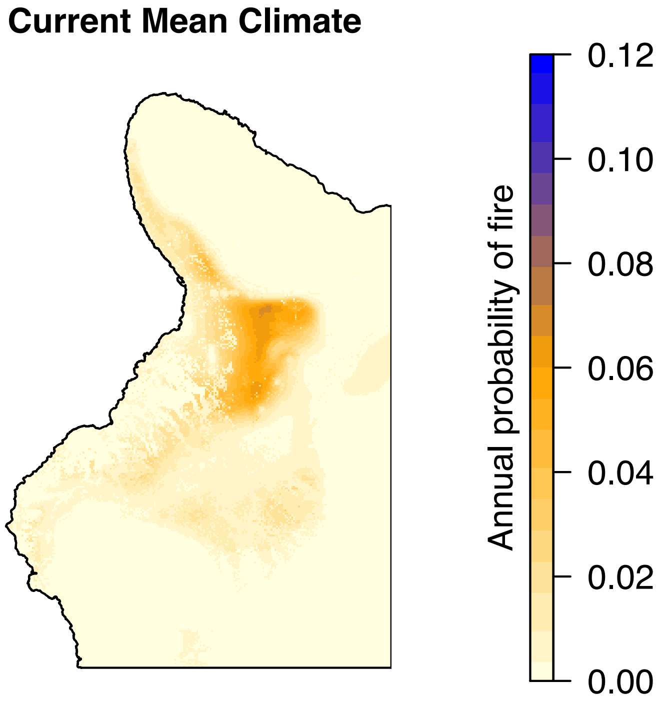

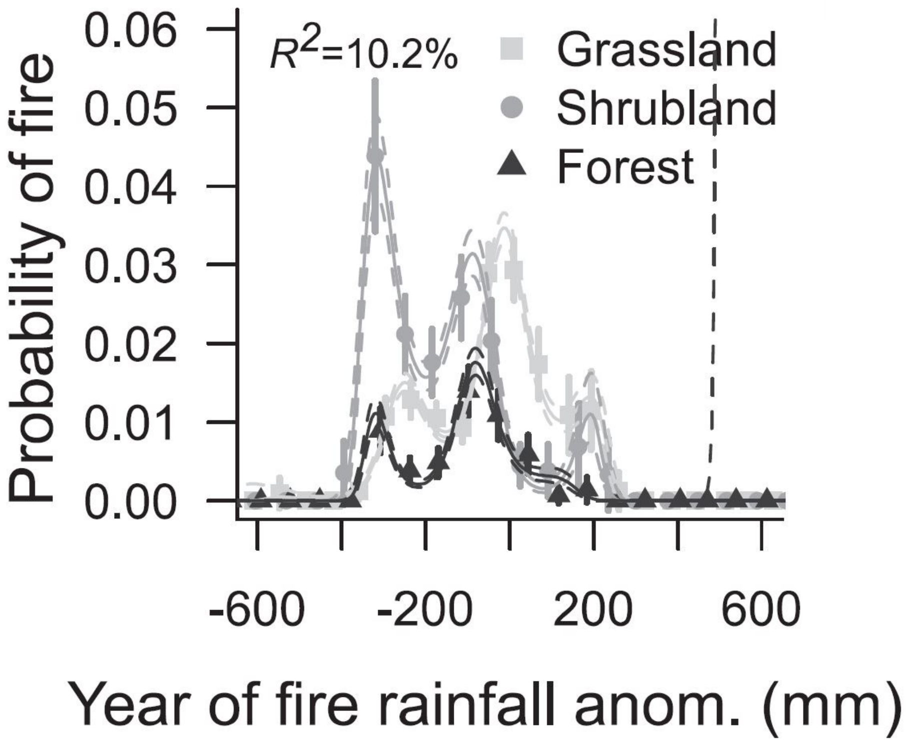

