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.

Human-Fire Interactions: A Global Database

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

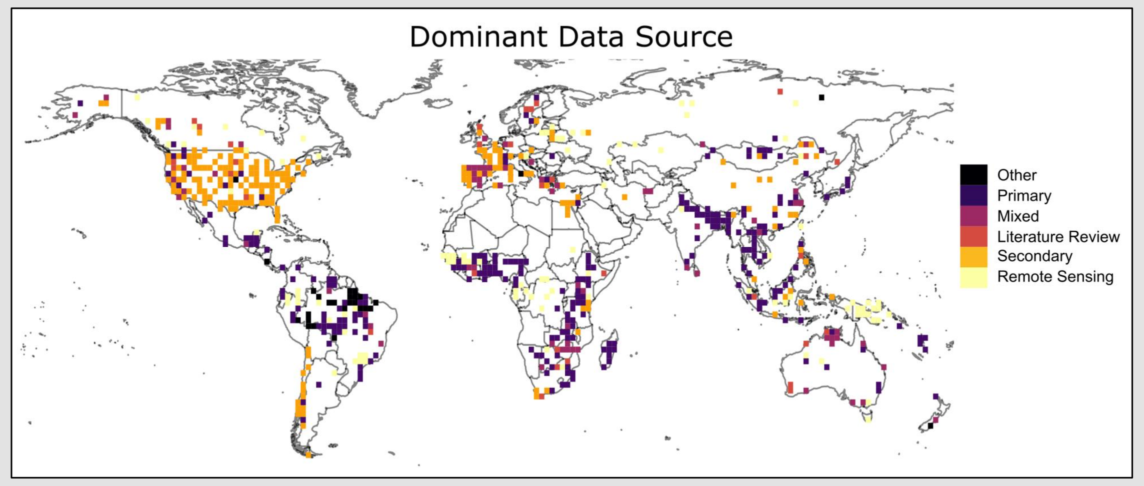
Empirical studies of human use and management of fire in landscapes around the world have been conducted in many different academic fields, including geography, anthropology, land economics and ecology. Studies have varied in approach, from quantitative and broad-scale (e.g., remote sensing) to qualitative 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.

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 1990-2020. Our 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-industrial, transition, industrial & post-industrial while land systems are cropland, pasture, forest & non-extractive. **The types of study included in DAFI vary 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).**

Table 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

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.

Table 2

Fire-use Type	DAFI Records (%)	Mean Size (ha)	Mean Burned Area (% LS)	Mean Return Period (yrs)	Escaped (%)
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.	12.3	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
Arson	3.3	N/A	N/A	N/A	N/A

