

Lost in Space

Revealing human impacts on forests & fires

Dr James Millington

Pint of Science, 2024-05-13

These slides available at:

landscapemodelling.net/pres/POS24



LEVERHULME
Centre for Wildfires,
Environment and Society

KING'S
College
LONDON
Geography

Revealing human impacts on forests & fires

We can't simply rely on what we 'see' from space, which is largely about physical attributes.



Lost in Space - from 1960s to 2020s



Data Tradeoffs

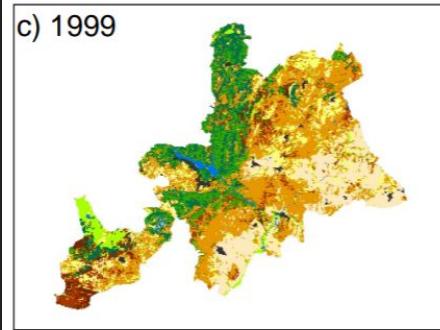
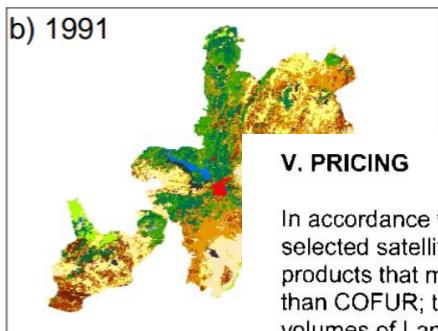
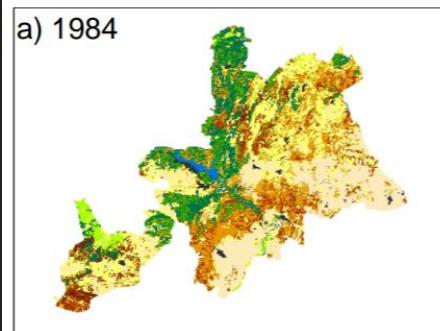


0.3 m, ~1 per year, visible only (Photo)

30 m, ~20 per year, multi-spectral (Landsat)

1000 m, ~2 per day, multi-spectral (MODIS)

From an expensive few, to a free-for-all



- Pine
- Transition F
- Pasture
- Deciduous
- Scrubland
- Holm Oak
- Holm Oak v
- Cropland
- Burnt
- Water/Quar
- Urban

V. PRICING

In accordance with OMB Circular A-130 and USGS Data Policy, the USGS provides selected satellite data products for retrieval via the Internet at no charge to users. Other products that may be ordered by users from the NSLRSDA are provided at no more than COFUR; this includes special arrangements made for users who require higher volumes of Landsat data products than can be provided by standard USGS distribution mechanisms.

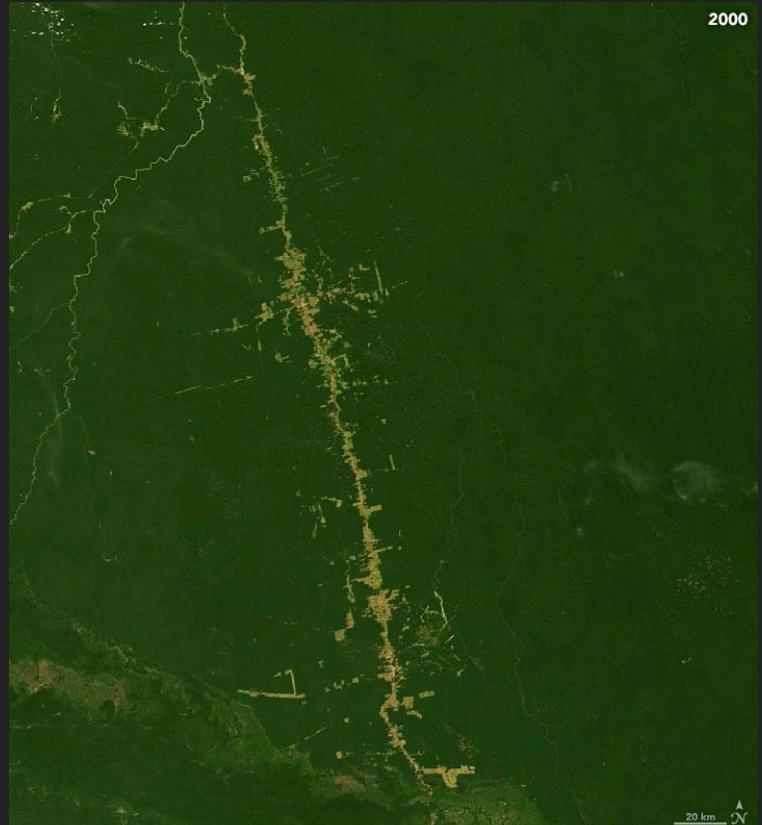
Barbara J. Ryan
Associate Director for Geography
U.S. Geological Survey

Michael H. Freilich, Director
Earth Science Division
National Aeronautics and Space
Administration

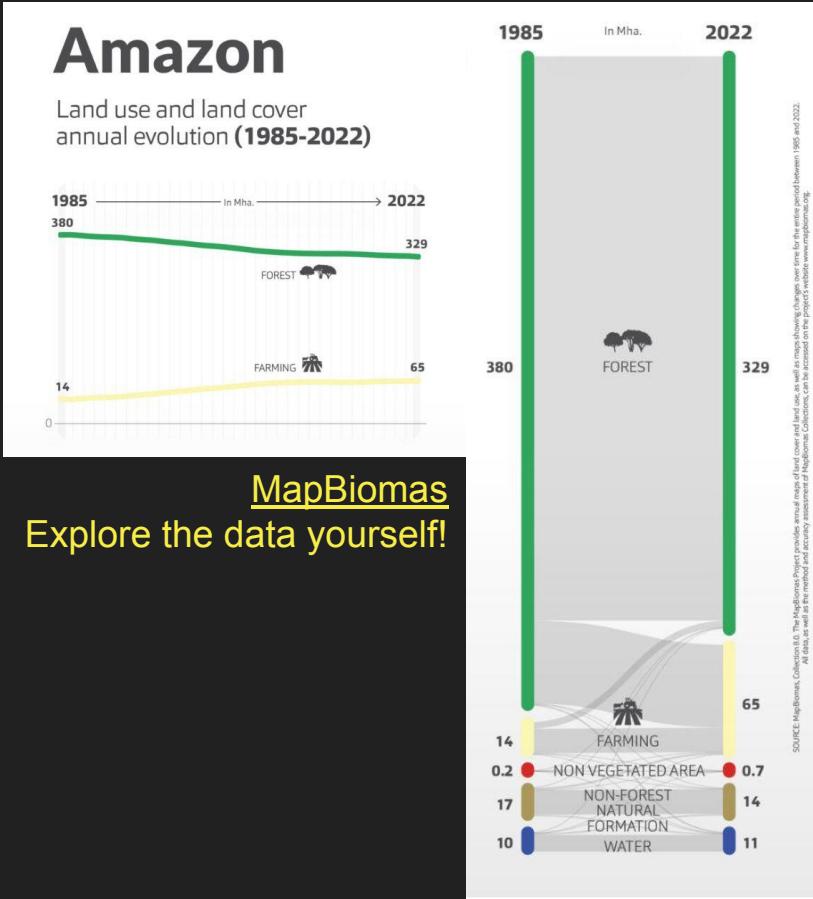
Date: 2 January 2008

Date: 7 Jun 08

Tracking land cover and land use change



[PRODES]



Tracking ownership: Rural Environmental Cadastre (CAR)



Image source

Tool to:

