Millington, Perkins and Smith (2022) Human fire use and management: A global database of anthropogenic fire impacts for modelling. *fire* Supplementary Material.

Main modes of fire use identified in the Database of Anthropogenic Fire Impacts

This document details the process used to identify the seven main modes of deliberate anthropogenic fire use described in Millington et al., (2022) and provides a narrative description of the rationale and drivers of variability within each type.

1. Process used to identify type of fire use

As described in the main article, literature around anthropogenic fire use and management is fractured across multiple disciplines – from anthropology to ecology, from development economics to remote sensing studies of greenhouse gas emissions. As such, our literature search was based on a conceptual framework, that sought to capture categorical differences in fire use in differing land systems and socio-economic contexts.

As fire uses were noted from the literature, a working set of categories was developed, and working definitions of these were circulated between the paper's authors. New categories were only added when they were agreed to meaningfully diverge from existing uses. This was discussed between authors during database construction. Given that there was subjectivity inherent in this process, to aid consistency in this, a reproducibility check was conducted. This consisted of three persons – two of the three lead authors and a research volunteer – who entered the same papers into the database. Inputs were then compared and checked for inconsistency and disagreement. This was conducted twice.

After the first consistency check, major changes were made to the database structure to aid consistent recording. This involved removing indirect impacts such as landscape fragmentation from the data is these could not be captured in a systematic way. The inputs from the second set of trial papers were in closer alignment. The major change made at this stage was to split quantitative information on anthropogenic fire use into 'reported' and 'estimated'. This was done because, much fire data available in papers was incidental to the core focus of the study, and therefore a degree of calculation was required to convert or interpolate this data into a consistent format for recording.

At completion of database construction, twenty deliberate anthropogenic fire uses were identified. These are presented in Table A. Having conducted this bottom-up data gathering process, and top down look was conducted to identify potential overlaps. The driving rationale for this was to arrive at a set of fire uses that captured the broad differences in anthropogenic fire use that could be

implemented in a dynamic global vegetation model (DGVM). Five fire uses with <=1% of instances (max_n = 45 / 1.01% of records) were simplified into an 'other' category. Then, categories where the underlying rationale overlapped were combined. For example, some rangeland management fires also served the purpose of renewing the quality of forage for livestock – this was the exclusive purpose of pasture renewal fires. Therefore, from a top-down perspective it was logical to combine these categories. Similarly, conservation fires seeking to promote diversity in a fire regime and those seeking to manipulate it for other reasons (typically to preserve human health and wellbeing) both served an underlying objective (to alter the fire regime in a given landscape) therefore these were also combined. Fishing, hunting and gathering fires, and forest and other vegetation clearance fires were also combined.

The most complex aspect of the realignment was in cases where a particular fire category partially overlapped with another, but also had its own distinctive aspects. Pest management was primarily conducted in livestock systems (46% of cases), but was also conducted by hunter gathers, foresters and arable farmers. Given that pest management fires in livestock systems served the dual purpose of renewing the pasture (Kull 2003), these were combined into the new pasture management category. However, pest management fires lit by other land users were assigned to the 'other' category. The result of this rationalisation was seven modes of fire use that captured more than 90% of anthropogenic fire use records in DAFI.

2. Description of fire use modes and their internal variability

2.1 Crop field preparation

Shifting cultivation is a semi-nomadic system of agriculture, in which small patches of land are cleared temporarily for agriculture; after a short period of cultivation the land is fallowed to allow it to recover (Mertz et al., 2009). Crop field preparation fire is typically used not only to clear the biomass on a planned field location, but also to clean the soil and to fix the nutrients from the biomass into the soil (Carmenta et al., 2013). It is therefore distinct from fire lit for the sole purpose of vegetation clearance.

At the latitudinal boundaries of shifting cultivation practice, where it is conducted in savanna woodlands or shrubby grasslands rather than dense tropical forests, lower net primarily productivity (NPP) and resulting sparsity of available biomass entails that fire use is sometimes replaced with labour-intensive 'mulching' practices (Dawoe et al., 2012). An intermediate stage, where biomass is collected from a wide area and then burned on a small plot, is observed, for example in the Miombo woodlands (Araki 2007).

Table S1. Overview of deliberate anthropogenic fire uses within DAFI.