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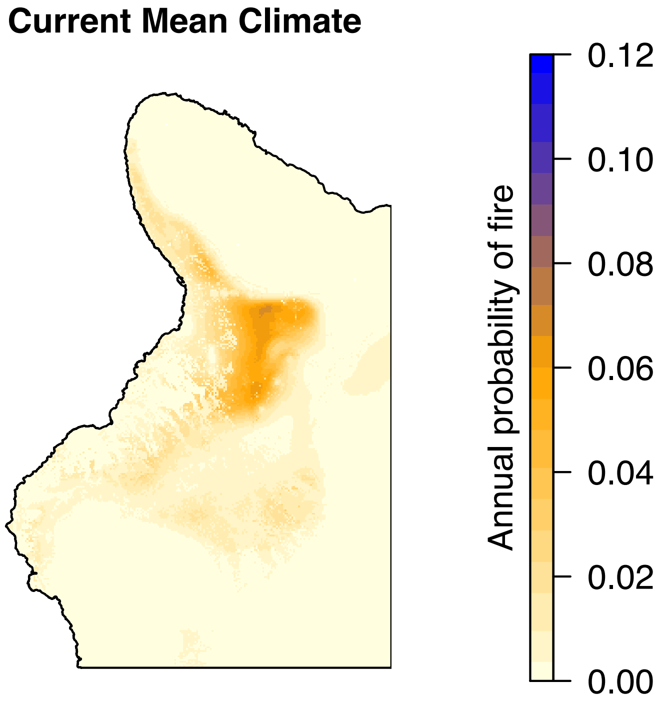