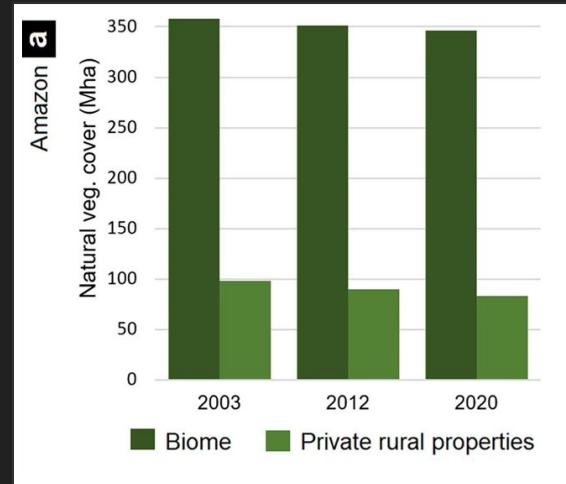
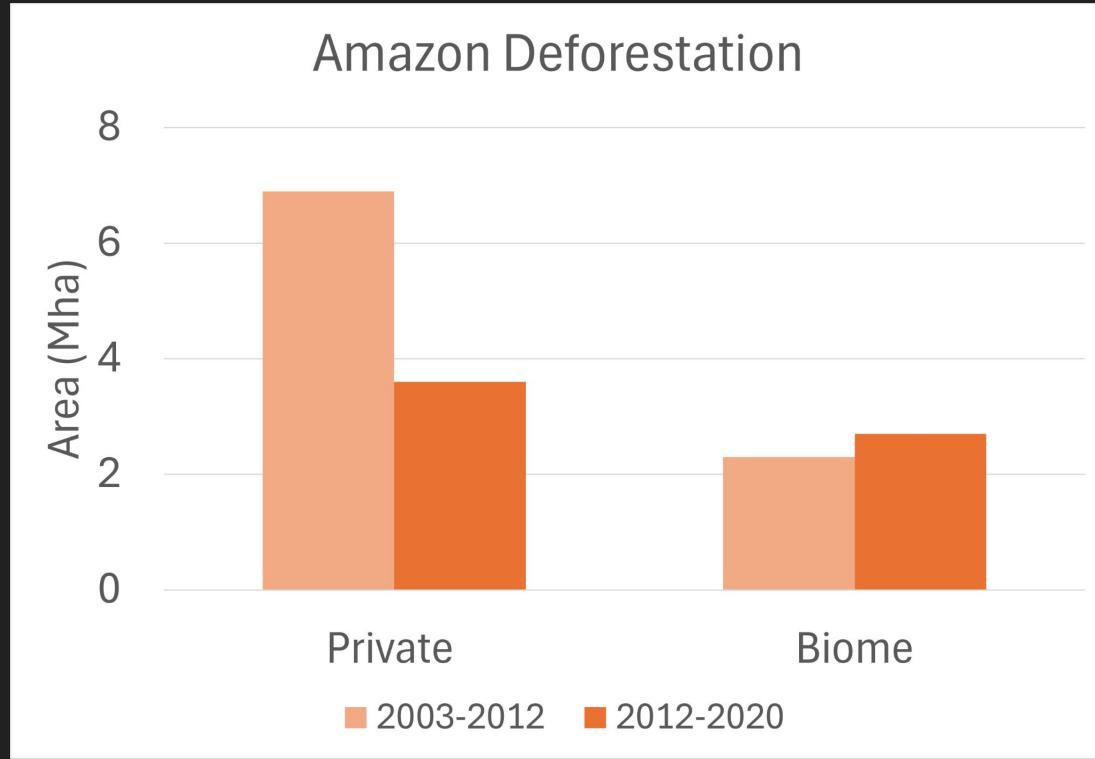
- obtain information about property for monitoring (e.g. deforestation)
- foster national forest code compliance

Data are self-declared by landowners

- >700,000 in Amazon



Who owns the land being deforested?



Paper: [Silva et al. \(2023\)](#)
Data: [CAR](#), [MapBiomass](#)



Should they be doing that?

Forest code rules on ‘legal reserve’ of forest on rural property:

1965: 50% of property reserved as forest

1989: 80% of property reserved as forest

2012: amnesty for ‘lost’ forest removed prior to 2008

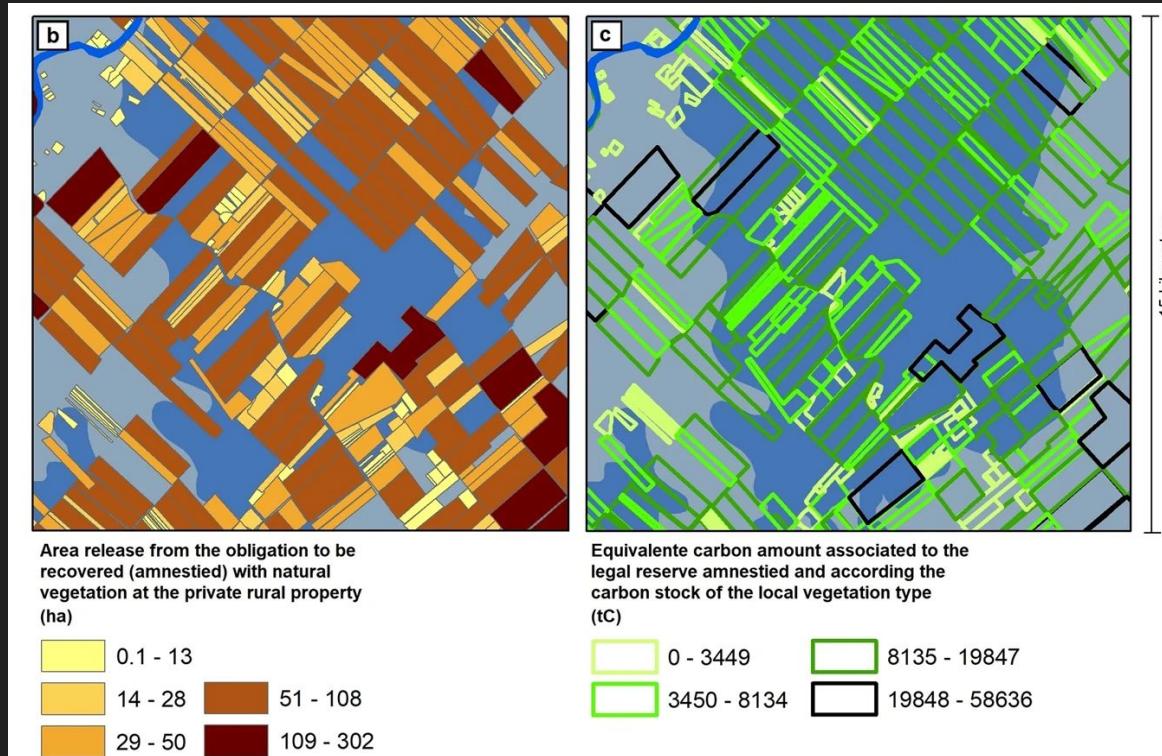
Read more: [Santos et al. \(2021\)](#)

In the Amazon, we found:

Lost forest: 25.5 Mha

Amnesty applied to 14.6 Mha
(511,658 properties)

