Dipartimento Scienze del Sistema Terra e Tecnologie per l'Ambiente

CONFERENZA DIPARTIMENTO SCIENZE DEL SISTEMA TERRA E TECNOLOGIE PER L'AMBIENTE, ROMA, 12 DICEMBRE 2023

Fire, plants and global change

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INSTITUTE OF ATMOSPHERIC SCIENCE AND CLIMATE (TORINO) AND NATIONAL BIODIVERSITY FUTURE CENTER

NATIONAL BIODIVERSITY FUTURE CENTER

Consiglio Nazionale delle Ricerche

CNR ISAC

- Fires across the world:
  - Are all the recent wildfires a new phenomena?
  - If so, is global climate and land use change responsible?
  - Can we predict the future of fire ecosystems?

Photo credit: Miguel Ángel Lázaro, Ecological Monograph

A lot of this in the news in the last years

▶2023

earch ⌄ The Guardian International edition ⌄

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Ukraine Environment Science Global development Football Tech Business Obituaries

This article is more than **3 months old**

Greece wildfire declared largest ever recorded in EU

Eleven planes and helicopter from bloc sent to tackle fire that has burned more than 300 sq miles of land

The wildfire at Dadia national park is still out of control, according to the Greek fire service. Photograph: Alexandros Avramidis/Reuters

earch International edition
The Guardian

This article is more than **11 months old**

Firefighters battle wildfires raging across south-west Sardinia

Fast-spreading blazes destroy 20,000 hectares of forest and force 1,500 people to be evacuated from homes

2021

A lot of this in the news in the last years

Wildfires

Ring of fire encircles Mediterranean amid record breaking heatwave - video

Faisal Ali, **Albert Villa Alsina** *and* **Monika Čvorak**, *Source: Reuters/AP/As credited*

Thu 27 Jul 2023 13.01 CEST

Wildfires spread across nine Mediterranean countries, killing at least 40 people, most of them in Algeria. Algerian authorities said 34 people had died in the mountainous

Italia 2023: 75k ettari in fumo

ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

Istituto Superiore per la Protezione e la Ricerca Ambientale

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Home / News / Ecosistemi forestali ed incendi: Stagione Incendi 2023

Ecosistemi forestali ed incendi: Stagione Incendi 2023

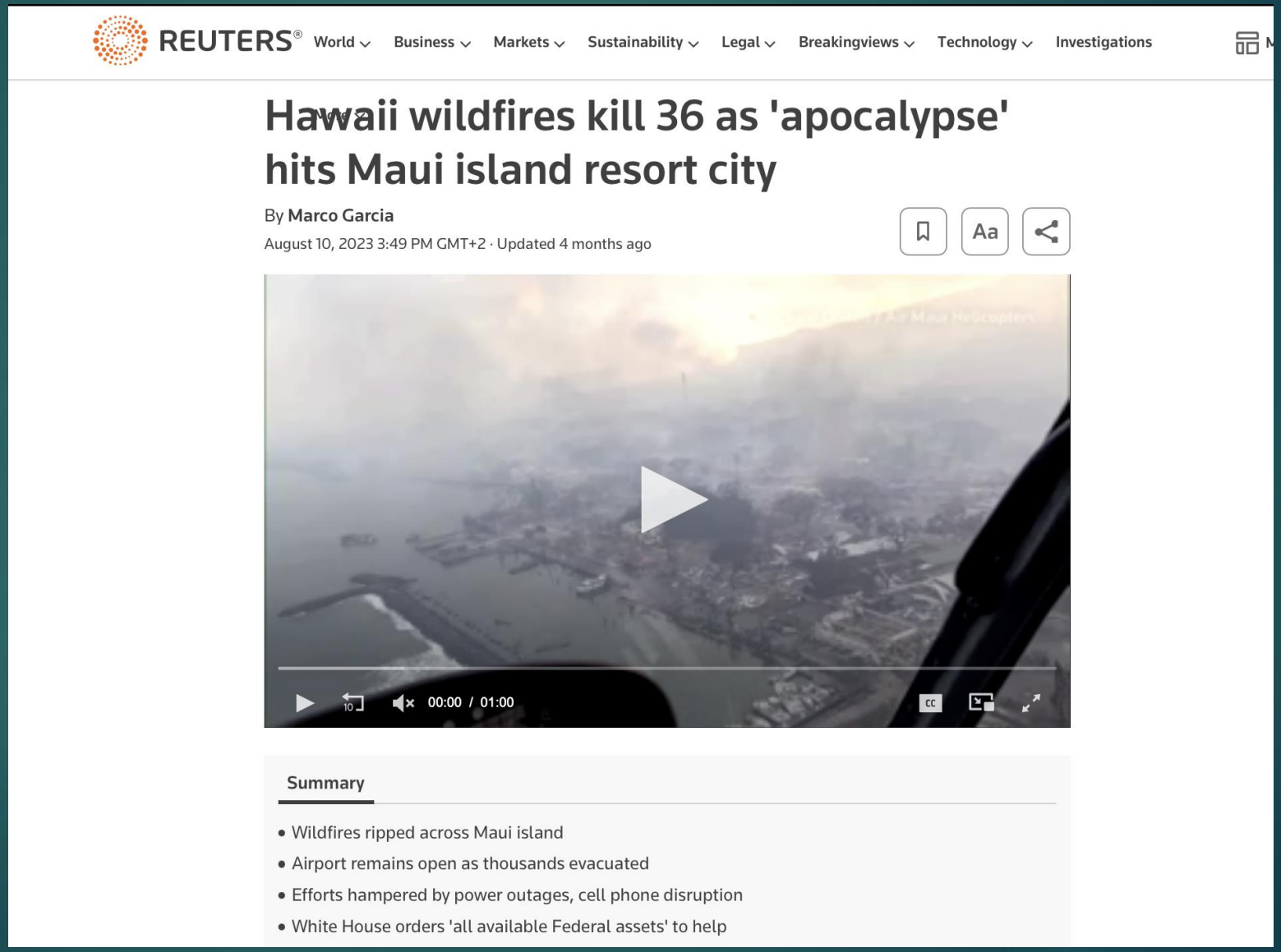
In Italia, durante la stagione degli incendi, definita dal 15 giugno al 15 settembre, risultano colpiti da incendi boschivi quasi 75000 ettari di territorio, di cui quasi 11000 ha coperti da ecosistemi forestali. Le foreste maggiormente coinvolte risultano, con buona approssimazione, porzioni di macchia mediterranea e boschi di leccio (65%) e superfici ricoperte da boschi e rimboschimenti di conifere (20%).

Le regioni principalmente colpite sono la Sicilia e la Calabria, all'interno delle quali ricade quasi l'87% del territorio nazionale colpito da incendio e l'85% della superficie forestale bruciata (7192 ha in Sicilia e 2043 ha in Calabria). La sola provincia di Palermo rappresenta circa 1/3 del totale nazionale delle superfici forestali percorse da incendio (AB For) durante la Stagione Incendi 2023.

Quasi il 48% degli ecosistemi forestali colpiti da incendio durante la Stagione Incendi 2023 si trova all'interno di aree naturali protette.

Gli incendi boschivi in Italia: stagione degli incendi 2023

Hawaii, summer 2023



A lot of this in the news in the last years

"California's 2020 wildfire season was unprecedented, the latest tragedy in a decades-long trend of increasing fire. Six of the 20 largest fires in state history burned during the calendar year."
Sidder, EOS 2021

The Apple Fire, seen here burning on 31 July north of Beaumont, Calif., was one of thousands of wildfires that burned across the state in 2020.
Credit: Brody Hessin, CC BY 4.0

Australia 2019-2020

Unprecedented burned area of 21% observed for Australian biome resulting from the 2019/20 forest fires.

de Boer et al 2020, *Nature CC*

The Dunn's Road fire burns pine trees near Maragle, New South Wales (Australia), on 10 January 2020. Credit: Matthew Abbott/New York Times/Redux/eyevine

Amazon, summer 2020

Amazon rainforest

This article is more than **1 year old**

Brazil's Amazon rainforest suffers worst fires in a decade

- **Satellites record 61% rise in hotspots over September 2019**
- **Scientist warns: 'It could get worse if the drought continues'**

Reuters in Brasîlia

Thu 1 Oct 2020 16.48 BST

Smoke and flames rise from an illegally lit fire in an Amazon rainforest reserve, south of Novo Progresso in Para State, Brazil, in August. Photograph: Carl de Souza/AFP/Getty Images

earch International edition

The Guardian

This is worrisome..