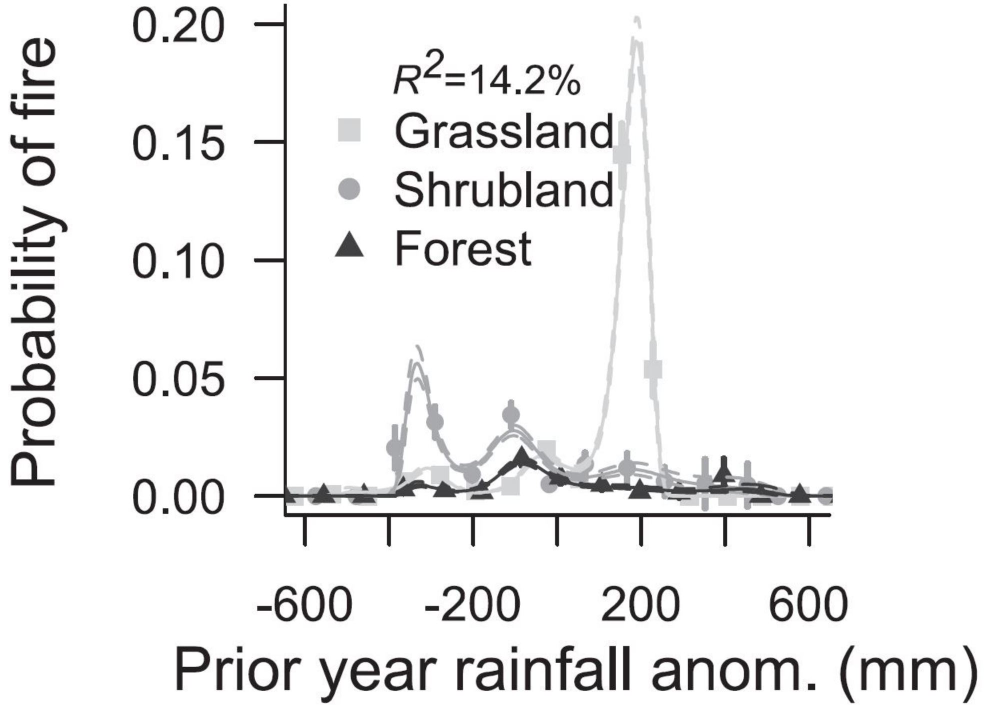
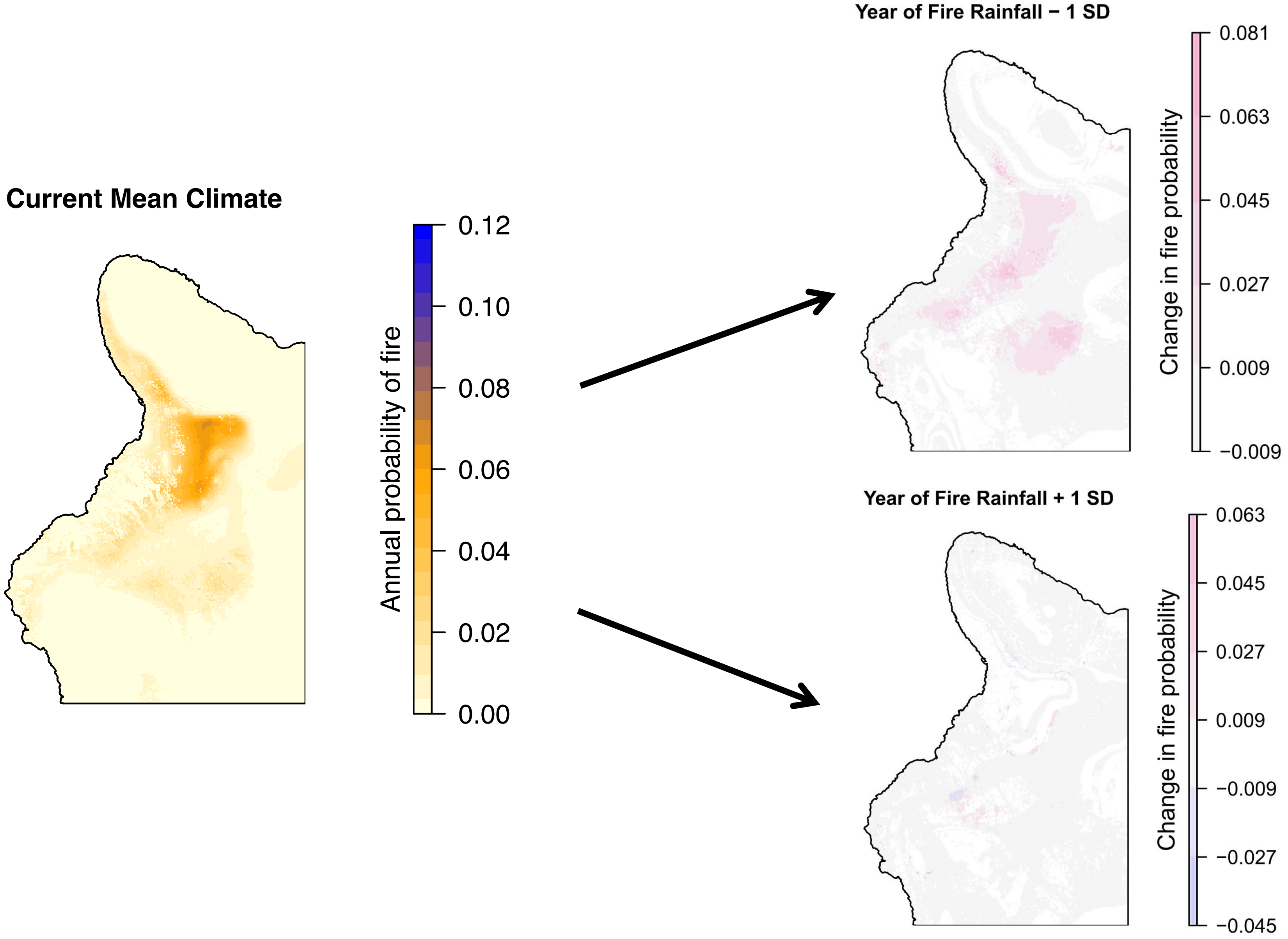