Original category (n = 20)	Simplified category (n = 7)	Description
Accessibility	Other (N/A)	Fire use to clear pathways through vegetation, typically in savannah landscapes. Used to facilitate land uses across pre-industrial land use systems
Arson	Arson	Fire used to cause damage to persons or property; in some contexts, fire damage caused through negligence may also be considered arson
Charcoal production	Other (N/A)	Fire used to burn wood for charcoal; as much production takes place in kilns, charcoal fires are principally important as a source of escaped fires
Conservation	Pyrome management	Fires lit to conserve biodiversity by creating diverse stages of vegetational succession in a landscape
Crop field preparation	Crop field preparation	Fire use in the context of shifting cultivation
Crop residue burning	Crop residue burning	Fire used to remove agricultural residues, either pre or post harvest
Cultural & Spiritual	Other (N/A)	Fire used for social or religious ceremonies; other fire uses may also take on a cultural or religious significance
Domestic	Other (N/A)	Relevant for escaped fires
Fishing	Hunting and gathering	Fires to facilitate fishing
Forest clearance	Vegetation clearance	Fire used to clear forest land cover
Forest management	Other (N/A)	Typically to promote / manipulate timber growth (does not include fuel load management, which is under pyrome management)

Original category (n = 20)	Simplified category (n = 7)	Description
Harvesting of NTFP	Hunting and gathering	Fire to harvest non-timber forest products such as honey, fruit or mushrooms
Harvesting of Timber	Arson	Fire was used for burning of forests to facilitate illicit salvage logging (n = 21)
Hunting	Hunting and gathering	Fires to facilitate hunting of wild animals
Land clearance	Vegetation clearance	Fires to clear non-forest vegetation types, typically savannas
Pasture renewal	Pasture management	Fires to regenerate livestock forage, typically in managed pastures
Pest management	Pasture management / Other (NA)	Pest management fires were most often used in the context of livestock (46%) - where fires often aimed simultaneously to control pests and improve forage (Kull 2003). Therefore, this category was split between pasture management and 'other', where pest management fire was used by arable and forestry fire user types.
Pyrome management	Pyrome management	Fires lit to manage the wider fire regime, for any purpose other than conservation - typically to prevent damage to persons or property from wildfires
Rangeland management	Pasture management	Fires to regenerate livestock forage, typically on open rangeland; fire may also have served purpose to remove coverage for predators or prevent livestock from tripping on hidden holes in the ground
Vegetation management	Crop residue burning / Other (NA)	Many instances were for sugar cane burning to facilitate harvest; this was grouped with crop residue burning (pre-burning)

2.2 Crop residue burning

As agriculture intensifies and becomes sedentary, yields increase and crop residue disposal comes to be a significant activity for farmers. Burning of surplus residues typically peaks in the latter stages of transition to an industrial fire regime, particularly as use of machinery becomes more widespread (Kumar et al., 2015). Machinery frequently drives residue burning as when residues are hand harvested it is less burdensome to gather them for use either as domestic fuel or fodder for cattle (Hong van 2014; Lasko et al., 2017). Furthermore, as farm sizes grow along with yields, residue availability exceeds amounts that can be practically used (Ahmed et al., 2015).

Conversely, therefore, in mixed arable-pastoral subsistence small-holders, burning may be absent because residues present an important source of livestock feed (Keck and Hung 2019). The main restriction on residue burning in an industrial or post-industrial fire regime is air quality legislation (Jajtic et al., 2019; Sun et al., 2019; Boosabong and Chamchong 2020). For this reason, the practice is largely absent in more densely populated agricultural regions of Northern America and Northern Europe (Smil 1999), Australia and Brazil (Mendoza 2015). Similar concerns are now driving policy in areas of Northern India and China (Peng et al., 2016; Sembhi et al., 2020).

2.3 Pasture management

Burning of both planted pastures and native grasslands used for livestock grazing is a widespread practice, serving to rejuvenate the nutrient quality of forage for livestock (Jakimow et al., 2018; Johansson et al. ,2019) and prevent the encroachment of woody shrubs (Twidwell et al., 2013; Vehrs 2016).