Conseguenze degli incendi

- Danni a persone o cose (specie all'interfaccia urbano-forestale) e alle attività agrosilvopastorali
- Emissioni rilasciate a seguito della combustione: significativo impatto su qualità dell'aria e salute umana

- Fenomeni erosivi
- Impatti sul bilancio del carbonio e radiativo -> sui cambiamenti climatici

Canberra, Australia's parliament building. Jan 5th 2020

Credit: Alex Ellinghausen/SMHFairfax Media via Getty


This is worrisome..
Is this new? Why is it happening?

Is this new?

- Fires have been an integral part of the Earth system for the past 350 million years *(paleorecords)*

- Shaped plant evolution and the emergence of certain biomes, e.g.: savannas

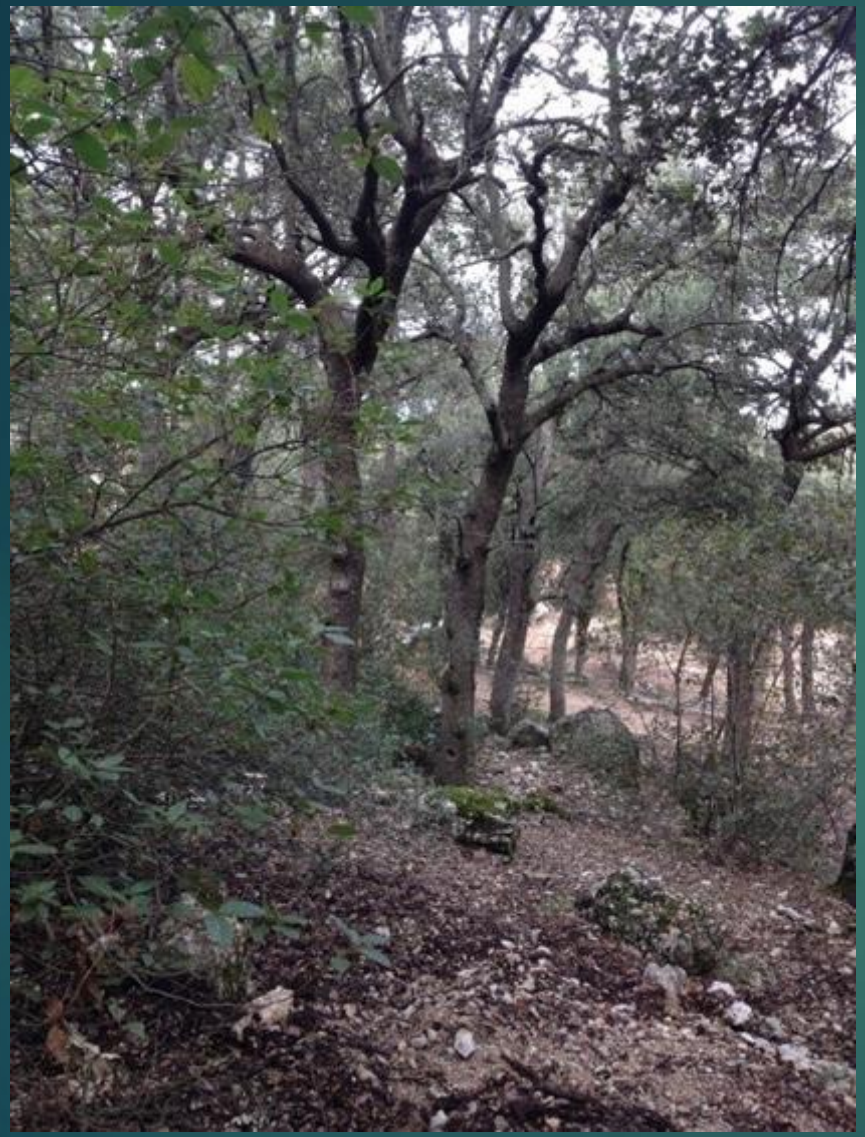
Credit: D. D'Onofrio

Fire response strategies

Aleppo pine and shrubs (Spain)

Esperimental fire. Credit: CEAM foundation, Valencia

Fire response strategies



Holm oak forest (Spain)

Credit: CEAM foundation, Valencia

Fire response strategies

ARY JOURNALS

Science

NEWS | PLANTS & ANIMALS

Ancient redwoods recover from fire by sprouting 1000-year-old buds

After a devastating conflagration, trees regrow using energy stored long ago

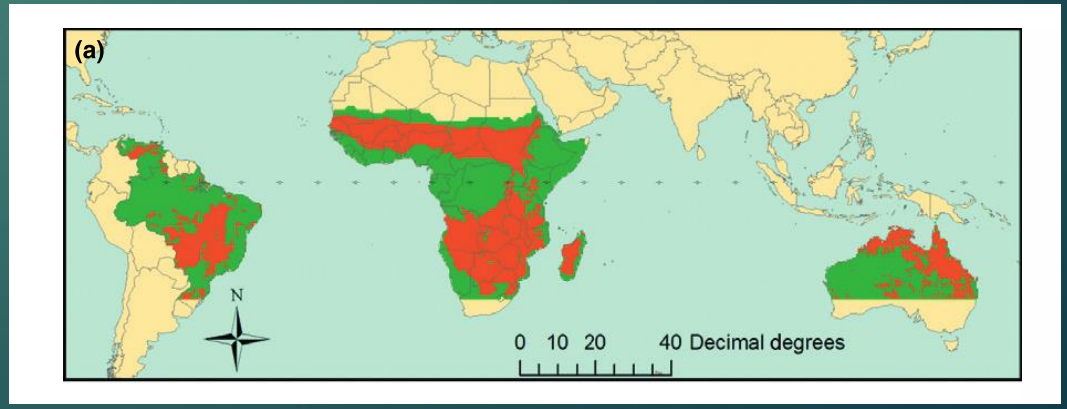
1 DEC 2023 · 5:55 PM ET · BY ERIK STOKSTAD