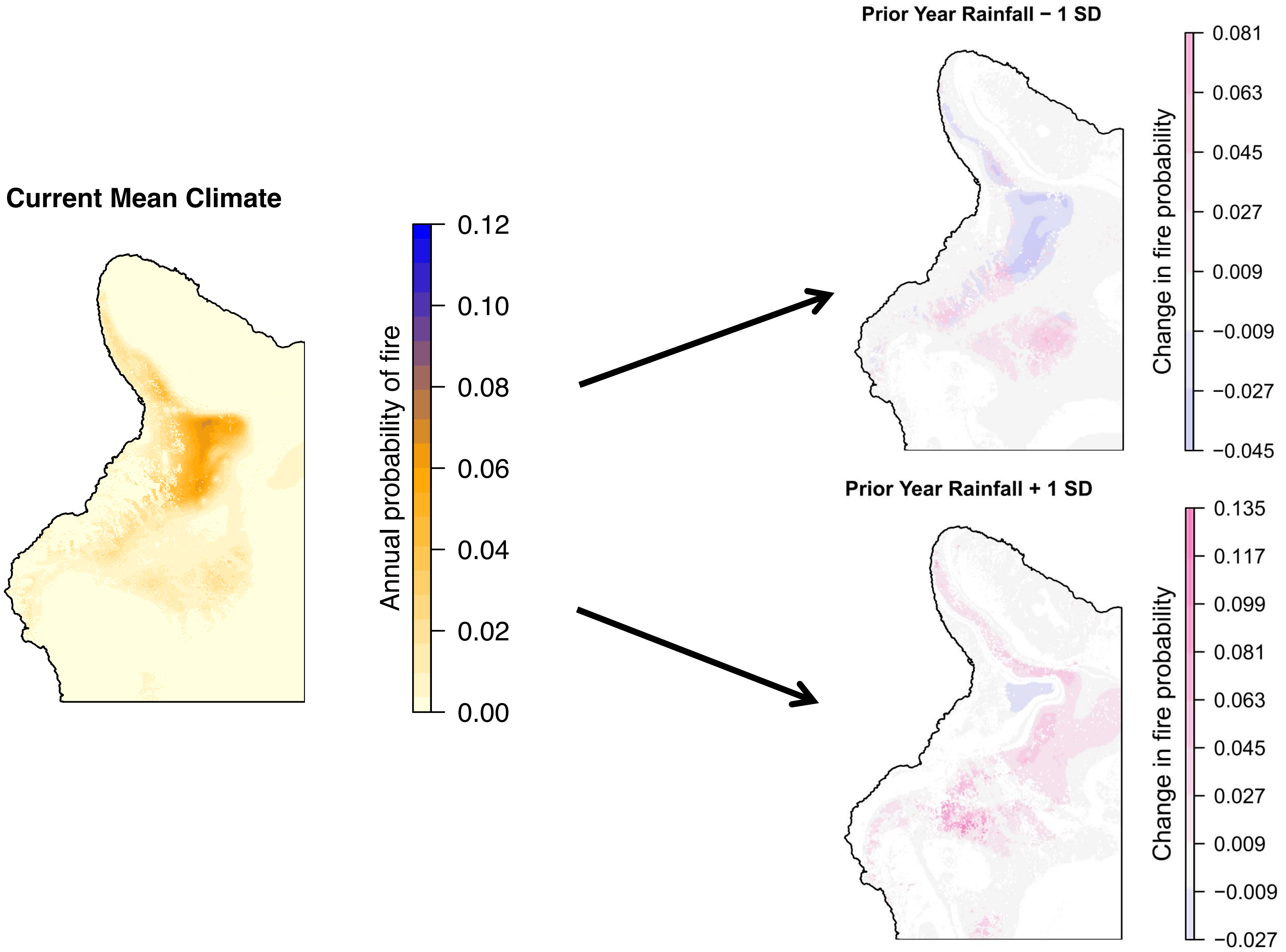
Results – spatial shifts in fire risk



Year of fire drought

Year of fire excess rainfall

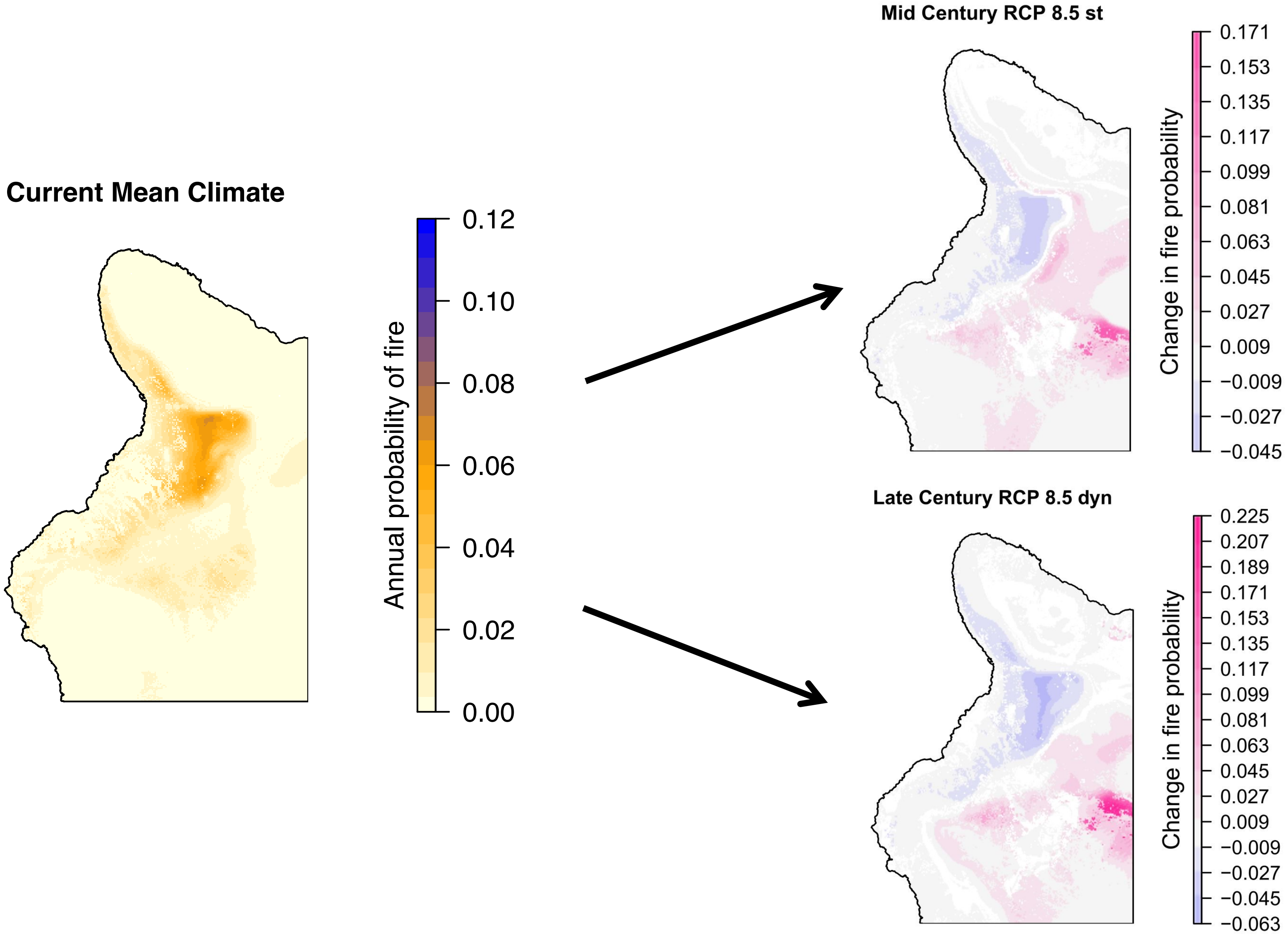
Results – spatial shifts in fire risk



Prior year drought