Carbon lost due to deforestation amnesty

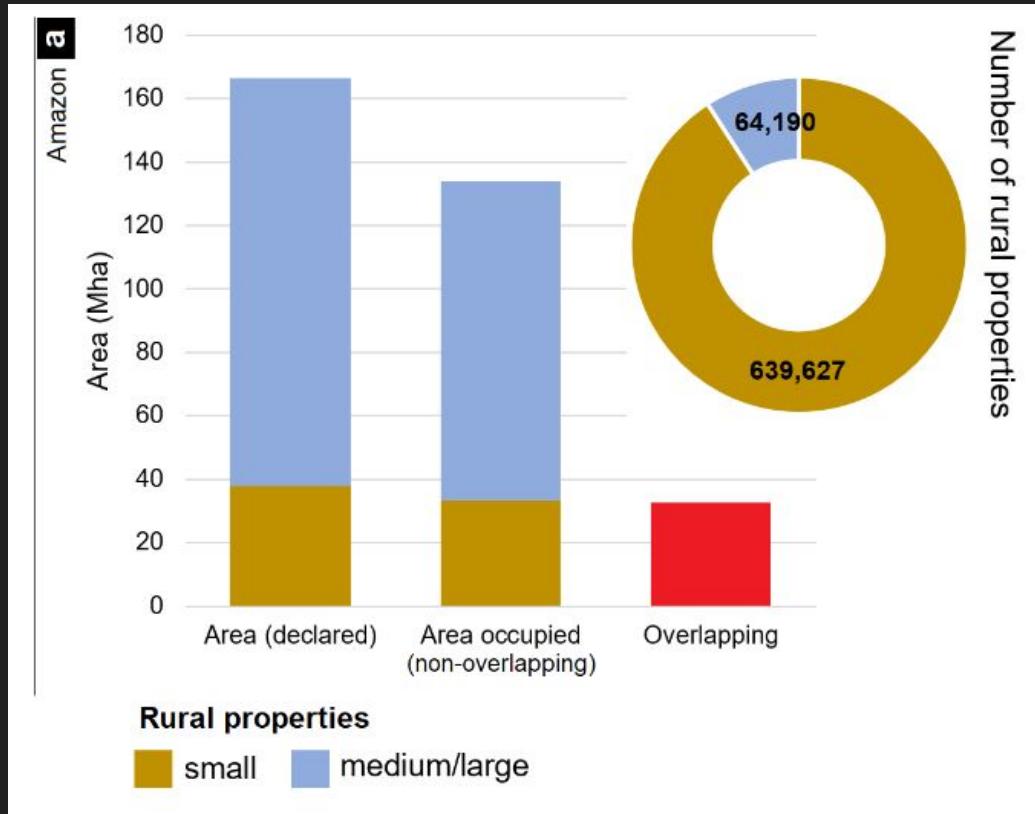


Paper: [Silva et al. \(2023\)](#)
Data: [CAR](#), [MapBiomas](#)

We estimate 2.4 Gt of carbon lost due to amnesty



The data are by no means perfect



Overlaps of property polygons

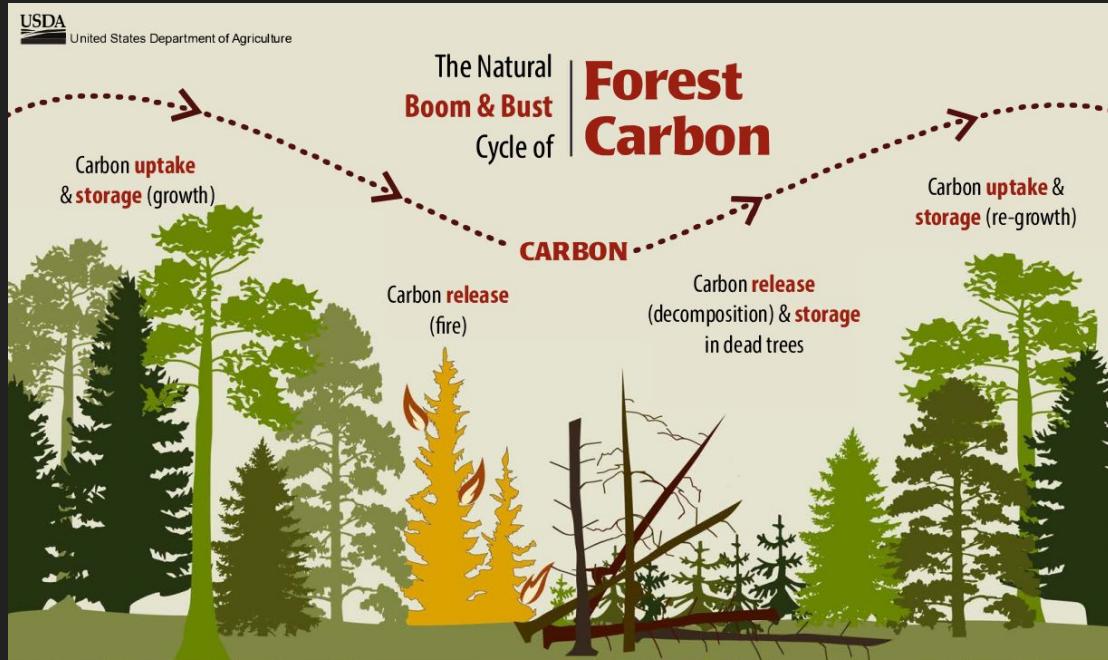
But also, 10% of conservation units in Amazon (20.5 Mha) marked private property!

- Mistakes
- Land grabbing

Fire emissions



$$\text{CO}_2 = \text{BA} \times \text{FL} \times \text{CE} \times \text{EF}$$



BA: Burned Area (ha)

FL: Fuel Load (kg ha⁻¹)

CE: Combustion Efficiency

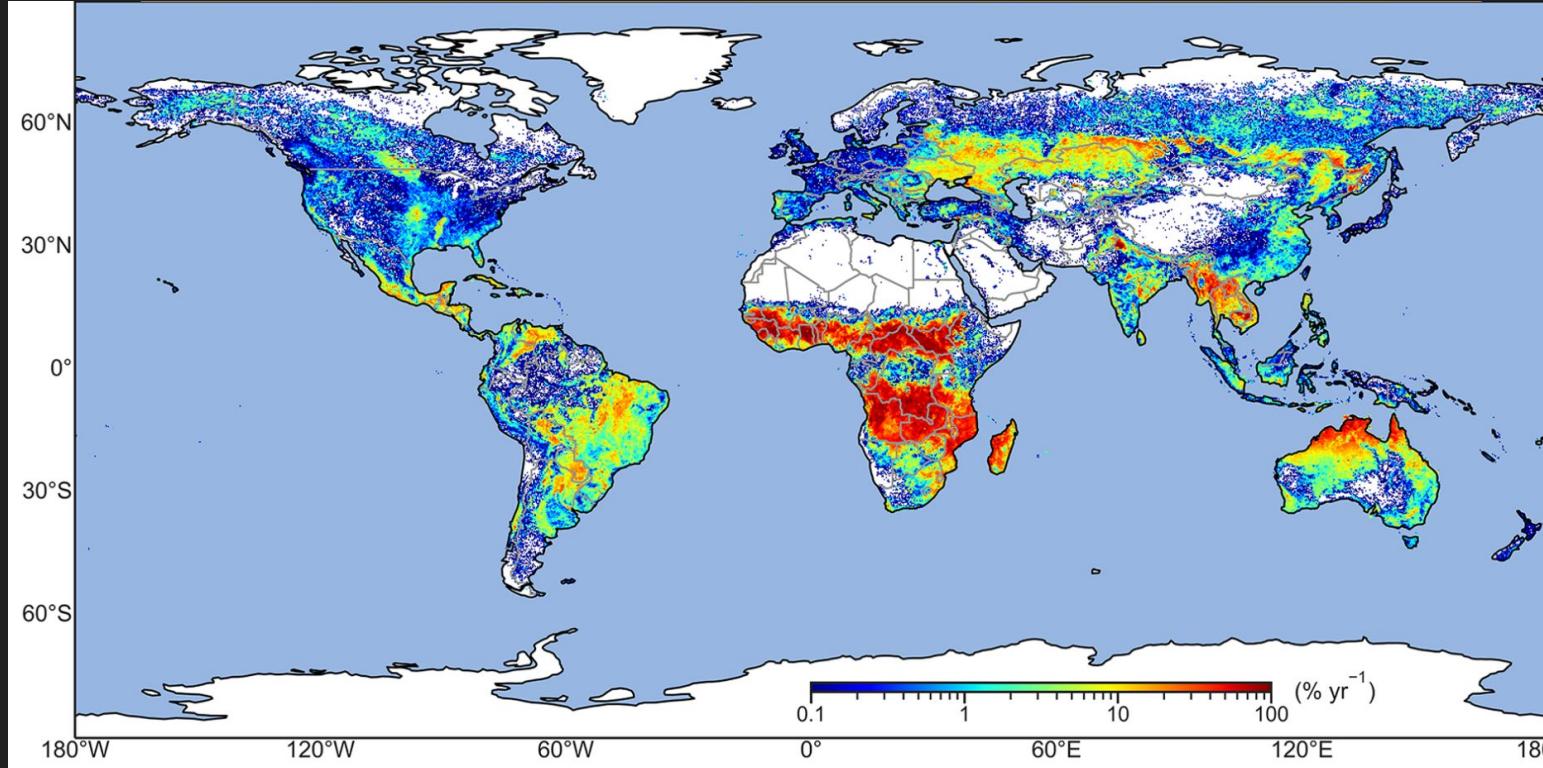
EF: Emissions Factor (g CO₂ kg⁻¹)

Need more on fire emission calc.?