Fire maintains open savannas

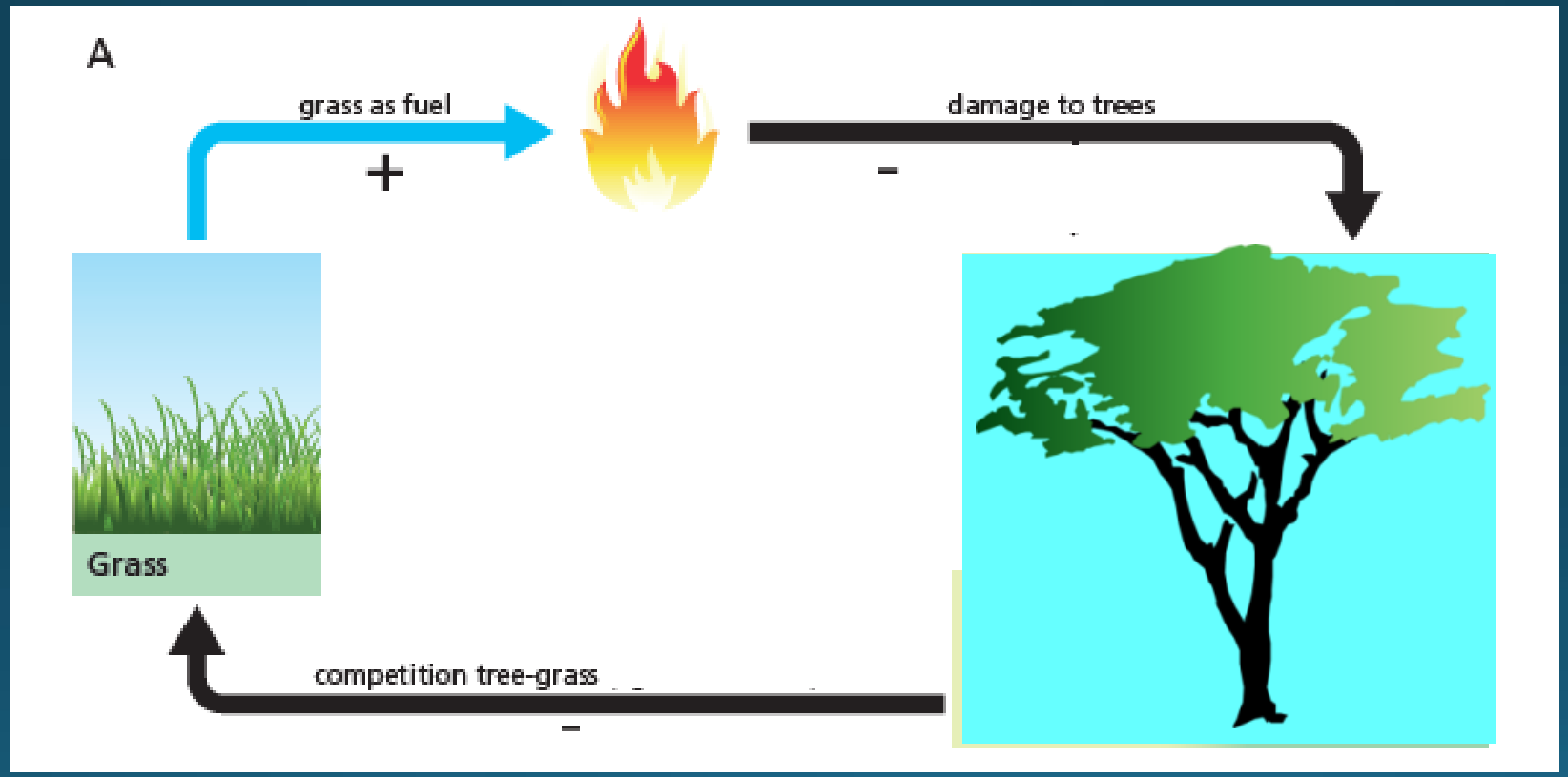
Cardoso et al 2018

Pellegrini et al 2016. Credit: C. Staver

- cover about 20% of the Earth's land surface
- wide socio-economic importance (biodiversity, land-use).



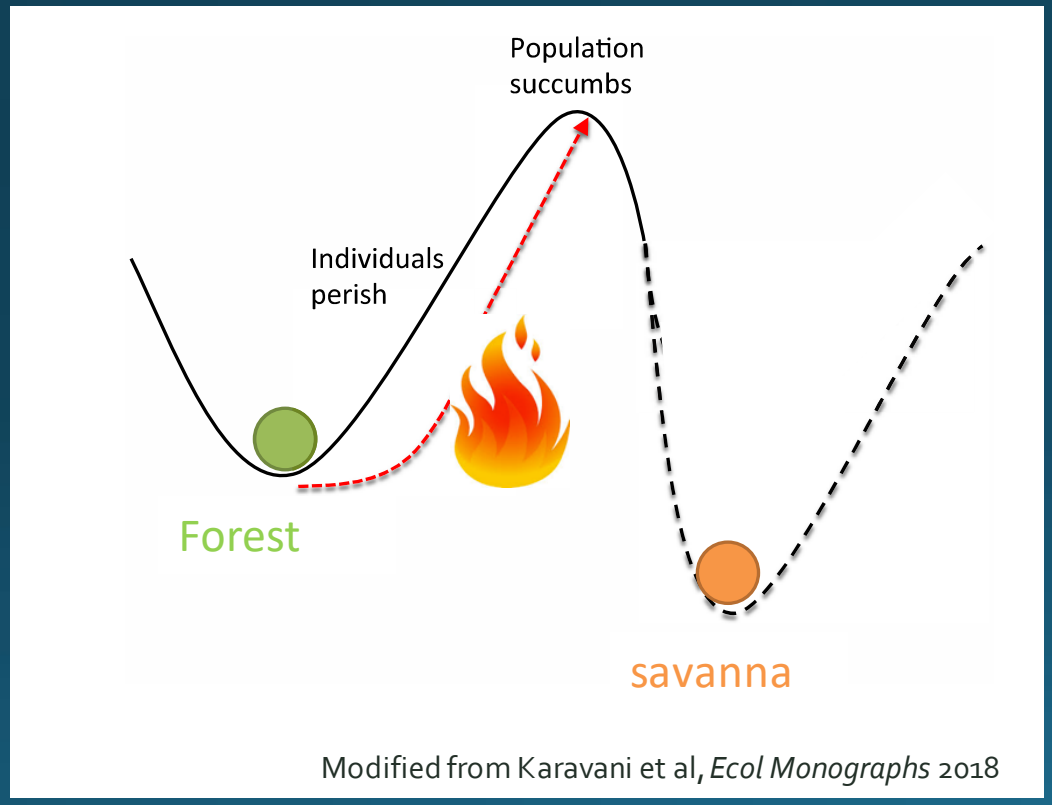
Savannas: The grass-fire feedback



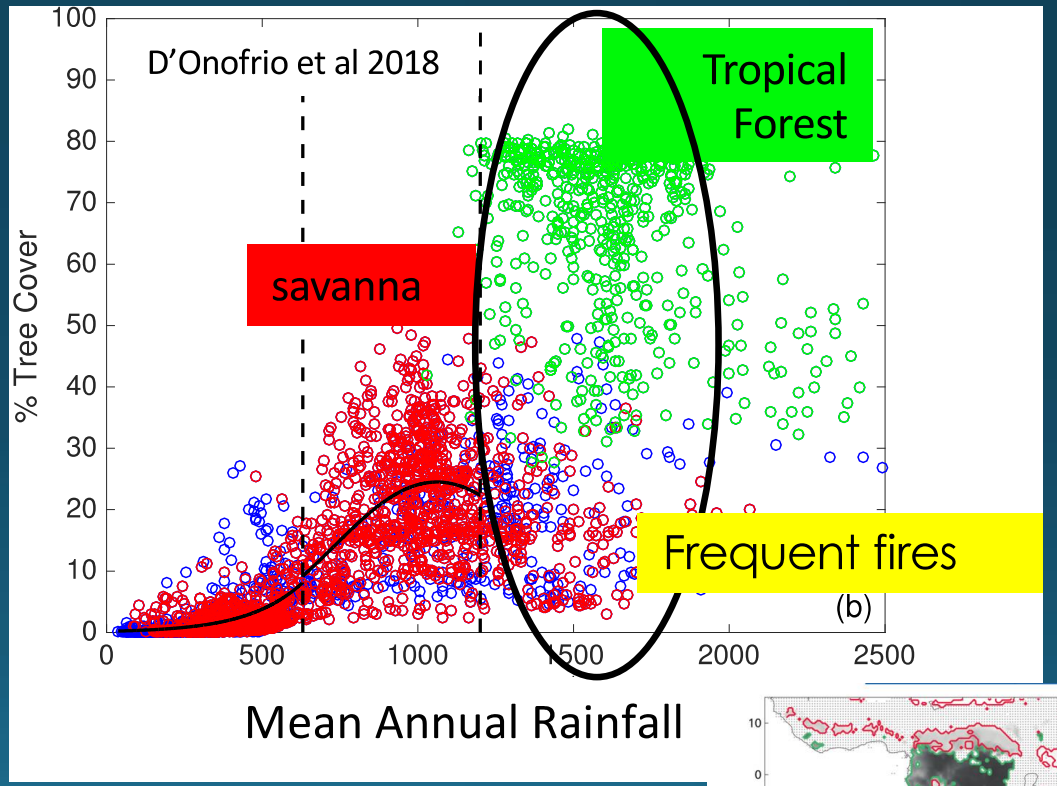
Humid savannas and forests observed for the same climate

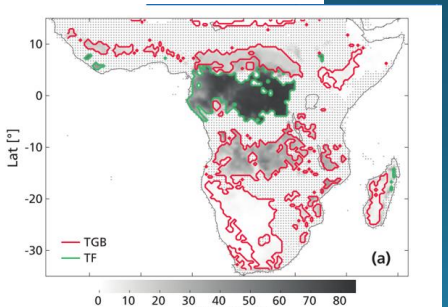
Baudena et al. 2015 *Biogeosciences*

Fire can maintain savanna and forests as alternative ecosystem states in the tropics



