Title:

Environmental and land defenders: Global patterns and determinants of repression

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Abstract

Environmental and land defenders play a crucial role in attempts to slow down environmental change and address power inequalities in land-use and resource development. Yet, they frequently face repression, including defamation, criminalization, and assassination. Recent policy and media coverage initiatives have provided much needed attention to the protection and support of defenders, but there has so far been little systematic analysis of patterns and determinants of repression at multiple scales. Here, we use databases providing the best available worldwide record of cases of socio-environmental conflicts and killings of defenders to identify patterns of repression and potential determinants of killings. Globally, about a third of socio-environmental conflicts involve mass mobilization, arrests and direct forms of violence. These 'high intensity' conflicts are more frequent in Asia and Latin America. At least 1734 killings of environmental and land defenders took place in a total of 53 countries between 2002-2018, most of them occurring in Brazil, the Philippines, Colombia, Honduras, Mexico and Peru. Our multivariate analysis indicates that major country-level determinants of killings include income level, foreign direct investment, dependency on mineral extraction, regime type, frequency of protest movements, and size of Indigenous populations. We suggest that more systematic reporting and analysis of repression – including through subnational level studies for which we provide testable hypotheses – can help protect and support defenders, notably through conflict-sensitive investment policies and greater accountability for abuses.

Keywords: environmental change; environmental defenders; environmental movements; Indigenous peoples; natural resources; repression.

1. Introduction

In March 2016, thousands of people took to the streets of Honduras' capital city to protest the killing of Berta Cáceres, a prominent environmentalist and Indigenous social movement leader opposing a hydroelectric dam project. Cáceres' international profile as a Goldman prize recipient had not deterred her killers, militaries and hired gunmen working on behalf of the dam company (Lakhani, 2020). Between 2002 and 2018, an estimated 1734 people in 53 countries were killed for defending their lands and the environment (Global Witness, 2019). Many of these 'environmental and land defenders' were, like Berta Cáceres, Indigenous people opposing large-scale resource projects, but the term is applied to a broad range of people defending their lands and environments and those seeking to protect defenders or support their cause, such as lawyers, journalists and staff from environmental or human rights organizations. Beyond the reported number of defenders killed, countless others were stigmatized, criminalized, and violently repressed by resource-based companies and government authorities (Forst, 2014; Rasch, 2017; see also, Navas et al., 2018).

The persecution of environmental and land defenders not only constitutes abuses against traditional human rights, such as rights to life, peaceful assembly or freedom from arbitrary arrest, but also against more specific rights such as the right to a healthy environment and Indigenous rights to free prior and informed consent (Knox, 2017). Persecution also represents

an attack against efforts to establish or protect the rights of nature (Boyd, 2017), as well as against Indigenous or agrarian community struggles for more sustainable forms of livelihoods and traditional forms of environmental conservation (Martinez-Alier et al., 2010; Porto-Gonçalves, 2016; Valladares and Boelens, 2017). In many cases, defenders resist environmentally destructive projects that would drastically undermine biodiversity and ecosystem services, thereby potentially contributing to slowing down the rate of environmental degradation, often at multiple scales as local extractive projects resonate through broader scales including water pollution, waste production, and greenhouse gas emissions (Gleason and Mitchell, 2009; Pigrau and Borràs, 2015; Temper et al., 2015; Glazebrook and Opoku, 2018).

Not only do defenders seek to stop environmentally harmful projects by 'putting their bodies on the line', but their message and mobilization can also contribute to environmentally progressive shifts in policy and public opinion (Agnone, 2007; Piggot, 2018). As such, the UN Environment Program (2018a) defines *environmental* defenders as "anyone … who is defending environmental rights, including constitutional rights to a clean and healthy environment, when the exercise of those rights is being threatened."[1] The killing of Brazilian rubber-tapper Chico Mendes in Brazil in 1988 and the execution of Ogoni activist Ken Saro-Wiwa in Nigeria in 1995, for example, contributed to the internationalization of environmental movements, but as well as the defense of agrarian and Indigenous community rights (Martinez-Allier et al., 2016). The persecution of environmental defenders is thus not only a failure of rights duty bearing by governments and corporations, but also an important and grievous dimension of environmental politics.