See e.g. [Shiraishi & Hirata \(2021\)](#)

Image source

Global Burned Area (from space)



GFED 0.25° (~25 km at equator)

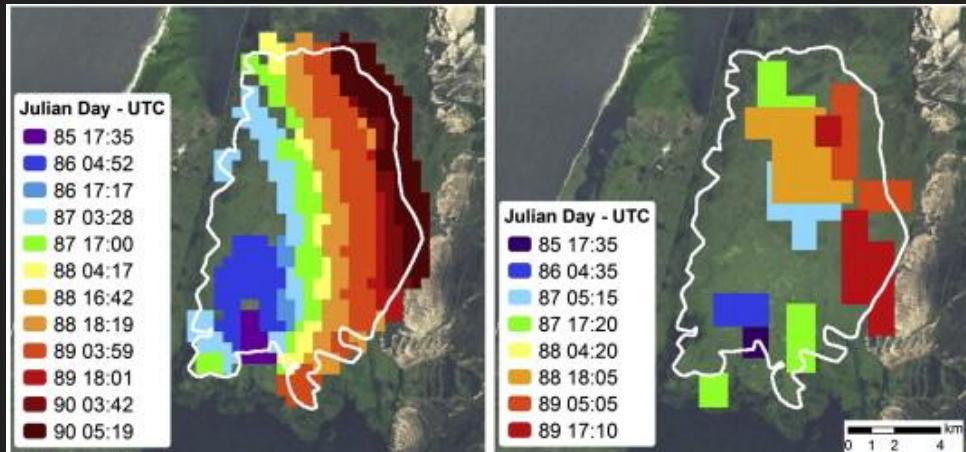
Annual mean %/yr

Paper: [Chen et al. 2024](#) | Data: [via Zenodo](#)

Observing fires from space



Active Fires (thermal IR)



Burned Area (SWIR)



VIIRS 375 m
Twice daily
Smallest fire: 10 m²

MODIS 500 m
Twice daily
Smallest fire: 21 ha

Landsat 30 m
Twice monthly
Smallest fire: 900 m²

Observing fires from space

Pre-fire

Post-fire



Burned Area (SWIR)



Landsat 30 m
Twice monthly
Smallest fire: 900 m²

How these images were made: [GEE code](#)

Science by WhatsApp





We constructed a freely available **Database of Anthropogenic Fire Impacts (DAFI)** from a meta-analysis of 1,800 worldwide case studies. We find seven main fire-use types, linked to land user intention.

Poster: [Perkins et al. 2021](#)
 Paper: [Millington et al. \(2022\)](#)
 Data: via [FigShare](#)

Human-Fire Interactions: A Global Database

Oliver Perkins^{1,3}, Cathy Smith^{2,3}, James D.A. Millington^{1,3}

¹King's College London, ²Royal Holloway University of London, ³Leverhulme Centre for Wildfires, Environment and Society

Presented at the American Association of Geographers Annual Meeting, April 2021



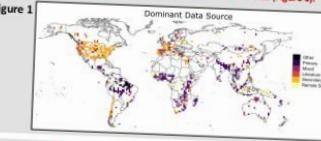
Studies of landscape fire vary in approach around the world. DAFI synthesises these studies.

Empirical studies of human use and management of fire in landscapes around the world have been conducted in many different academic fields, including geosciences, anthropology, land economics and ecology. Studies have varied in approach, from quantitative and broad-scale (e.g., remote sensing) to qualitative and local-scale case studies (e.g., anthropological). No global synthesis of human-fire interactions has yet been attempted that covers the breadth of human fire use and suppression approaches. We present the most comprehensive meta-analysis of global fire use to date, spanning all key land systems and policy regimes from over 105 countries on all continents (except Antarctica) between 1990–2019. This study has produced a database comprising data (Table 1) from 523 papers containing 1808 case studies that we call the Database of Anthropogenic Fire Impacts (DAFI; Perkins and Millington 2021). Because existing studies vary across disciplines and approaches, DAFI was developed in an iterative manner but based on a framework that accounts for fire 'stages' (after Pyne 2019) and land system. Fire stages are pre-across space, with a prevalence of secondary studies in Europe and North America versus a dominance of primary studies in Asia and Africa (Figure 1).

Information	Data Format (case study)	Data Type (DAFI)	Example Variables (DAFI)
Fire Use	Quantitative	Continuous	Intended or actual fire size
Suppression	Mixed	Ordinal	Activity type & effort level
Policies	Qualitative	Boolean	Existence of laws or incentives
Land Use & Cover	Mixed	Continuous & Nominal	Land use intensity & type

Table 1

Figure 1



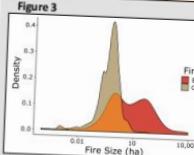
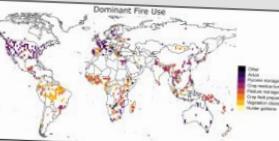
Quantitatively distinct fire regimes arise from local interactions between fire use, suppression and policy.

Analysis of DAFI reveals that seven fire-use types (listed in Table 2) account for >90% of case studies. The seven fire-use types have distinctive quantitative signatures (Table 2) and spatial distributions (Figure 2). Shifting cultivation field preparation has a similar mean fire size to non-shifting crop residue burning. However, the relatively low fire-return period and high density of fields when compared to shifting cultivation combine to produce a much greater proportional mean burned area. Pyrome management activities dominate in North America and Europe, while vegetation clearance is a primary use across much of Brazil, and crop residue burning is dominant across parts of Asia.

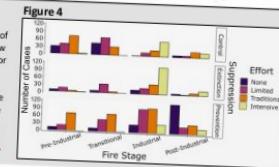
Fire-use Type	DAFI Records (%)	Mean Size (ha)	Mean Burned Area (% LS)	Mean Return Period (yrs.)	Expt. Burn (%)
Field Prep.	19.8	0.8	14.2	10.2	0.05
Crop Residue Burning	16.7	3.9	36.3	2.0	0.01
Pasture Prep.	12.9	33.9	32.1	3.4	4.97
Hunt/Gather	6.4	2.1	14.3	5.0	2.90
Veg. Clearing	14.2	9.2	2.5	N/A	3.23
Pyrome Mgmt.	17.7	357.2	14.0	5.9	0.30
Arisen	3.3	N/A	N/A	N/A	N/A

Table 2

Figure 2



DAFI enables examination of fire regime characteristics as a function of broader fire use approaches and how fire uses vary between fire regimes. For example, cropland fires tend to be smaller than fire broadcast across pasture and forest landscapes (Figure 3). We find distinct differences in fire suppression between fire stages (Figure 4). Code for analysis of DAFI and plots is available (Perkins 2021).



Representation of anthropogenic fire in global models demands consideration of land use context.