Modified from Karavani et al, *Ecol Monographs* 2018

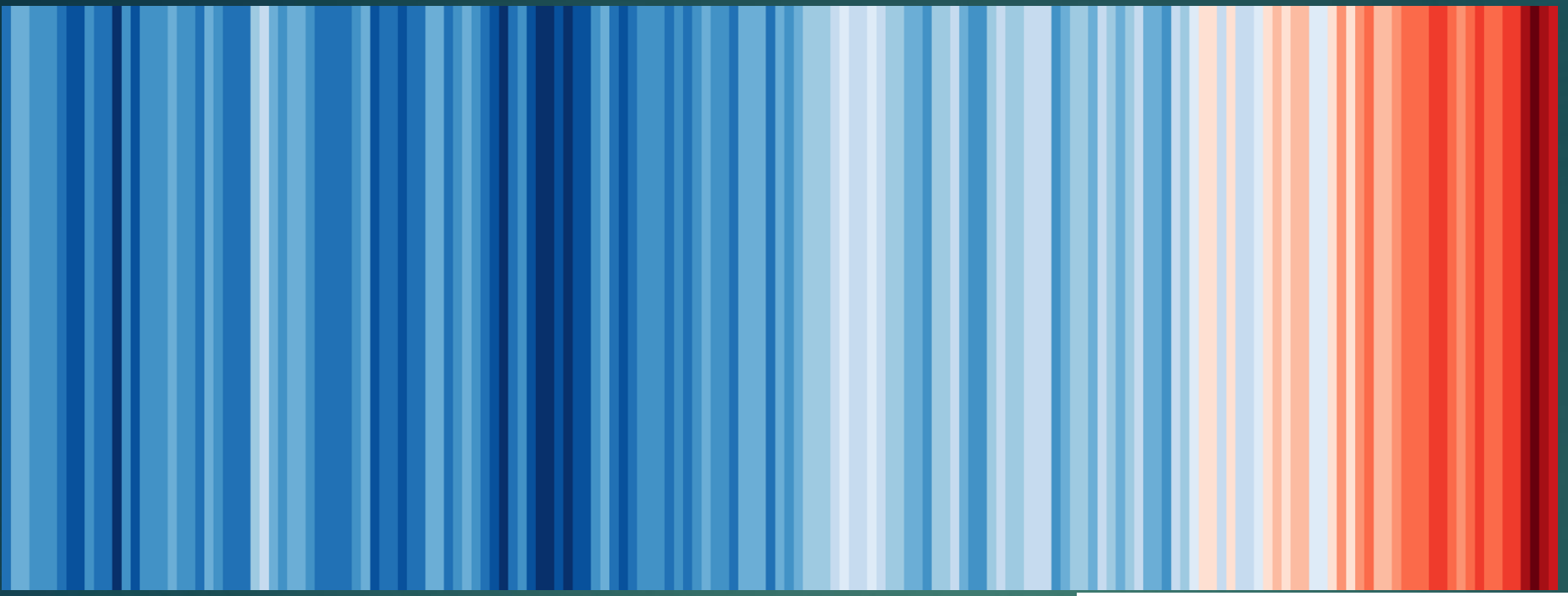




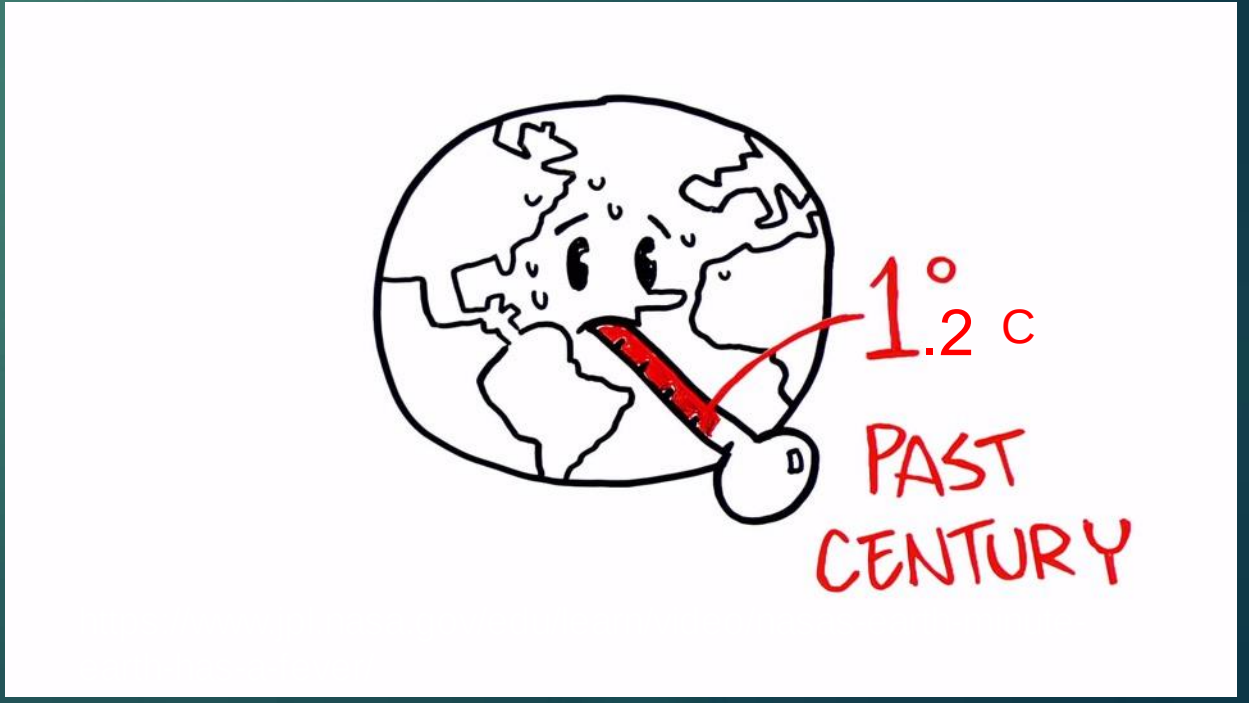
same climate

So, it's not new. But what about the news. Did something change?

Let's take a look at how fire works



Climate change?



Influenza del cambiamento climatico: Mediterraneo

- Aumento temperature e diminuzione delle precipitazioni estive
- Stagioni più lunghe e secche, più giorni con condizioni meteo eccezionali