Figure 2

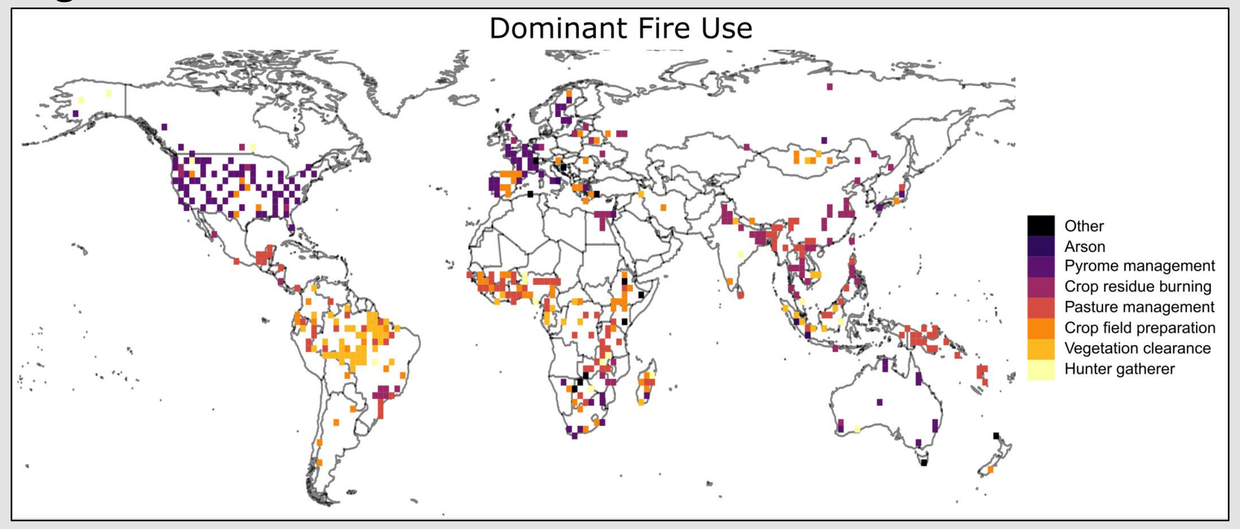
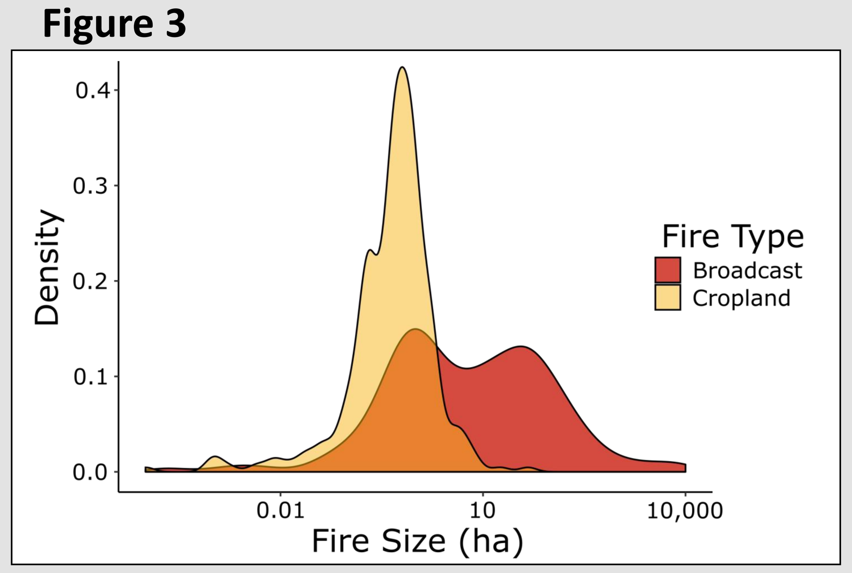
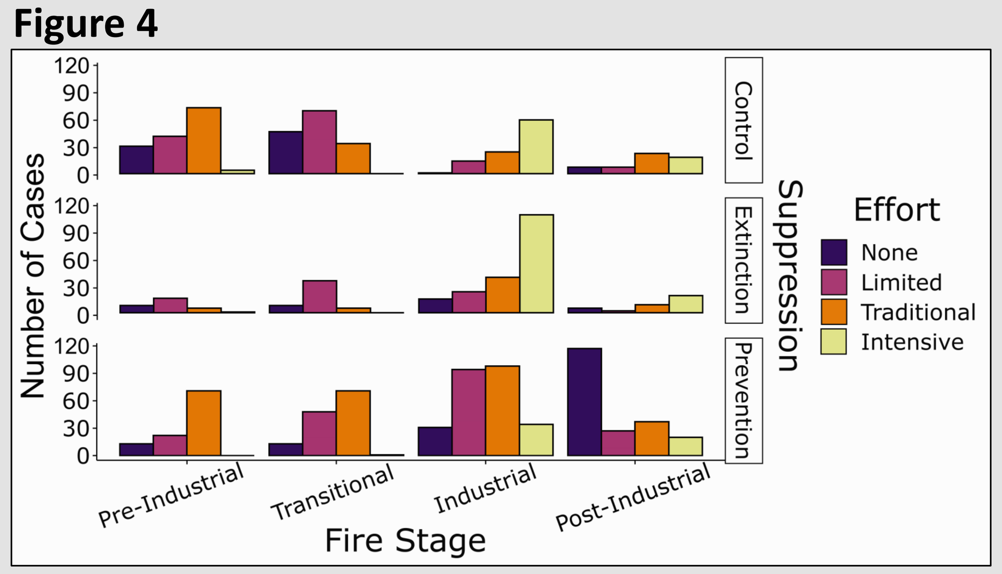


Figure 3



DAFI enables examination of fire regime characteristics as a function of broader fire use approaches and how fire uses vary between fire stages. 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).**

Figure 4



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 moisture (e.g., McWethy *et al.* 2013). Such approaches have not yet developed a coherent overall framework to capture human impacts on wildfire. A key finding of the Fire Model Intercomparison Project was that the lack of a systematic empirical basis for understanding human impacts on wildfire regimes presents a challenge to incorporating anthropogenic fire into Dynamic Global Vegetation Models (DGVMs; Teckentrup *et al.* 2019). The work presented here contributes to improving this empirical basis. **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 DGVMs. Representation of anthropogenic fire in DGVMs still relies on few readily-available metrics of human activity, such as population density and GDP. The poor performance of models using these variables in globally-uniform relationships may be due to the disregard for how people use and manage fire in the context of different 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 Ecology and Biology*; Perkins (2021) *AnthroFireDB* https://github.com/OliPerkins1987/AnthroFireDB; Perkins and Millington (2021) *FigShare* https://doi.org/10.6084/m9.figshare.c.5290792.v1; Pyne (2019) *Fire: A Brief History*; Teckentrup et al. (2019) *Biogeosciences* **Contact:** Oliver Perkins, oliver.perkins@kcl.ac.uk; Cathy Smith, c.smith@rhul.ac.uk; James Millington, james.Millington@kcl.ac.uk, http://www.landscapemodelling.net