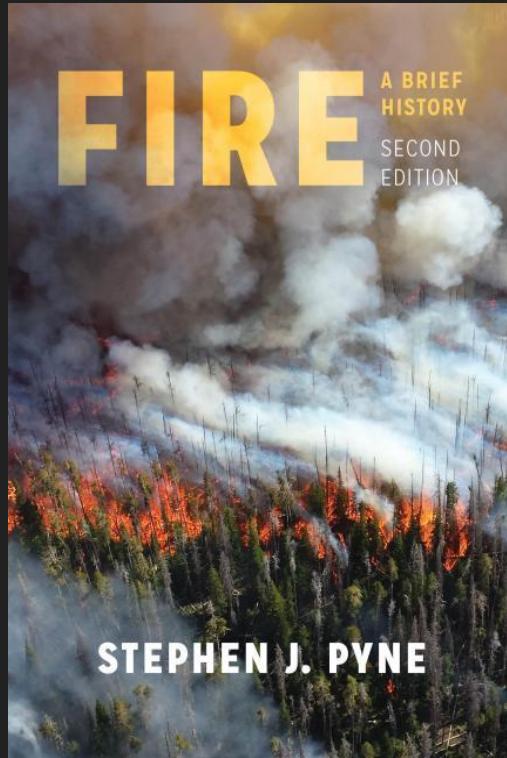
Attempts to systematise human-fire interactions have sought to configure human impacts as deviations from underlying 'natural' axes of vegetation and fire regimes (e.g., McWethy et al. 2013). Such approaches have not yet developed a coherent framework to capture human impacts on wildfire. A key finding of the Global Human-landfire Intercomparison Project was that the lack of a systematic empirical basis for understanding human impacts on wildfire regimes here contributes to improving this representation. DAFI is freely available (see Perkins and Millington 2021) and continues to grow. We plan to use DAFI to support the development of agent-based modelling approaches to better represent human fire in GCMs. The poor performance of anthropogenic fire in GCMs still relies on fire spread rate metrics of human activity, such as population density and GDP. The poor performance of land systems. To provide this context, we will use DAFI to develop agent functional types that characterise anthropogenic fire use and suppression as a function of underlying land use objectives. Examples may include shifting cultivation farmer, large-scale industrial logger, and conservationist. We expect that by mapping these types globally using ancillary data, we will be able to improve simulation model representation of human fire, including feedbacks with vegetation and climate.