%

Influenza del cambiamento climatico: Mediterraneo

- Aumento temperature e diminuzione delle precipitazioni estive
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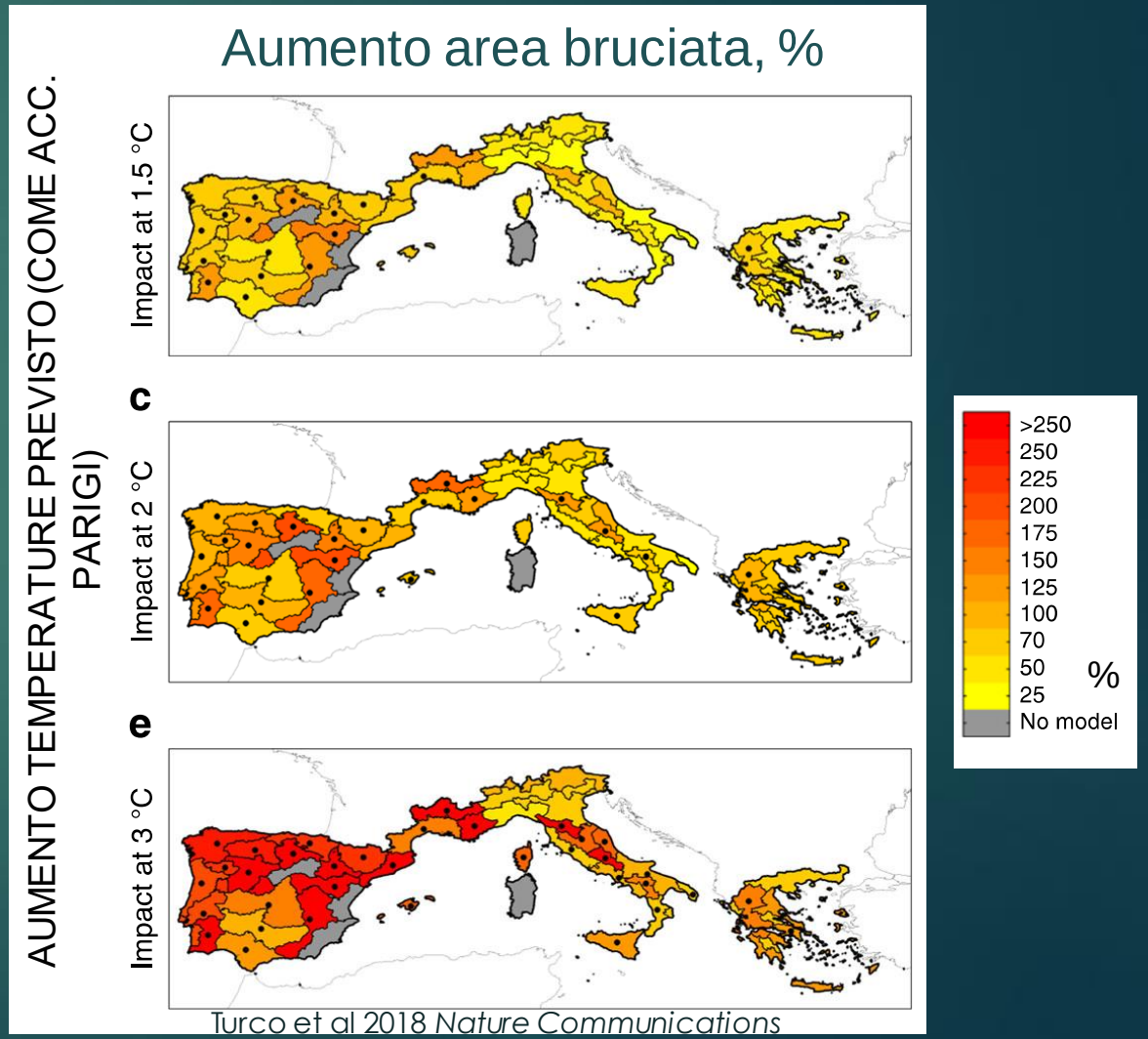
Conseguenza: aumento di incendi previsto in futuro con cambiamento climatico



Turco et al 2018 *Nature Communications*

CLIMATE CHANGE

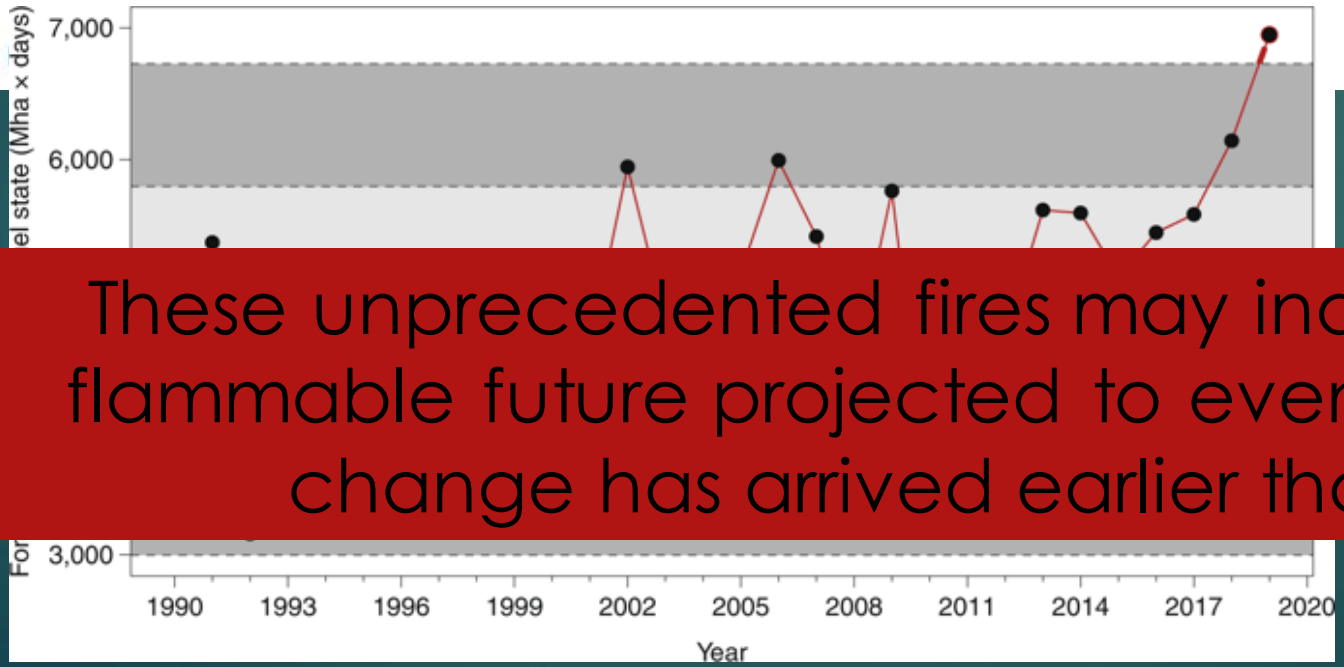
NU ▾ nature Subscribe

NEWS · 04 MARCH 2020

Climate change made Australia's devastating fire season 30% more likely

But researchers say the result is conservative, and that weather conditions that make fires more likely will continue to worsen.

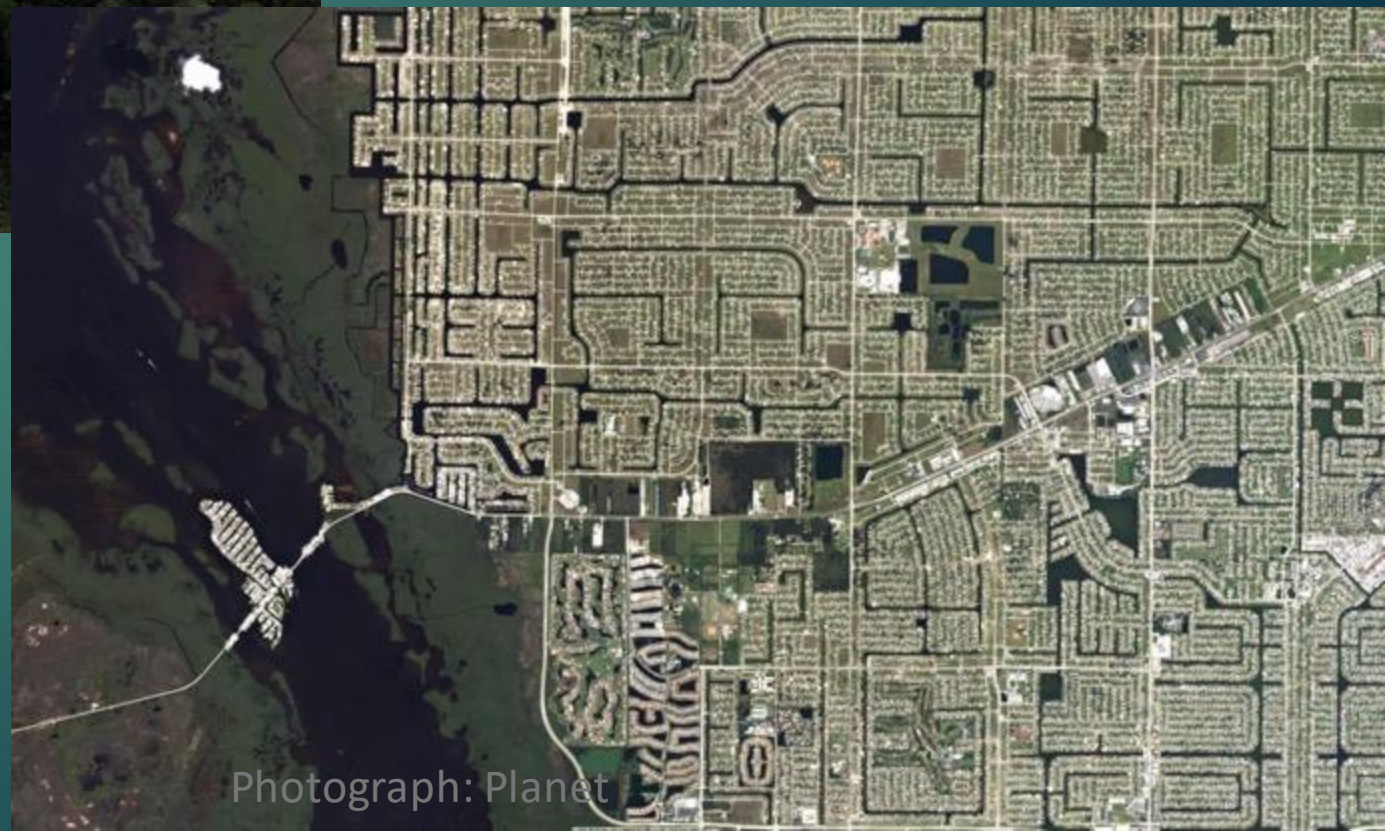
https://australianbushfiresandclimatechange.com