Several UN Special Rapporteurs have been vocal about the importance of protecting environmental human rights defenders (Forst, 2014; Knox, 2017). In 2018, the UN Environment agency launched an environmental governance policy dedicated to the support and protection of environmental defenders (UNEP, 2018a), and in 2019 the UN General Assembly recognized "the contribution of environmental human rights defenders to the enjoyment of human rights, environmental protection and sustainable development", condemned the violence against defenders, and called upon states and business enterprises to respect their rights (UNGA, 2019; for a review of policy recommendations, see Khanna and Le Billon, 2019). Such high-level initiatives reflect a growing concern about the rise of anti-environmental movements and their backing not only by many conservative governments but also left-wing 'neo-extractivist' regimes (Rowell, 2017; Tilzey, 2019).[2]

A growing body of scholarly literature is more systematically studying the persecution of environmental defenders to better understand risk factors (Clark, 2009; Jeffords and Thompson, 2016; Butt et al., 2019; Middeldorp and Le Billon, 2019; Scheidel et al., 2020). The case study literature suggests that killings of environmental and land defenders are particularly prominent in countries experiencing high levels of inequality and corruption, historical marginalization of Indigenous and peasant communities, a liberalization of foreign and private investment into land-based sectors, weak rule of law and recent reversals in partial democratization processes taking place within a broader context of high homicidal violence and impunity rates (Middeldorp and Le Billon, 2019). So far, statistical analyses have provided evidence for that at the country level there is an inverted U-shaped relationship between number of killings and per capita income level (Jeffords and Thompson, 2016) and a positive correlation between killings weak rule of law (Butt et al., 2019).

Here, we examine global patterns of repression across socio-environmental conflicts, focusing on the record of killings of environmental and land defenders between 2002 and 2018,

and test for potential country-level determinants of killings of environmental defenders. We make two contributions. The first is to review the concept, definition, data, and main descriptive statistics associated with the repression of socioenvironmental conflicts and killings of environmental and land defenders. The second is to extend the range of variables tested through multivariate panel data analysis to determine country-level determinants of killings. We also outline a range of local level determinants to be tested in further sub-national spatial analysis. The study draws from a literature review, expert interviews,[3] and analyses of two global datasets on environmental and land defender killings (Global Atlas of Environmental Justice on socio-environmental conflicts and Global Witness dataset of environmental and land defenders killings).

Following this introduction, section 2 briefly presents the data and methods. Section 3 provides an overview of the main categories of defenders and perpetrators, as well as patterns of conflicts and repression at global and regional levels. In section 4, we outline determinants of killings at country, local, project and defender levels. Section 5 presents the results from a cross-national panel data study of the determinants of killings. We conclude in section 6 with a discussion of key findings, policy implications including the need for greater protection of defenders and stricter investment vetting processes in countries with high risks of killings including the respect for Indigenous consent rights, and outline further research to identify high risk sectors, areas, and authorities to prevent killings and increase accountability.

2. Data and methods

2.1. Empirical strategy

This study uses two levels of analysis to explore the characteristics of killings of environmental defenders, and possible determinants. Our first level of analysis consists of descriptive statistics of the datasets to identify patterns of repression, and the number and characteristics of defenders killed as well as those of perpetrators. The second level tests a set of country-level hypotheses outlined in Table 3 by estimating the following model using negative binomial regressions:

$$y_{it} = \alpha + \beta_E E_{it} + \beta_P P_{it} + \beta_I I_{it} + \beta_C C_{it} + \beta_D D_{it} + \delta_X X_{it} + \varepsilon_{it} \quad (1)$$

where y_{it} is the outcome (a count variable; the number of killings of environmental and land defenders) for country *i* in year *t*. Our interest is in all coefficients β that capture the effects of our independent variables measuring economic *E*, political *P*, institutional *I*, conflictual *C* and demographic *D* factors. The vector *X* includes our controls for time (year dummies), geographic region, countries known to underreport environmental and land defender killings, and variables used in robustness analysis. All variables, except for the measures for the Indigenous people (see below), underreporting and region, are time-variant. We run the analysis using two samples: a global sample that includes all countries, and a sub-sample that contains the countries with at least one environmental and land defender killing during the study period.

We use negative binomial regressions as our outcome is an over-dispersed count variable (i.e., the mean of our outcome variable is much lower than its variance suggesting that over-dispersion is present). To check whether this assumption holds for our estimations, we use a likelihood ratio test that compares our model to a model that uses a Poisson distribution. For all our estimations, the test statistics strongly suggest that the negative binomial model is more

appropriate than the simpler Poisson model. We use random effects models for three main reasons: first, we want to exploit the full variation in our dataset; second, we want to obtain an estimate for our measure for Indigenous people that is time-invariant; and finally, as the fixed effects model effectively excludes all countries with no environmental and land defender killings during the study period from the analysis (as there is no variation in the outcome variable), it would substantially reduce our sample. For the restricted sample that only includes the countries where there was at least one environmental and land defender killing during the study period, we also run a fixed effect estimation as a robustness check, noting that this specification only exploits within country variation in our data and can lead to inflation of standard errors for variables that change little over time. Stata 15.1 was used in all multivariate analyses. Replication data and instructions will be made available through Mendeley Data upon publication of the article.