References: [McWethy et al. \(2013\)](#); [Global Human-landfire Intercomparison Project](#); [Perkins et al. \(2021\)](#); [Perkins and Millington \(2021\)](#); [Pyne \(2019\)](#); [James Millington et al. \(2022\)](#); [https://doi.org/10.5281/zenodo.5907722](#); [https://doi.org/10.5281/zenodo.5907723](#); [https://doi.org/10.5281/zenodo.5907724](#); [https://doi.org/10.5281/zenodo.5907725](#); [https://doi.org/10.5281/zenodo.5907726](#); [https://doi.org/10.5281/zenodo.5907727](#); [https://doi.org/10.5281/zenodo.5907728](#); [https://doi.org/10.5281/zenodo.5907729](#); [https://doi.org/10.5281/zenodo.5907730](#); [https://doi.org/10.5281/zenodo.5907731](#); [https://doi.org/10.5281/zenodo.5907732](#); [https://doi.org/10.5281/zenodo.5907733](#); [https://doi.org/10.5281/zenodo.5907734](#); [https://doi.org/10.5281/zenodo.5907735](#); [https://doi.org/10.5281/zenodo.5907736](#); [https://doi.org/10.5281/zenodo.5907737](#); [https://doi.org/10.5281/zenodo.5907738](#); [https://doi.org/10.5281/zenodo.5907739](#); [https://doi.org/10.5281/zenodo.5907740](#); [https://doi.org/10.5281/zenodo.5907741](#); [https://doi.org/10.5281/zenodo.5907742](#); [https://doi.org/10.5281/zenodo.5907743](#); [https://doi.org/10.5281/zenodo.5907744](#); [https://doi.org/10.5281/zenodo.5907745](#); [https://doi.org/10.5281/zenodo.5907746](#); [https://doi.org/10.5281/zenodo.5907747](#); [https://doi.org/10.5281/zenodo.5907748](#); [https://doi.org/10.5281/zenodo.5907749](#); [https://doi.org/10.5281/zenodo.5907750](#); [https://doi.org/10.5281/zenodo.5907751](#); [https://doi.org/10.5281/zenodo.5907752](#); [https://doi.org/10.5281/zenodo.5907753](#); [https://doi.org/10.5281/zenodo.5907754](#); [https://doi.org/10.5281/zenodo.5907755](#); [https://doi.org/10.5281/zenodo.5907756](#); [https://doi.org/10.5281/zenodo.5907757](#); [https://doi.org/10.5281/zenodo.5907758](#); [https://doi.org/10.5281/zenodo.5907759](#); [https://doi.org/10.5281/zenodo.5907760](#); [https://doi.org/10.5281/zenodo.5907761](#); [https://doi.org/10.5281/zenodo.5907762](#); [https://doi.org/10.5281/zenodo.5907763](#); [https://doi.org/10.5281/zenodo.5907764](#); [https://doi.org/10.5281/zenodo.5907765](#); [https://doi.org/10.5281/zenodo.5907766](#); [https://doi.org/10.5281/zenodo.5907767](#); [https://doi.org/10.5281/zenodo.5907768](#); [https://doi.org/10.5281/zenodo.5907769](#); [https://doi.org/10.5281/zenodo.5907770](#); [https://doi.org/10.5281/zenodo.5907771](#); [https://doi.org/10.5281/zenodo.5907772](#); [https://doi.org/10.5281/zenodo.5907773](#); [https://doi.org/10.5281/zenodo.5907774](#); [https://doi.org/10.5281/zenodo.5907775](#); [https://doi.org/10.5281/zenodo.5907776](#); [https://doi.org/10.5281/zenodo.5907777](#); [https://doi.org/10.5281/zenodo.5907778](#); [https://doi.org/10.5281/zenodo.5907779](#); [https://doi.org/10.5281/zenodo.5907780](#); [https://doi.org/10.5281/zenodo.5907781](#); [https://doi.org/10.5281/zenodo.5907782](#); [https://doi.org/10.5281/zenodo.5907783](#); [https://doi.org/10.5281/zenodo.5907784](#); [https://doi.org/10.5281/zenodo.5907785](#); [https://doi.org/10.5281/zenodo.5907786](#); [https://doi.org/10.5281/zenodo.5907787](#); [https://doi.org/10.5281/zenodo.5907788](#); [https://doi.org/10.5281/zenodo.5907789](#); [https://doi.org/10.5281/zenodo.5907790](#); [https://doi.org/10.5281/zenodo.5907791](#); [https://doi.org/10.5281/zenodo.5907792](#); [https://doi.org/10.5281/zenodo.5907793](#); [https://doi.org/10.5281/zenodo.5907794](#); [https://doi.org/10.5281/zenodo.5907795](#); [https://doi.org/10.5281/zenodo.5907796](#); [https://doi.org/10.5281/zenodo.5907797](#); [https://doi.org/10.5281/zenodo.5907798](#); [https://doi.org/10.5281/zenodo.5907799](#); [https://doi.org/10.5281/zenodo.5907800](#); [https://doi.org/10.5281/zenodo.5907801](#); [https://doi.org/10.5281/zenodo.5907802](#); [https://doi.org/10.5281/zenodo.5907803](#); [https://doi.org/10.5281/zenodo.5907804](#); [https://doi.org/10.5281/zenodo.5907805](#); [https://doi.org/10.5281/zenodo.5907806](#); [https://doi.org/10.5281/zenodo.5907807](#); [https://doi.org/10.5281/zenodo.5907808](#); [https://doi.org/10.5281/zenodo.5907809](#); [https://doi.org/10.5281/zenodo.5907810](#); [https://doi.org/10.5281/zenodo.5907811](#); [https://doi.org/10.5281/zenodo.5907812](#); [https://doi.org/10.5281/zenodo.5907813](#); [https://doi.org/10.5281/zenodo.5907814](#); [https://doi.org/10.5281/zenodo.5907815](#); [https://doi.org/10.5281/zenodo.5907816](#); [https://doi.org/10.5281/zenodo.5907817](#); [https://doi.org/10.5281/zenodo.5907818](#); [https://doi.org/10.5281/zenodo.5907819](#); [https://doi.org/10.5281/zenodo.5907820](#); [https://doi.org/10.5281/zenodo.5907821](#); [https://doi.org/10.5281/zenodo.5907822](#); [https://doi.org/10.5281/zenodo.5907823](#); [https://doi.org/10.5281/zenodo.5907824](#); [https://doi.org/10.5281/zenodo.5907825](#); [https://doi.org/10.5281/zenodo.5907826](#); [https://doi.org/10.5281/zenodo.5907827](#); [https://doi.org/10.5281/zenodo.5907828](#); [https://doi.org/10.5281/zenodo.5907829](#); [https://doi.org/10.5281/zenodo.5907830](#); [https://doi.org/10.5281/zenodo.5907831](#); [https://doi.org/10.5281/zenodo.5907832](#); [https://doi.org/10.5281/zenodo.5907833](#); [https://doi.org/10.5281/zenodo.5907834](#); [https://doi.org/10.5281/zenodo.5907835](#); [https://doi.org/10.5281/zenodo.5907836](#); [https://doi.org/10.5281/zenodo.5907837](#); [https://doi.org/10.5281/zenodo.5907838](#); [https://doi.org/10.5281/zenodo.5907839](#); [https://doi.org/10.5281/zenodo.5907840](#); [https://doi.org/10.5281/zenodo.5907841](#); [https://doi.org/10.5281/zenodo.5907842](#); [https://doi.org/10.5281/zenodo.5907843](#); [https://doi.org/10.5281/zenodo.5907844](#); [https://doi.org/10.5281/zenodo.5907845](#); [https://doi.org/10.5281/zenodo.5907846](#); [https://doi.org/10.5281/zenodo.5907847](#); [https://doi.org/10.5281/zenodo.5907848](#); [https://doi.org/10.5281/zenodo.5907849](#); [https://doi.org/10.5281/zenodo.5907850](#); [https://doi.org/10.5281/zenodo.5907851](#); [https://doi.org/10.5281/zenodo.5907852](#); [https://doi.org/10.5281/zenodo.5907853](#); [https://doi.org/10.5281/zenodo.5907854](#); [https://doi.org/10.5281/zenodo.5907855](#); [https://doi.org/10.5281/zenodo.5907856](#); [https://doi.org/10.5281/zenodo.5907857](#); [https://doi.org/10.5281/zenodo.5907858](#); [https://doi.org/10.5281/zenodo.5907859](#); [https://doi.org/10.5281/zenodo.5907860](#); [https://doi.org/10.5281/zenodo.5907861](#); [https://doi.org/10.5281/zenodo.5907862](#); [https://doi.org/10.5281/zenodo.5907863](#); [https://doi.org/10.5281/zenodo.5907864](#); [https://doi.org/10.5281/zenodo.5907865](#); [https://doi.org/10.5281/zenodo.5907866](#); [https://doi.org/10.5281/zenodo.5907867](#); [https://doi.org/10.5281/zenodo.5907868](#); [https://doi.org/10.5281/zenodo.5907869](#); [https://doi.org/10.5281/zenodo.5907870](#); [https://doi.org/10.5281/zenodo.5907871](#); [https://doi.org/10.5281/zenodo.5907872](#); [https://doi.org/10.5281/zenodo.5907873](#); [https://doi.org/10.5281/zenodo.5907874](#); [https://doi.org/10.5281/zenodo.5907875](#); [https://doi.org/10.5281/zenodo.5907876](#); [https://doi.org/10.5281/zenodo.5907877](#); [https://doi.org/10.5281/zenodo.5907878](#); [https://doi.org/10.5281/zenodo.5907879](#); [https://doi.org/10.5281/zenodo.5907880](#); [https://doi.org/10.5281/zenodo.5907881](#); [https://doi.org/10.5281/zenodo.5907882](#); [https://doi.org/10.5281/zenodo.5907883](#); [https://doi.org/10.5281/zenodo.5907884](#); [https://doi.org/10.5281/zenodo.5907885](#); [https://doi.org/10.5281/zenodo.5907886](#); [https://doi.org/10.5281/zenodo.5907887](#); [https://doi.org/10.5281/zenodo.5907888](#); [https://doi.org/10.5281/zenodo.5907889](#); [https://doi.org/10.5281/zenodo.5907890](#); [https://doi.org/10.5281/zenodo.5907891](#); [https://doi.org/10.5281/zenodo.5907892](#); [https://doi.org/10.5281/zenodo.5907893](#); [https://doi.org/10.5281/zenodo.5907894](#); [https://doi.org/10.5281/zenodo.5907895](#); [https://doi.org/10.5281/zenodo.5907896](#); [https://doi.org/10.5281/zenodo.5907897](#); [https://doi.org/10.5281/zenodo.5907898](#); [https://doi.org/10.5281/zenodo.5907899](#); [https://doi.org/10.5281/zenodo.5907900](#); [https://doi.org/10.5281/zenodo.5907901](#); [https://doi.org/10.5281/zenodo.5907902](#); [https://doi.org/10.5281/zenodo.5907903](#); [https://doi.org/10.5281/zenodo.5907904](#); [https://doi.org/10.5281/zenodo.5907905](#); [https://doi.org/10.5281/zenodo.5907906](#); [https://doi.org/10.5281/zenodo.5907907](#); [https://doi.org/10.5281/zenodo.5907908](#); [https://doi.org/10.5281/zenodo.5907909](#); [https://doi.org/10.5281/zenodo.5907910](#); [https://doi.org/10.5281/zenodo.5907911](#); [https://doi.org/10.5281/zenodo.5907912](#); [https://doi.org/10.5281/zenodo.5907913](#); [https://doi.org/10.5281/zenodo.5907914](#); [https://doi.org/10.5281/zenodo.5907915](#); [https://doi.org/10.5281/zenodo.5907916](#); [https://doi.org/10.5281/zenodo.5907917](#); [https://doi.org/10.5281/zenodo.5907918](#); [https://doi.org/10.5281/zenodo.5907919](#); [https://doi.org/10.5281/zenodo.5907920](#); [https://doi.org/10.5281/zenodo.5907921](#); [https://doi.org/10.5281/zenodo.5907922](#); [https://doi.org/10.5281/zenodo.5907923](#); [https://doi.org/10.5281/zenodo.5907924](#); [https://doi.org/10.5281/zenodo.5907925](#); [https://doi.org/10.5281/zenodo.5907926](#); [https://doi.org/10.5281/zenodo.5907927](#); [https://doi.org/10.5281/zenodo.5907928](#); [https://doi.org/10.5281/zenodo.5907929](#); [https://doi.org/10.5281/zenodo.5907930](#); [https://doi.org/10.5281/zenodo.5907931](#); [https://doi.org/10.5281/zenodo.5907932](#); [https://doi.org/10.5281/zenodo.5907933](#); [https://doi.org/10.5281/zenodo.5907934](#); [https://doi.org/10.5281/zenodo.5907935](#); [https://doi.org/10.5281/zenodo.5907936](#); [https://doi.org/10.5281/zenodo.5907937](#); [https://doi.org/10.5281/zenodo.5907938](#); [https://doi.org/10.5281/zenodo.5907939](#); [https://doi.org/10.5281/zenodo.5907940](#); [https://doi.org/10.5281/zenodo.5907941](#); [https://doi.org/10.5281/zenodo.5907942](#); [https://doi.org/10.5281/zenodo.5907943](#); [https://doi.org/10.5281/zenodo.5907944](#); [https://doi.org/10.5281/zenodo.5907945](#); [https://doi.org/10.5281/zenodo.5907946](#); [https://doi.org/10.5281/zenodo.5907947](#); [https://doi.org/10.5281/zenodo.5907948](#); [https://doi.org/10.5281/zenodo.5907949](#); [https://doi.org/10.5281/zenodo.5907950](#); [https://doi.org/10.5281/zenodo.5907951](#); [https://doi.org/10.5281/zenodo.5907952](#); [https://doi.org/10.5281/zenodo.5907953](#); [https://doi.org/10.5281/zenodo.5907954](#); [https://doi.org/10.5281/zenodo.5907955](#); [https://doi.org/10.5281/zenodo.5907956](#); [https://doi.org/10.5281/zenodo.5907957](#); [https://doi.org/10.5281/zenodo.5907958](#); [https://doi.org/10.5281/zenodo.5907959](#); [https://doi.org/10.5281/zenodo.5907960](#); [https://doi.org/10.5281/zenodo.5907961](#); [https://doi.org/10.5281/zenodo.5907962](#); [https://doi.org/10.5281/zenodo.5907963](#); [https://doi.org/10.5281/zenodo.5907964](#); [https://doi.org/10.5281/zenodo.5907965](#); [https://doi.org/10.5281/zenodo.5907966](#); [https://doi.org/10.5281/zenodo.5907967](#); [https://doi.org/10.5281/zenodo.5907968](#); [https://doi.org/10.5281/zenodo.5907969](#); [https://doi.org/10.5281/zenodo.5907970](#); [https://doi.org/10.5281/zenodo.5907971](#); [https://doi.org/10.5281/zenodo.5907972](#); [https://doi.org/10.5281/zenodo.5907973](#); [https://doi.org/10.5281/zenodo.5907974](#); [https://doi.org/10.5281/zenodo.5907975](#); [https://doi.org/10.5281/zenodo.5907976](#); [https://doi.org/10.5281/zenodo.5907977](#); [https://doi.org/10.5281/zenodo.5907978](#); [https://doi.org/10.5281/zenodo.5907979](#); [https://doi.org/10.5281/zenodo.5907980](#); [https://doi.org/10.5281/zenodo.5907981](#); [https://doi.org/10.5281/zenodo.5907982](#); [https://doi.org/10.5281/zenodo.5907983](#); [https://doi.org/10.5281/zenodo.5907984](#); [https://doi.org/10.5281/zenodo.5907985](#); [https://doi.org/10.5281/zenodo.5907986](#); [https://doi.org/10.5281/zenodo.5907987](#); [https://doi.org/10.5281/zenodo.5907988](#); [https://doi.org/10.5281/zenodo.5907989](#); [https://doi.org/10.5281/zenodo.5907990](#); [https://doi.org/10.5281/zenodo.5907991](#); [https://doi.org/10.5281/zenodo.5907992](#); [https://doi.org/10.5281/zenodo.5907993](#); [https://doi.org/10.5281/zenodo.5907994](#); [https://doi.org/10.5281/zenodo.5907995](#); [https://doi.org/10.5281/zenodo.5907996](#); [https://doi.org/10.5281/zenodo.5907997](#); [https://doi.org/10.5281/zenodo.5907998](#); [https://doi.org/10.5281/zenodo.5907999](#); [https://doi.org/10.5281/zenodo.5907990](#); [https://doi.org/10.5281/zenodo.5907991](#); [https://doi.org/10.5281/zenodo.5907992](#); [https://doi.org/10.5281/zenodo.5907993](#); [https://doi.org/10.5281/zenodo.5907994](#); [https://doi.org/10.5281/zenodo.5907995](#); [https://doi.org/10.5281/zenodo.5907996](#); [https://doi.org/10.5281/zenodo.5907997](#); [https://doi.org/10.5281/zenodo.5907998](#); [https://doi.org/10.5281/zenodo.5907999](#); [https://doi.org/10.5281/zenodo.5907990](#); [https://doi.org/10.5281/zenodo.5907991](#); [https://doi.org/10.5281/zenodo.5907992](#); [https://doi.org/10.5281/zenodo.5907993](#); [https://doi.org/10.5281/zenodo.5907994](#); [https://doi.org/10.5281/zenodo.5907995](#); [https://doi.org/10.5281/zenodo.5907996](#); [https](#)