Prior year excess rainfall

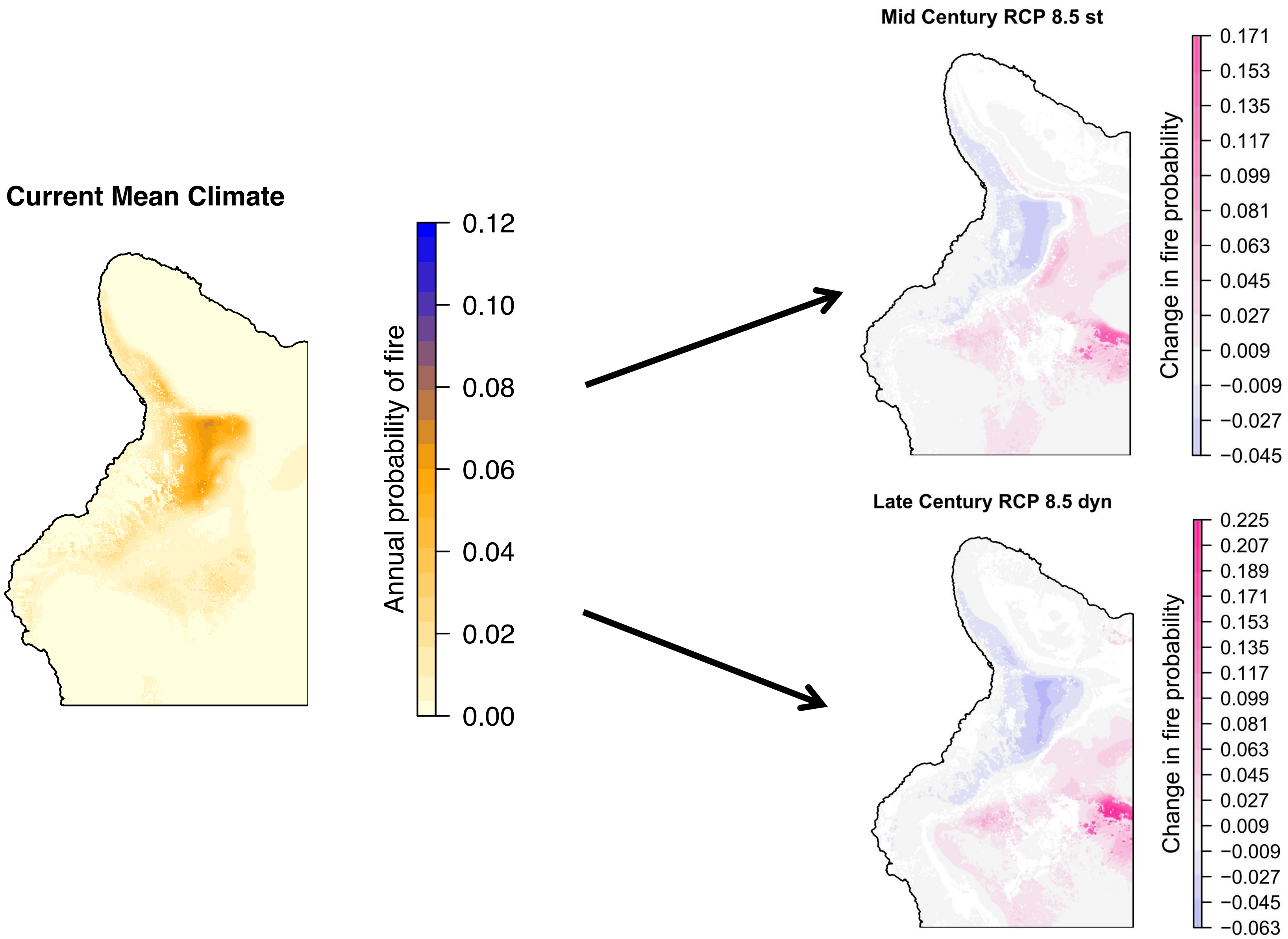
Results – spatial shifts in fire risk



Mid-century climate (RCP 8.5)

Late-century climate (RCP 8.5)

Results – spatial shifts in fire risk



Mid-century climate (RCP 8.5)