As with shifting cultivation, NPP is a principal driver of whether livestock farmers use fire, and how frequently. For example, whilst pasture renewal fires are widespread across much of Sub-Saharan Africa and Amazonia, the practice is not used by pastoralists on the Mongolian steppe (Saladyga et al., 2013) or in mountainous areas of Patagonia (Easdale and Aguiar 2018). Simply put, if all available forage in an ecosystem is required to feed a livestock herd, a farmer will not burn it to improve its nutrient quality; this trade-off has been observed not only in pre-industrial, but also in comparatively intensive farming in the USA (Taylor 2003). However, fire use among livestock farmers is driven by a range of factors in addition to NPP. Fire use to control the tsetse fly is common in Sub-Saharan Africa and can cause farmers to decrease fire return period to around two years (global mean of 3-4 years) to keep grass short enough to prevent tsetse fly infestations (Trollope 2011). Similarly, on communal rangelands, livestock farmers may also use fire to facilitate accessibility and ward off predators and snakes (Mbow et al., 2000).

2.4 Hunting and gathering

Fire use by indigenous and other subsistence-oriented communities in hunting and gathering is a global practice (Coughlan et al., 2018). Use of fire for hunting and gathering is closely linked to the properties of the underlying ecosystem in which it is used. Therefore, the range of techniques used in hunting and gathering and resultant impacts on the fire regime are hugely diverse.

For example, in the Western Australian Desert, Aboriginal can light hunting 'drive' fires – where fire is lit to push wild animals towards a certain location – over very long distances (up to 130km) (Burrows et al., 2006). Conversely, Aboriginal people hunting for turtles in a wetland environment used fires with a mean size <1ha (McGregor et al., 2010); fire use for fishing in peat swamps follows a broadly similar pattern, with multiple very small fires (<10m^2) lit each year on the same patch of ground. By contrast, gathering of non-timber forest products (NTFPs) consistently results in small fires. Harvesting of wild honey, for example, uses fires often no bigger than a single fire stick, but can be important to a fire regime due to escaped fires (Schmerbeck 2003; Shaffer et al., 2010).

2.5 Vegetation clearance

Vegetation clearance fires principally covered deforestation fires (360 cases), but also included fires to clear savannas, grasslands and other mixed vegetation types (114 cases) As a frequently illicit practice, vegetation clearance was primarily studied through remote sensing (259 / 474 instances).

A large literature documents the processes that lead to tropical deforestation in a degree of nuance that is beyond the scope of DAFI (e.g. Rakatama et al., 2017; Fischer et al., 2020). However, in general terms, the size of clearances increased with anthropogenic fire regime (AFR), and a greater proportion of fire use instances for livestock and intensive arable farmers were attributed to deforestation than for more subsistence-oriented land users. This may suggest that, rather than enabling land to be spared (Cerri et al., 2018), land use intensification increases farmers' economic incentives to deforest land (Kubitza et al., 2018) and may increase the overall quantity of fire use in land clearing.

2.6 Pyrome management and pyro-diversity

Fire is widely adopted by a wide range of land users to manipulate the overall fire regime of a landscape. This includes burning done to reduce the risk of wildfire damage to persons and property, but also fires lit for biodiversity conservation purposes – where fire creates vegetation of differing successional stages on a landscape, and therefore encourages biodiversity (Parr and Andersen 2006; Bowman et al., 2016).

Fire regimes generated by these behaviours differ widely. For example, although fire fighting agencies conduct prescribed burns, these can be met with internal resistance from fire fighters (Spencer et al., 2015), resulting in smaller burned areas on average and smaller fires. However, there is also large variation in how state forestry agencies used fire depending on the climate and vegetation type managed: the US Forestry Service prescribed burn size averaged around 20ha in densely populated California, but was between 500-1000ha in the Sonoran Desert in Arizona (Barnett et al., 2016). On the other hand, where biodiversity conservationists manage large land areas, such as in the Savannas and grasslands of Southern Africa, these can be burned in blocks of 60-400ha on a rotational basis to foster pyro- and bio-diversity (Goodenough et al., 2017).

2.7 Arson

We defined arson as the deliberate use of fire to cause damage to persons or property. This differentiates it from merely negligent fire use or ignition (e.g. escaped barbeques or poorly disposed cigarette butts), which would be covered as 'accidental' fire in DAFI. As an inherently illicit and often clandestine practice, arson was poorly quantified in the available data.