These unprecedented fires may indicate that the more flammable future projected to eventuate under climate change has arrived earlier than anticipated

Boer et al 2020, *Nature Climate Change*

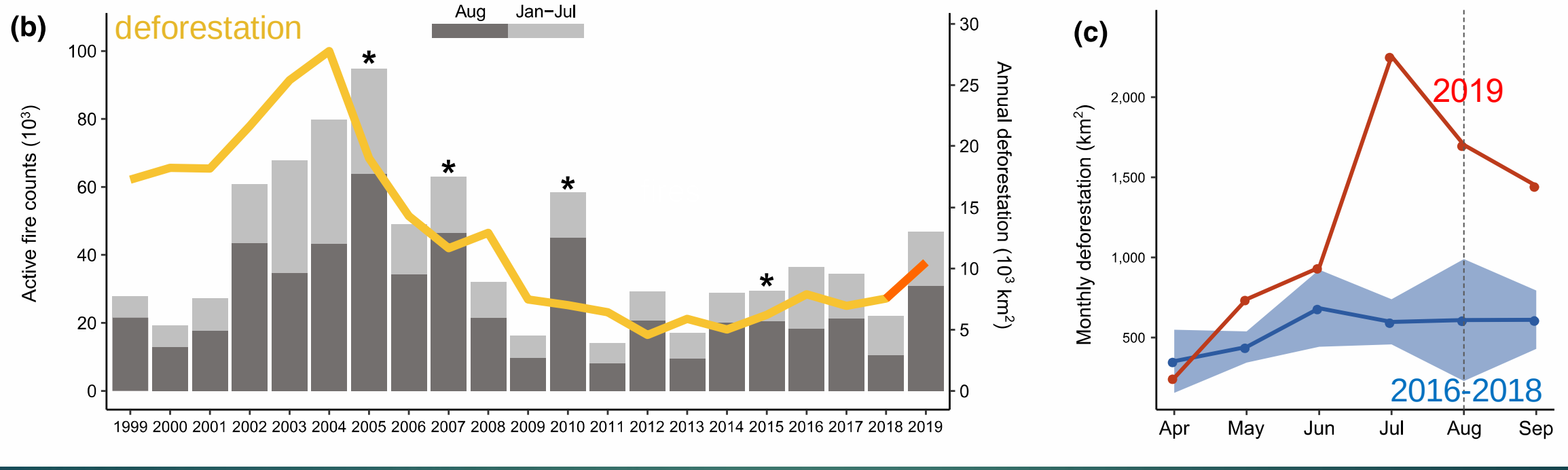
Land use change?



LAND USE CHANGE

Amazon

Amazon, summer 2019



- even low-intensity forest fires can kill up to 50% of the trees and reduce the value of the forests for locals
- The number of active fires in August 2019 was nearly three times higher than in August 2018 and the highest since 2010 (Figure 1b).

Barlow et al 2019

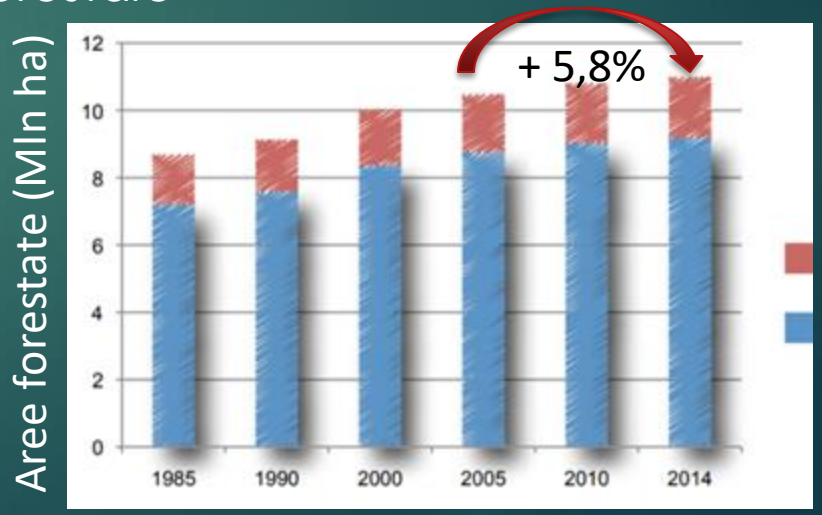
LAND USE CHANGE

Italia: cambiamento del territorio

Cambiamenti di uso del suolo e socio-economici in aree montane

- Abbandono di vaste aree marginali
- Spopolamento e invecchiamento della popolazione
- Abbandono pratiche tradizionali selvo-colturali, agricole e pastorali (incluso l'uso controllato del fuoco)
- Aumento delle zone di interfaccia urbano-forestale

Aumento delle superfici forestali e della continuità del combustibile vegetale



Elaborazione CFS dati Cra-Mpf

Future challenges: predicting fire ecosystems' fate **in a changing climate**

MODELLING MEDITERRANEAN FORESTS (AND BEYOND)

How will wildfire be in the future? The fire-climate-vegetation nexus

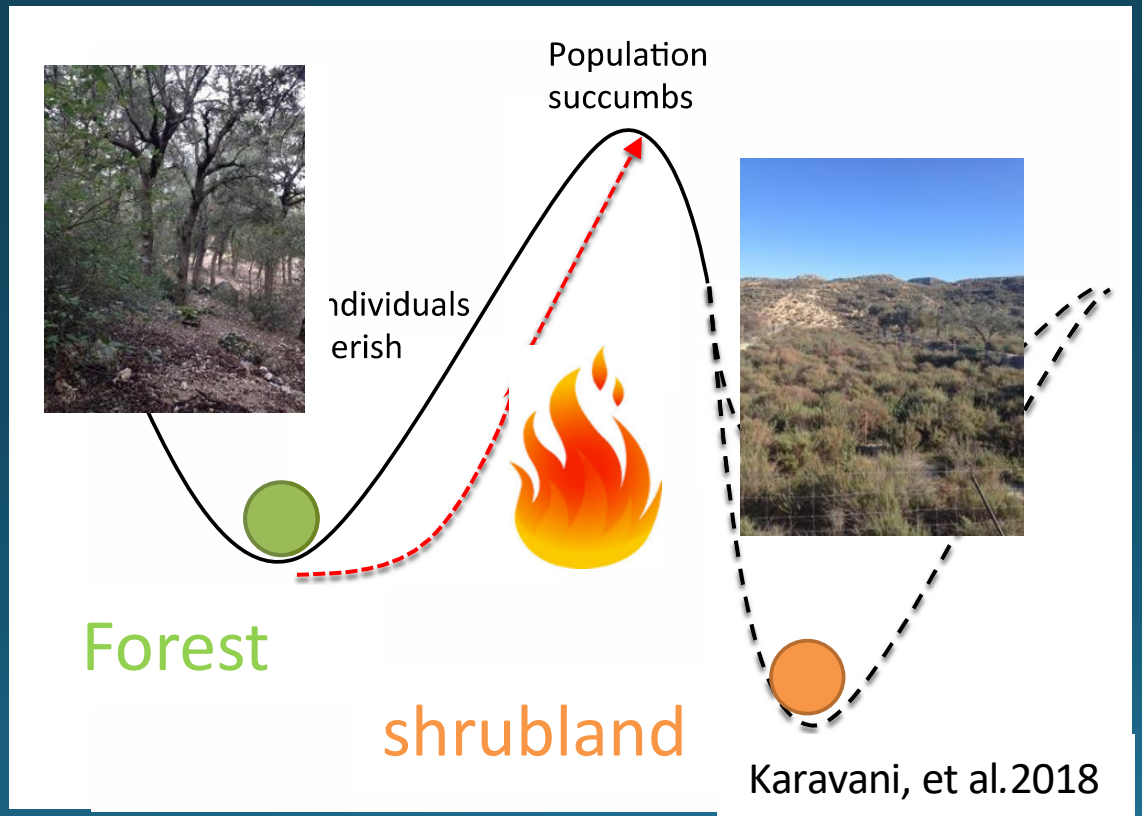
Climate change

- Usually studied: increases droughts, flammability

BUT ALSO:

- if too dry vegetation won't grow enough, not enough fuel
- Drought limits plant regrowth after fire

Can fire lead Mediterranean forests to lose resilience?