Late-century climate (RCP 8.5)

Conclusions

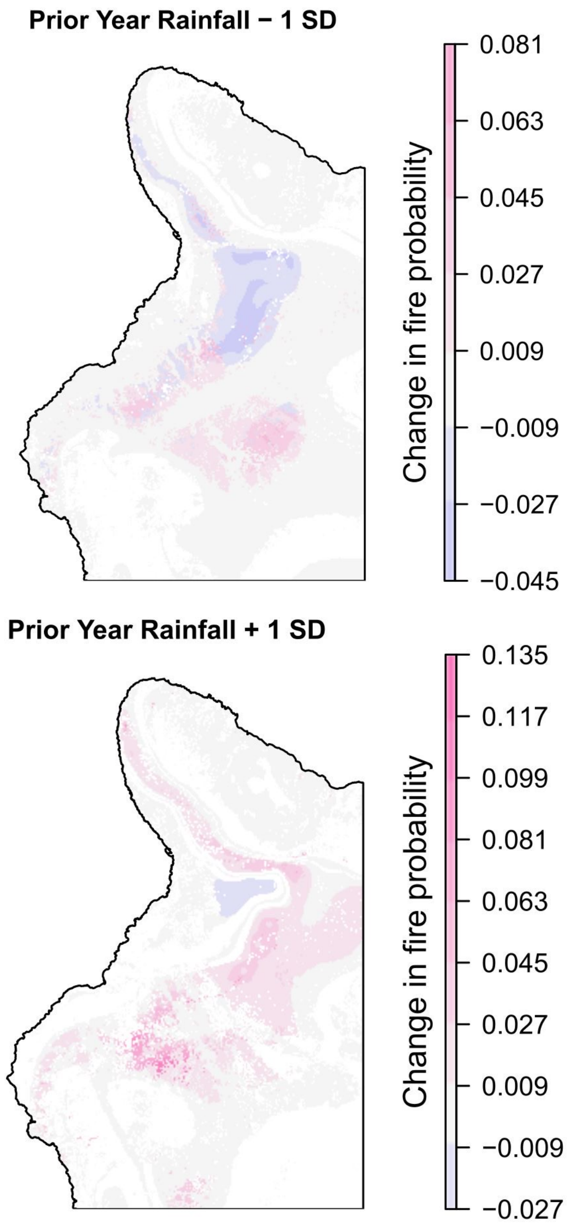
Antecedent rainfall critical to fire risk assessment/prediction

Fire risk projected to decline by communities and increase adjacent/within high value watersheds