Arson was most frequently observed where conflicts over land use occurred: land tenure was recorded as insecure in 48 of 81 database instances where arson was present and a description of land tenure was also given in a case study. A further 15 of these 81 cases were recorded as 'mixed' land tenure. Arson as a weapon in land use and land tenure conflict was most frequent where shifting cultivation and industrial forestry were present, as local small-holders protested allocation of their former lands held under traditional land tenure to large-scale commercial plantations (e.g. Suyanto et al., 2004; Chokkalingam et al., 2007). A similar pattern was also observed where arson was present on lands allocated for biodiversity conservation: in 23/35 cases such arson was used by small-holder farmers or hunter-gatherers, primarily to protest the restrictions placed on their livelihoods by protected areas.

References

Ahmed, T., Ahmad, B., & Ahmad, W. (2015). Why do farmers burn rice residue? Examining farmers' choices in Punjab, Pakistan. *Land Use Policy*, *47*, 448–458. https://doi.org/10.1016/j.landusepol.2015.05.004

Araki, S. (2007). Ten Years of Population Change and the Chitemene Slash-and-Burn System around the Mpika Area, Northern Zambia. *African Study Monographs. Supplementary Issue*, 34. http://hdl.handle.net/2433/68482

Barnett, K., Parks, S. A., Miller, C., & Naughton, H. T. (2016). Beyond Fuel Treatment Effectiveness: Characterizing Interactions between Fire and Treatments in the US. *Forests*, *7*(10). https://doi.org/10.3390/f7100237

Boossabong, P., & Chamchong, P. (2020). Public policy in the face of post-truth politics and the role of deliberation. *Critical Policy Studies*, 1–18. https://doi.org/10.1080/19460171.2020.1724168

Bowman, D. M. J. S., Perry, G. L. W., Higgins, S. I., Johnson, C. N., Fuhlendorf, S. D., & Murphy, B. P. (2016). Pyrodiversity is the coupling of biodiversity and fire regimes in food webs. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1696), 20150169. https://doi.org/10.1098/rstb.2015.0169

Burrows, N., Burbidge, A., Fuller, P., & Behn, G. (2006). Evidence of altered fire regimes in the Western Desert region of Australia. *Conservation Science Western Australia*, 5 (3), 272-284.

Carmenta, R., Vermeylen, S., Parry, L., & Barlow, J. (2013). Shifting Cultivation and Fire Policy: Insights from the Brazilian Amazon. *Human Ecology*, *41*(4), 603–614. https://doi.org/10.1007/s10745-013-9600-1

Cerri, C. E., Cerri, C. C., Maia, S., Cherubin, M., Feigl, B., & Lal, R. (2018). Reducing Amazon Deforestation through Agricultural Intensification in the Cerrado for Advancing Food Security and Mitigating Climate Change. *Sustainability*, 10 (4), 989. https://doi.org/10.3390/su10040989

Chokkalingam, U., Suyanto, Permana, R. P., Kurniawan, I., Mannes, J., Darmawan, A., Khususyiah, N., & Susanto, R. H. (2007). Community fire use, resource change, and livelihood impacts: The downward spiral in the wetlands of southern Sumatra. *Mitigation and Adaptation Strategies for Global Change*, *12*(1), 75–100. https://doi.org/10.1007/s11027-006-9038-5

Coughlan, M. R., Magi, B. I., & Derr, K. M. (2018). A Global Analysis of Hunter-Gatherers, Broadcast Fire Use, and Lightning-Fire-Prone Landscapes. *Fire*, *1*(3). https://doi.org/10.3390/fire1030041

Dawoe, E. K., Quashie-Sam, J., Isaac, M. E., & Oppong, S. K. (2012). Exploring farmers' local knowledge and perceptions of soil fertility and management in the Ashanti Region of Ghana. *Geoderma*, *179–180*, 96–103. https://doi.org/10.1016/j.geoderma.2012.02.015

Easdale, M., & Aguiar, M. (2018). From traditional knowledge to novel adaptations of transhumant pastoralists the in face of new challenges in North Patagonia. *Journal of Rural Studies*, *63*, 65–73. https://doi.org/10.1016/j.jrurstud.2018.09.001

Fischer, R., Giessen, L., & Günter, S. (2020). Governance effects on deforestation in the tropics: A review of the evidence. *Environmental Science & Policy*, *105*, 84–101. https://doi.org/10.1016/j.envsci.2019.12.007