1. Anthropogenic Fire Regimes

- First Fire pre-human
- Second Fire pre-industrial
- 2.5th Fire transition
- Third Fire industrial
- Pyrocene post-industrial

After Pyne's Fire 'stages', AFRs reflect available resources and management perspectives



[TED 15 min summary]

2. Land Use Systems



Non-Extractive



Pasture



Forest



Cropland



Combine land use intensity and land management practices

See Václavík *et al.* 2013 [[GEC](#)], Dou *et al.* 2021 [[Lsp Ecol](#)]

Land-Fire Systems

From combination of Anthro. Fire Regimes and Land Use Systems

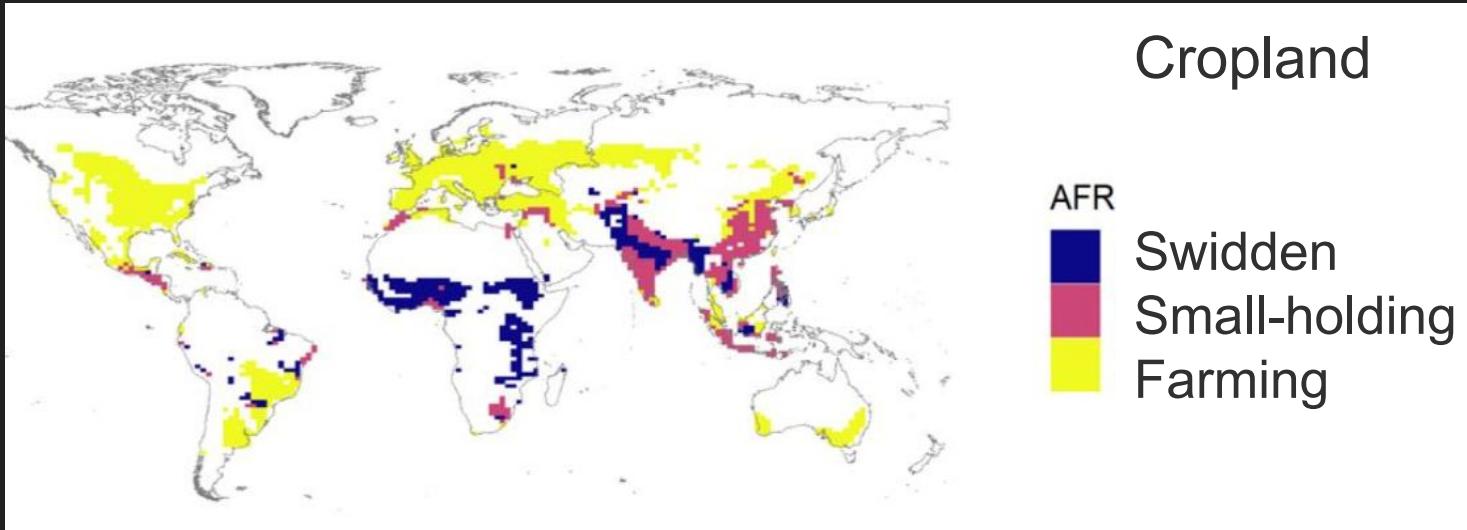
More here: [Perkins et al. \(2024\)](#)



Anthro. Fire Regime	Land Use System			
	Non-Extractive	Livestock	Crops	Forestry
Pre-Industrial	Unoccupied	Pastoralism (S)	Swidden (S)	Hunt & Gather (S)
Transition	Unmanaged	Ranching (Extensive, S M)	Small-holding (S M)	Logging (Primary Forest)
Industrial	Pyro-exclusion (State Manager)	Ranching (Intensive, M)	Farming (Intensive, M)	Managed (Plantation or Second Forest)
Post-Industrial	Pyro-diverse (Fuel Load Management)	Grazing (Subsidised, Fuel Mgmt)	Abandoned	Abandoned