Largest future change by mid-century (2040-2060)

Model is applicable to watershed assessment/planning
(Wada et al. 2017. Pacific Science; Bremer et al. 2018. Ecology and Society)

Opportunities are emerging for model improvement



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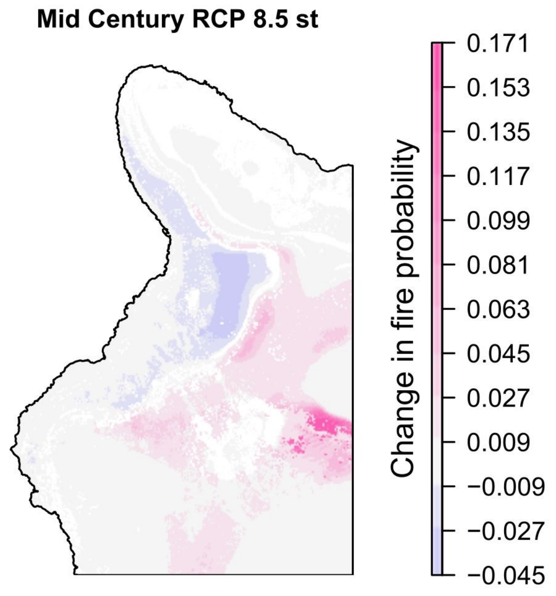

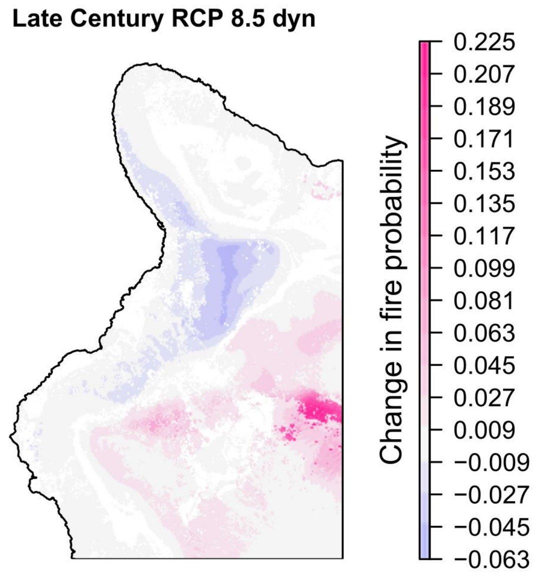

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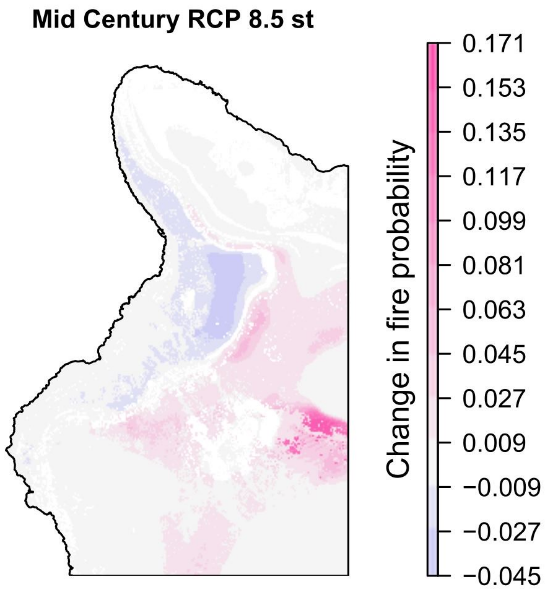

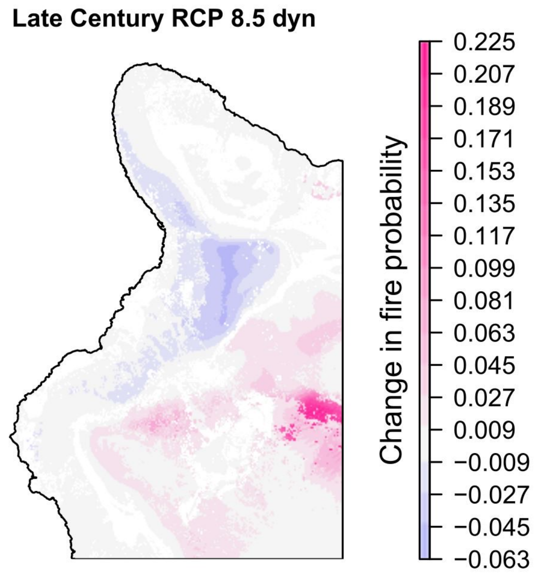

MAHALO!