Baudena et al 2020 *New Phytologist*
Vasques et al 2023 *Ecosystems*

Model ingredients

1- A classical model for succession (Tilman 1994)

2-Fire:

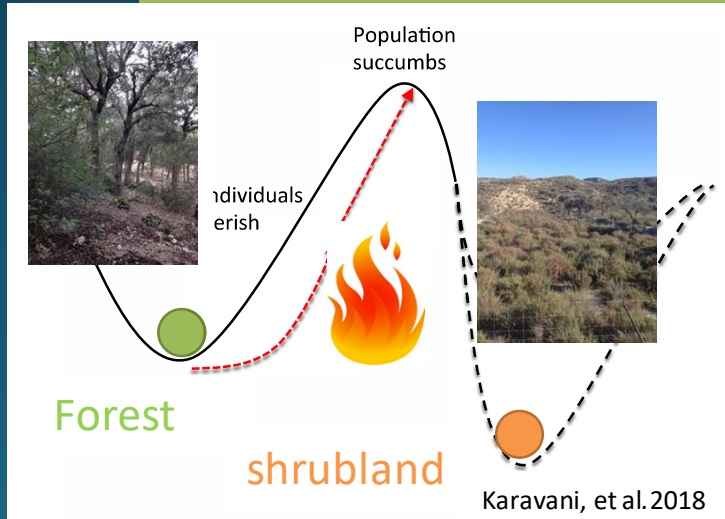
- different plant functional types
- Stochastic fires
- vegetation-fire feedback

Calibration with data from:
old-fields (no fire) or from sites with repeated fires

Baudena et al, 2020

Can fire lead Mediterranean forests to lose resilience?

Predicted increase in aridity, decreasing post fire recovery, could drive Mediterranean forests towards open shrublands



This can be used for post-fire management (planting of species with strong post-fire recovery), Santana et al *in prep*

Baudena et al 2020 *New Phytologist*
Vasques et al 2023 *Ecosystems*

Plant post-fire responses determine the resilience of all fire ecosystems

VOL. 202, NO. 3 THE AMERICAN NATURALIST SEPTEMBER 2023

Fire Responses Shape Plant Communities in a Minimal Model for Fire Ecosystems across the World

Marta Magnani,[1,2,3,4,*] Rubén Díaz-Sierra,[5,6] Luke Sweeney,[7] Antonello Provenzale,[1,4] and Mara Baudena[3,4,5,8]

NATIONAL BIODIVERSITY FUTURE CENTER

Future challenges: predicting fire ecosystems' fate **under global change**

A MULTI-FACETED APPROACH TO STUDY THE RESILIENCE OF MEDITERRANEAN FORESTS

Finanziato dall'Unione europea NextGenerationEU

Ministero dell'Università e della Ricerca

Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

NATIONAL BIODIVERSITY FUTURE CENTER

11 Gruppi di ricerca che partecipano al tavolo tematico incendi e biodiversità del National Biodiversity Future Center

Coordinamento

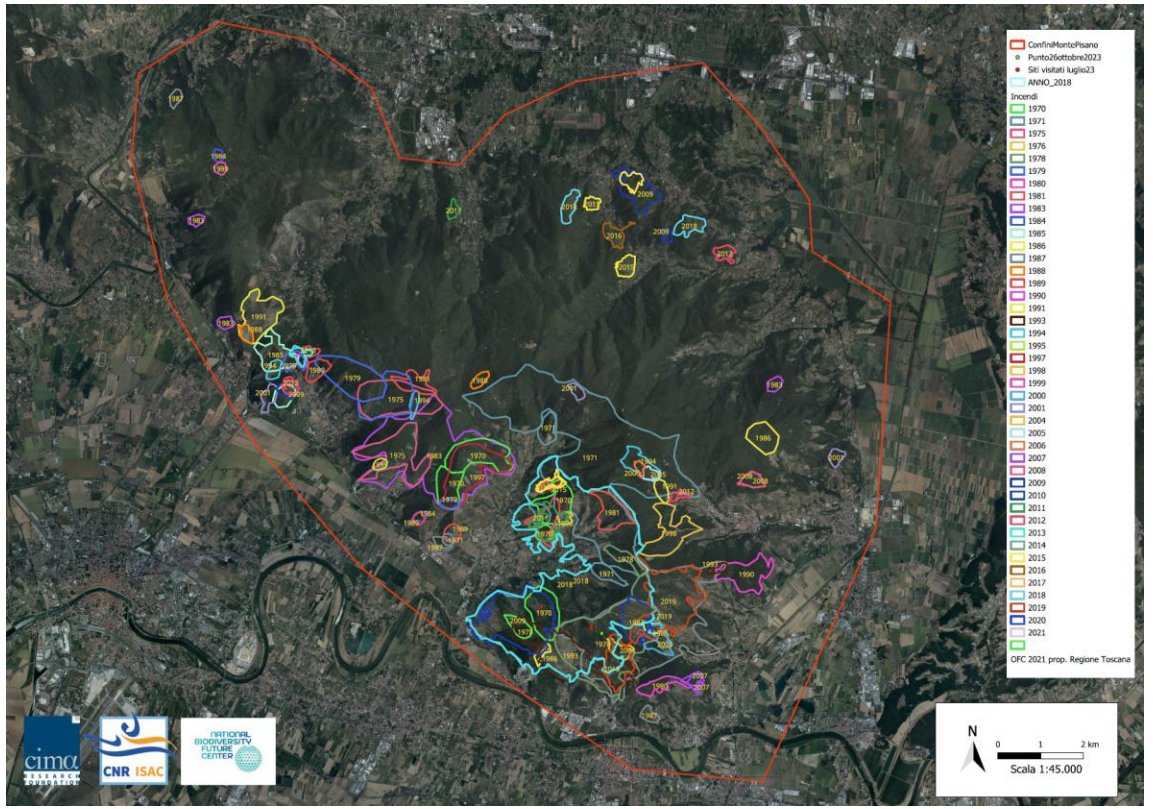
CNR ISAC (Baudena) e Fondazione CIMA (Fiorucci)

Partecipanti

CNR IMATI
CNR-IGG
CNR IGAG
CNR IRET
UNIBO
UNIFI
UNISS
UNISapienza
CMCC
ISPRA (partecipante esterno)

Tavolo incendi e biodiversità NBFC: Master site Monte Pisano

- Ricostruzione della storia passata della vegetazione, incendi, uso del suolo nel periodo più lungo possibile.
- Misure multi-level e multi-faceted, abiotiche e biotiche
- Intensità incendio, incendi ripetuti, gestione post-incendio