Goodenough, A. E., Harrell, A. N., Keating, R. L., Rolfe, R. N., Stubbs, H., MacTavish, L., & Hart, A. G. (2017). Managing grassland for wildlife: the effects of rotational burning on tick presence and abundance in African savannah habitat. *Wildlife Biology*, *2017*(4). https://doi.org/10.2981/wlb.00318

Hong Van, N., Nga, T., Arai, H., Hosen, Y., Chiem, N., & Inubishi, K. (2014). Rice Straw Management by Farmers in a Triple Rice Production System in the Mekong Delta, Viet Nam. *Tropical Agriculture and Development*, *58*(4), 155–162. https://doi.org/10.11248/jsta.58.155

Jajtic, K., Galijan, V., Zafran, I., & Cvitanovic, M. (2019). Analysing wildfire occurrence through a mixed-method approach: a case study from the Croatian Mediterranean. *Erdkunde*, 73 (4), 323-341. https://doi.org/10.3112/erdkunde.2019.04.05

Jakimow, B., Griffiths, P., van der Linden, S., & Hostert, P. (2018). Mapping pasture management in the Brazilian Amazon from dense Landsat time series. *Remote Sensing of Environment*, *205*, 453–468. https://doi.org/10.1016/j.rse.2017.10.009

Johansson, M. U., Senay, S. D., Creathorn, E., Kassa, H., & Hylander, K. (2019). Change in heathland fire sizes inside vs. outside the Bale Mountains National Park, Ethiopia, over 50 years of fire-exclusion policy: lessons for REDD+. *Ecology and Society*, *24*(4). https://doi.org/10.5751/ES-11260-240426

Keck, M., & Hung, D. T. (2019). Burn or bury? A comparative cost–benefit analysis of crop residue management practices among smallholder rice farmers in northern Vietnam. *Sustainability Science*, *14*(2), 375–389. https://doi.org/10.1007/s11625-018-0592-z

Kubitza, C., Krishna, V. v, Urban, K., Alamsyah, Z., & Qaim, M. (2018). Land Property Rights, Agricultural Intensification, and Deforestation in Indonesia. *Ecological Economics*, *147*, 312–321. https://doi.org/10.1016/j.ecolecon.2018.01.021

Kull, C. (2003). *Isle of Fire: The Political Ecology of Landscape Burning in Madagascar*. Chicago: The University of Chicago Press.

Kumar, P., Kumar, S., & Joshi, L. (2015). *Socioeconomic and Environmental Implications of Agricultural Residue Burning: a Case Study of Punjab, India*. New Delhi: Springer.

Lasko, K., Vadrevu, K. P., Tran, V. T., Ellicott, E., Nguyen, T. T. N., Bui, H. Q., & Justice, C. (2017). Satellites may underestimate rice residue and associated burning emissions in Vietnam. *Environmental Research Letters*, *12*(8), 085006. https://doi.org/10.1088/1748-9326/aa751d

Mbow, C., Nielsen, T. T., & Rasmussen, K. (2000). Savanna Fires in East-Central Senegal: Distribution Patterns, Resource Management and Perceptions. *Human Ecology*, *28*(4), 561–583. https://doi.org/10.1023/A:1026487730947

McGregor, S., Lawson, V., Christophersen, P., Kennett, R., Boyden, J., Bayliss, P., Liedloff, A., McKaige, B., & Andersen, A. N. (2010). Indigenous Wetland Burning: Conserving Natural and Cultural Resources in Australia's World Heritage-listed Kakadu National Park. *Human Ecology*, *38*(6), 721–729. https://doi.org/10.1007/s10745-010-9362-y

Mendoza, T. C. (2015). Enhancing Crop Residues Recycling in the Philippine Landscape. In S. S. Muthu (Ed.), *Environmental Implications of Recycling and Recycled Products* (pp. 79–100). Springer Singapore. https://doi.org/10.1007/978-981-287-643-0_4

Mertz, O., Padoch, C., Fox, J., Cramb, R. A., Leisz, S. J., Lam, N. T., & Vien, T. D. (2009). Swidden Change in Southeast Asia: Understanding Causes and Consequences. *Human Ecology*, *37*(3), 259–264. http://www.jstor.org/stable/40343969

Millington, J., Smith, C., & Perkins, O. (2022) Human fire use and management: A global database of anthropogenic fire impacts for modelling. *fire*.