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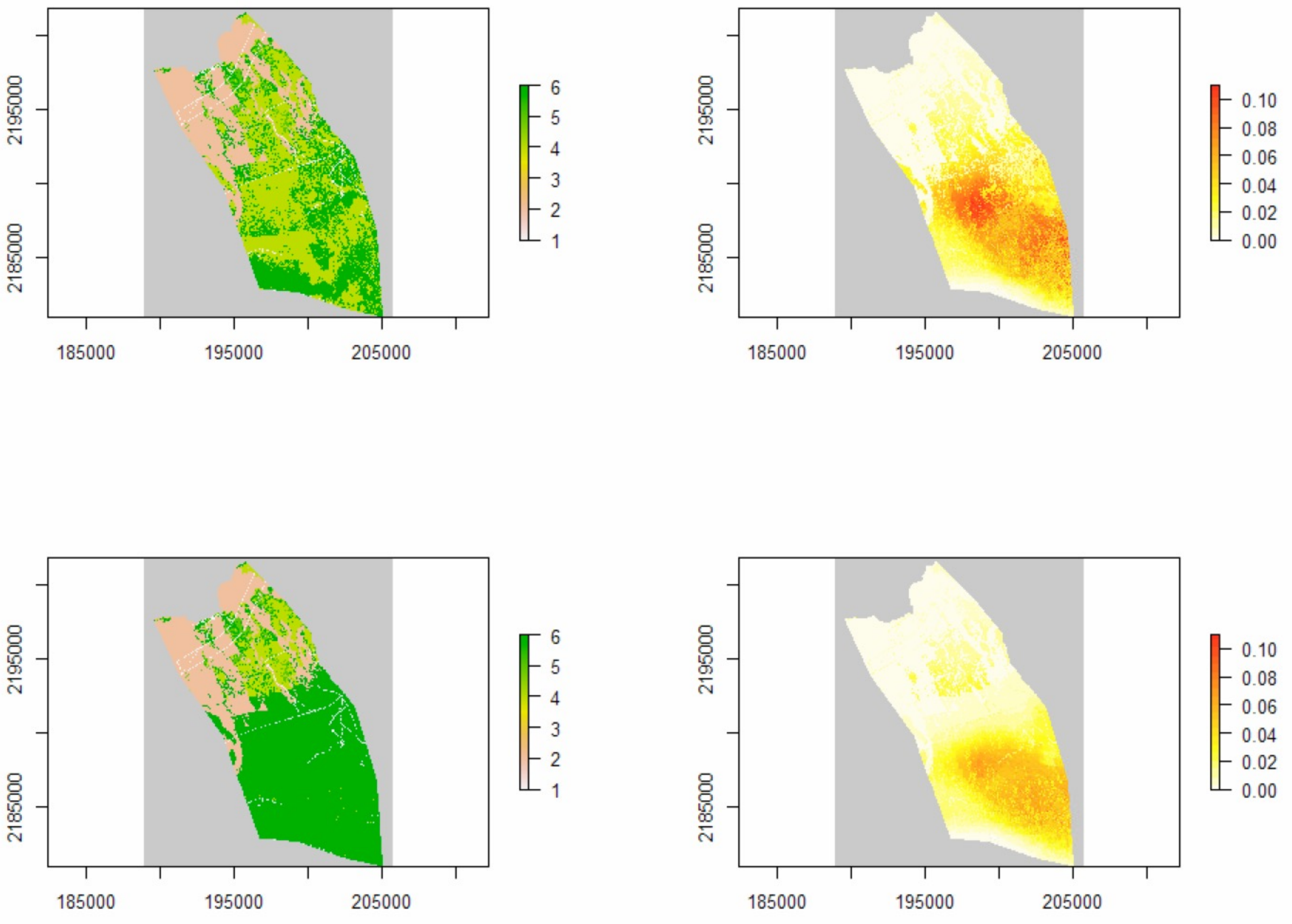
@claytrau

www.PacificFireExchange.org

Reducing fire as an ecosystem service: Puu Waawaa



FUTURE CLIMATE,
NO RESTORATION

FUTURE CLIMATE,
FULL RESTORATION

Wada et al. 2017. Pacific Science

Including x,y as a predictor (spatial autocorrelation)