Finanziato dall'Unione europea NextGenerationEU
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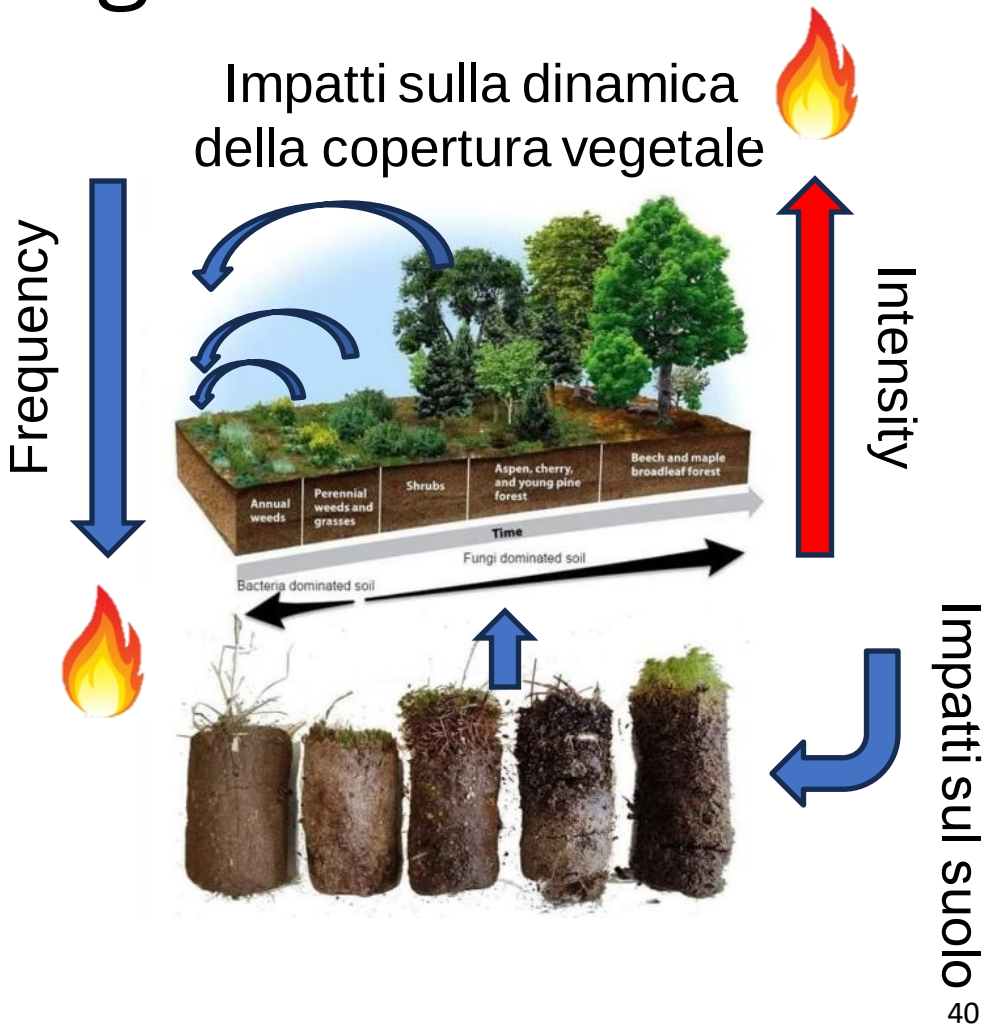
Modellistica per predizioni a lungo termine

- Dalla comprensione dei fenomeni alla predizione
- Ecosistemi e incendi in evoluzione verso?
- Nel medio-lungo termine, includendo interazione piante incendi, gestione forestale e cambiamento climatico

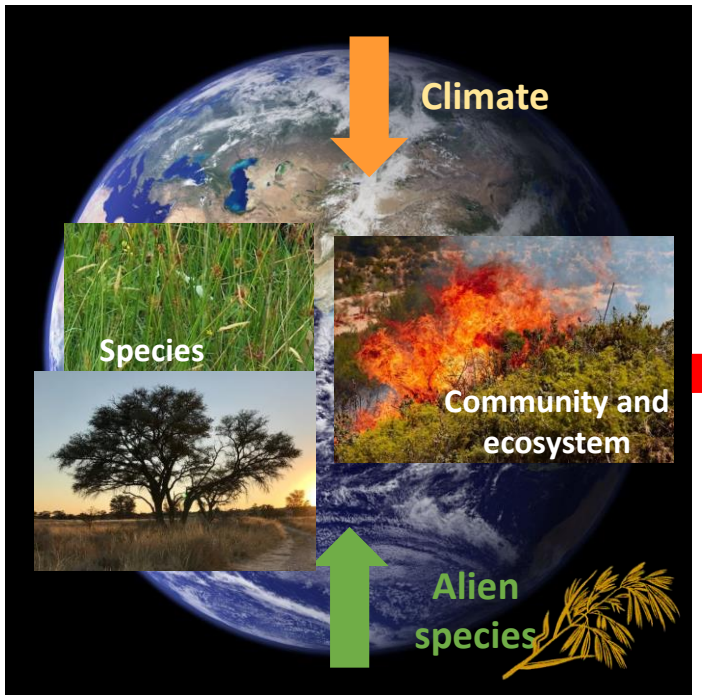


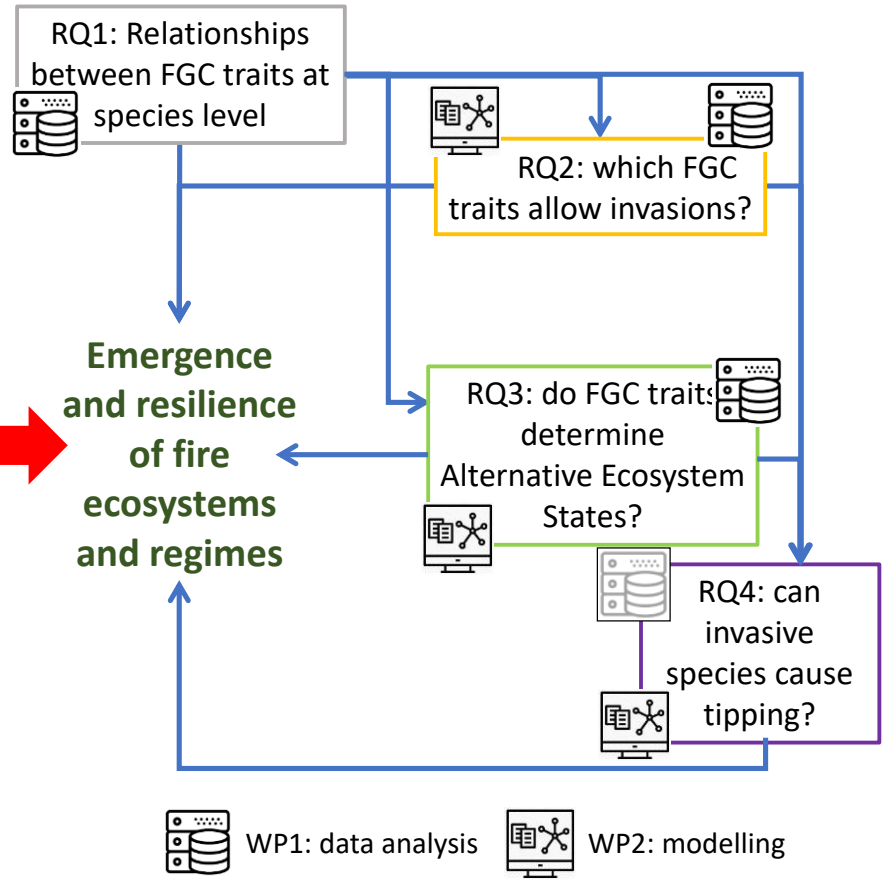
Future challenges: invasive species and fires worldwide

How Invasive Plants Caused the Maui Fires to Rage

A sweeping series of plantation closures in Hawaii allowed highly flammable nonnative grasses to spread on idled lands, providing the fuel for huge blazes.

“WiFin” project: Plant traits of native and invasive species in fire ecosystems across the world





Funded project (PRIN PNRR 2022)
Co-PI: Marta Carboni, Univ. Roma III

CLIMATE CHANGE

LAND USE CHANGE

Summary

- Fires are an integral part of the Earth system. However, several areas worldwide have observed exceptional fire seasons
- Climate change and land use change, and their interactions with plant responses, have increased the chances of such fires
- Land use and post-fire management actions can help restoring natural ecosystem resilience to wildfires

WITH MANY THANKS TO:

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MARTA MAGNANI, RUBÉN DIAZ-SIERRA, ANTONELLO PROVENZALE, LUKE SWEENEY

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ARIE STAAL, OBBE TUINENBURG