Parr, C., & Andersen, A. (2006). Patch Mosaic Burning for Biodiversity Conservation: a Critique of the Pyrodiversity Paradigm. *Conservation Biology*, 20 (6) 1610-1619. https://doi.org/10.1111/j.1523-1739.2006.00492.x

Peng, L., Zhang, Q., & He, K. (2016). Survey-based pollutant emission inventory from open burning of straw in China. *Environmental Sciences*, 8, 1109-1118. https://doi.org/10.13198/j.issn.1001-6929.2016.08.02

Rakatama, A., Pandit, R., Ma, C., & Iftekhar, S. (2017). The costs and benefits of REDD+: A review of the literature. *Forest Policy and Economics*, *75*, 103–111. https://doi.org/10.1016/j.forpol.2016.08.006

Saladyga, T., Hessl, A., Nachin, B., & Pederson, N. (2013). Privatization, Drought, and Fire Exclusion in the Tuul River Watershed, Mongolia. *Ecosystems*, *16*(6), 1139–1151. https://doi.org/10.1007/s10021-013-9673-0

Schmerbeck, J. (2003). *Patterns of forest use and its influence on degraded dry forests: a case study in Tamil Nadu, South India*. PhD thesis, University of Munich. https://mediatum.ub.tum.de

Sembhi, H., Wooster, M., Zhang, T., Sharma, S., Singh, N., Agarwal, S., Boesch, H., Gupta, S., Misra, A., Tripathi, S. N., Mor, S., & Khaiwal, R. (2020). Post-monsoon air quality degradation across Northern India: assessing the impact of policy-related shifts in timing and amount of crop residue burnt. *Environmental Research Letters*, *15*(10), 104067. https://doi.org/10.1088/1748-9326/aba714

Shaffer, L. J. (2010). Indigenous Fire Use to Manage Savanna Landscapes in Southern Mozambique. *Fire Ecology*, *6*(2), 43–59. https://doi.org/10.4996/fireecology.0602043

Smil, V. (1999). Crop residues incorporate more than half of the world's agricultural phytomass. *BioScience*, *49*(4), 299–308. http://www.jstor.org/stable/10.1525/bisi.1999.49.4.299

Spencer, A. G., Schultz, C. A., & Hoffman, C. M. (2015). Enhancing adaptive capacity for restoring fire-dependent ecosystems: the Fire Learning Network Prescribed Fire Training Exchanges. *Ecology and Society*, *20*(3). https://doi.org/10.5751/ES-07847-200338

Sun, D., Ge, Y., & Zhou, Y. (2019). Punishing and rewarding: How do policy measures affect crop straw use by farmers? An empirical analysis of Jiangsu Province of China. *Energy Policy*, *134*, 110882. https://doi.org/10.1016/j.enpol.2019.110882

Suyanto, S., G. Applegate, R. P. Permana, N. Khususiyah, and I. Kurniawan. (2004). The role of fire in changing land use and livelihoods in Riau-Sumatra. *Ecology and Society* 9(1): 15. http://www.ecologyandsociety.org/vol9/iss1/art15/

Taylor, C. A. (2003). Rangeland Monitoring and Fire: Wildfires and Prescribed Burning, Nutrient Cycling, and Plant Succession. *Arid Land Research and Management*, *17*(4), 429–438. https://doi.org/10.1080/713936109

Trollope, W. S. W. (2011). Personal Perspectives on Commercial versus Communal African Fire Paradigms when Using Fire to Manage Rangelands for Domestic Livestock and Wildlife in Southern and East African Ecosystems. *Fire Ecology*, *7*(1), 57–73. https://doi.org/10.4996/fireecology.0701057

Twidwell, D., Rogers, W. E., Fuhlendorf, S. D., Wonkka, C. L., Engle, D. M., Weir, J. R., Kreuter, U. P., & Taylor Jr, C. A. (2013). The rising Great Plains fire campaign: citizens' response to woody plant encroachment. *Frontiers in Ecology and the Environment*, *11*(s1), e64–e71. https://doi.org/10.1890/130015

Vehrs, H. (2016). Changes in landscape vegetation, forage plant composition and herding structure in the pastoralist livelihoods of East Pokot, Kenya. *Journal of Eastern African Studies*, *10*(1), 88–110. https://doi.org/10.1080/17531055.2015.1134401