Non-Extractive = e.g. parks S = subsistence M = market

Modelled Spatial Distribution of LFS

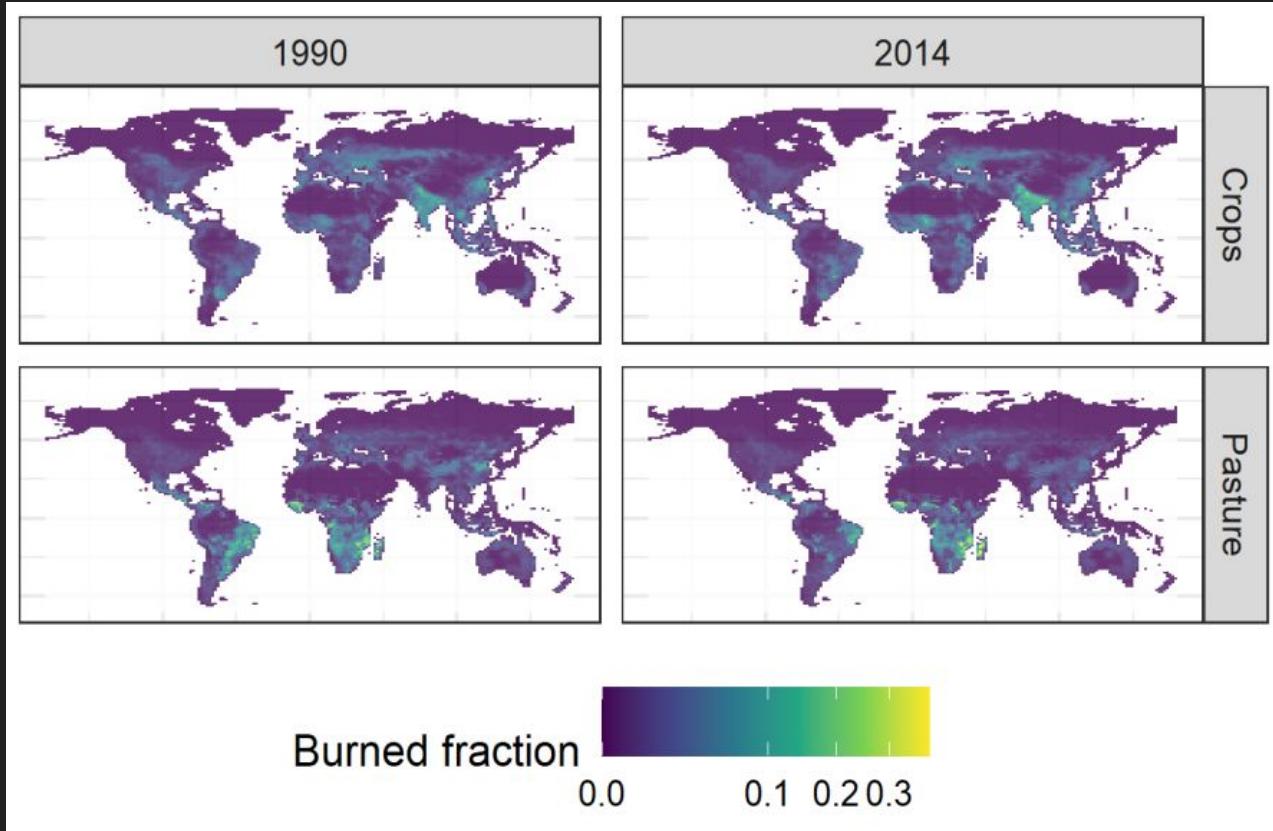


Combine density of LFS with
data from DAFI to
estimate human Burned Area

Paper: [Perkins et al. \(2022\)](#)

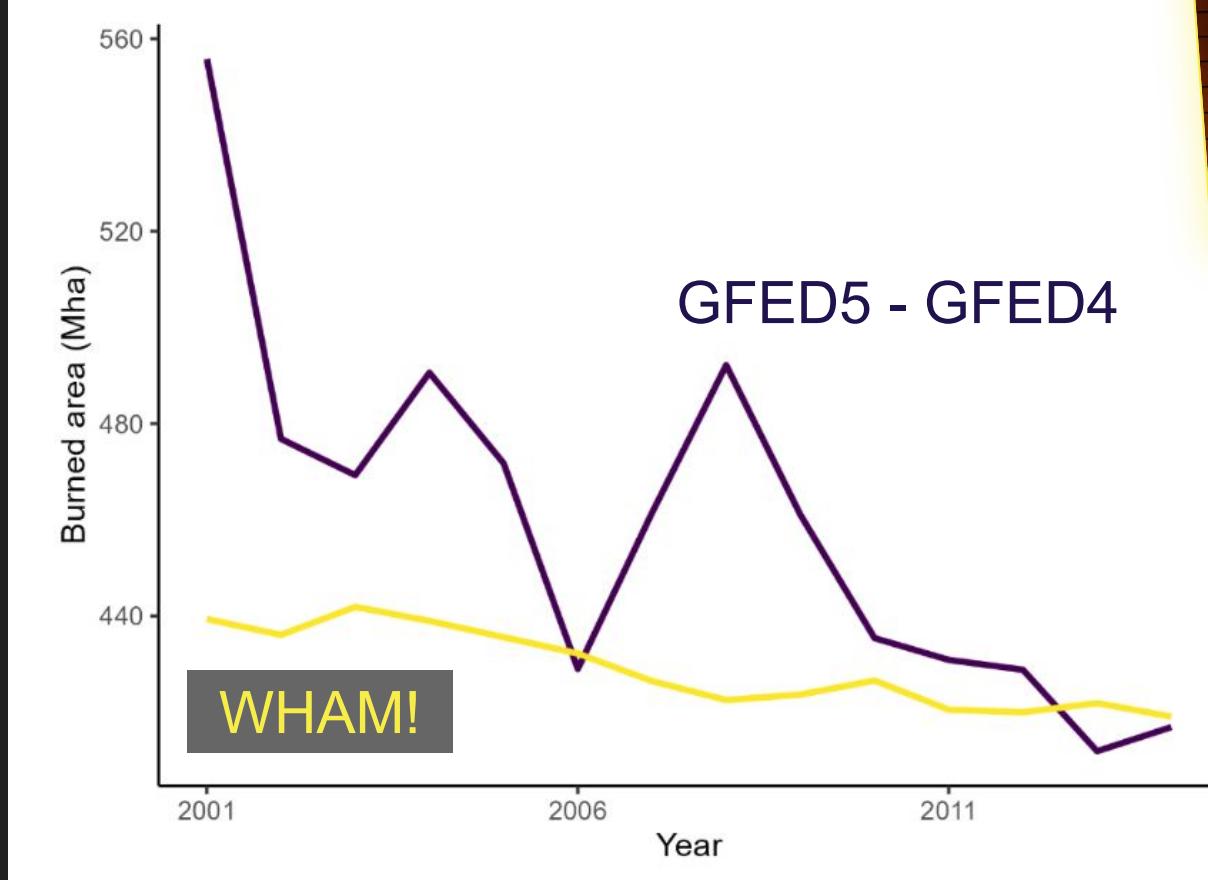


Anticipating the ‘lost’ fires



Paper:
[Perkins et al. \(2024\)](#)

Anticipating the ‘lost’ fires



GFED5 - GFED4



Paper:
Perkins et al. (2024)

Revealing human impacts on forests & fires



We can't simply rely on what we 'see' from space, which is largely about physical attributes.

We need to think about what humans are doing on the ground and whether that is detectable from space.

Usually it won't be, so then we need to work on ways to generate data about people and institutions on the ground.

That could be user-generated (like CAR for forests), or it could be modelled (like WHAM! with DAFI for fires)