2.2. Data

This study relies on two global datasets. The Global Environmental Justice Atlas (EJAtlas) provides geolocalized reports of social conflicts around environmental issues (see Temper et al., 2015). While providing the best worldwide record of cases, with 2957 cases reported at the time of analysis,[4] EJAtlas is not comprehensive, and statistics must thus be understood as reflecting the database's limits, including uneven geographical coverage (e.g. link with transnational activist networks), variable quality of information and updating, and possible biases in interpretation of contexts, processes and outcomes.

The second dataset, on killings of environmental and land defenders, is gathered by Global Witness (GW), a London-based organization exposing networks behind conflict, corruption and environmental abuse. Drawing from non-governmental organizations and media reports, as well as verifications with local sources, Global Witness (2019) has been annually documenting worldwide killings of environmental and land defenders. Totalling 1734 killings in 53 countries between 2002 and 2018, these records include the year and country in which a killing occurred, along with the name and gender of the defender killed as well as other information and sources. Like the EJAtlas, the GW dataset cannot be considered comprehensive. As further discussed in 3.2, the dataset only includes the identified, reported, and verified part of a possibly much larger number of killings, itself only one form of a broad range of threats faced by environmental and land defenders.

In the multivariate analysis, our outcome variable is the annual number environmental and land defenders killed in the country according to the GW dataset. The analysed panel dataset includes all independent countries with a population of 500,000 or larger in 2006, corresponding to the inclusion criteria of Polity V dataset (Marshall and Gurr 2018). In total, the dataset includes 169 countries and covers the period 2002–2018. The unit of analysis is country-year, and in total we have 2816 observations. Some of these are lost in the analysis due to missing data. Appendix 1 presents summary statistics for all variables used in estimations.

Our variables for the economic factors come from the World Development Indicators (World Bank 2020). *Per capita income* is measured in constant 2017 international dollars and adjusted for purchasing power parity (PPP). For the analysis, we log the measure using natural logarithm and include also its square term to capture the hypothesized non-linear effect on environmental and land defender killings (see Table 3). Foreign direct investment (*FDI*) is measured as net inflows of FDI and is expressed as a share of GDP. To address the skewness in the data and to limit the influence of the extreme values, the variable was transformed using the

inverse hyperbolic sine.[5] Forest and mineral rents are calculated as the difference between the international market value of the production and the production costs, and are expressed as shares of GDP. Since the values for these variables are highly skewed, *forest rents* and *mineral rents* were transformed using natural logarithms.

Our measure for political *regime type* is drawn from the Polity V dataset (variable polity2) (Marshall and Gurr 2018). It ranges from -10 (strong autocracy) to 10 (strong democracy). As we expect that the regime types has a nonlinear impact on our outcome variable, we first added 10 to all scores (so that the variable only takes positive values) and then include the variable alongside its square term in the analysis. Our second variable for political factors measures contentious politics and comes from the Mass Mobilization Protest dataset (Clark and Regan 2016). This data is available for the period 1990-2018 (until March 31) and includes protests against own government that had over 50 participants. From the data, we counted the number of all *protests* in each country. We also separately counted the number of protests with demands related to land tenure or farm issues (*land protests*), police brutality or arbitrary actions (*police brutality protests*), and political behaviour/processes (*political protests*). To keep the year 2018 in the analysis, we divided the total annual number of protests in each country by 12, except for the 2018, which we divided by 3 to get a monthly rate. We use the log transformed monthly rates in our analysis.

Our measure for institutions is *corruption*, which comes from the Worldwide Governance Indicators (WGI 2019).[6] We measure the level of violence in the country in two ways. Using the UCDP/PRIO Armed Conflict Dataset v1-2019 (Gleditsch et al., 2002; Pettersson et al., 2019) we constructed a dummy variable that codes all years for which there were at least 25 battle-related deaths in the country. Data for the *homicides* (per 100,000 persons) comes from the World Development Indicators. The homicide data is missing for nearly 1000 country-years. Using interpolation, we were able to increase the number by 99 observations. The variable is log transformed.

Our demographic variables come from the World Development Indicators and include the log transformed population size as well as population density, share of rural population, and share of young males (ages 15-29) of all males. Estimates on Indigenous population was drawn from the annual report of the International Work Group for Indigenous Affairs (IWGIA 2020).[7] The number of Indigenous people is expressed as share of the total population in the country in 2018 and is time-invariant. For the analysis, the variable was log transformed.

We constructed a dummy for countries for which there is severe *underreporting* regarding environmental and land defender killings (Ethiopia, Myanmar, Venezuela and Nigeria, see SI). We coded region dummies for sub-Saharan Africa, Asia, Americas (except for US and Canada), and Middle East and North Africa; Europe and North America, together with Japan, Australia and New Zealand, are used as the reference category in the estimations. In robustness analysis we use *forest cover* (% of land area covered by forests); *gini* index (a measure for economic inequality; Gini index of 0 represents perfect equality and index value of 100 implies perfect inequality); *poverty* rate (share of population living on less than $1.90 a day at 2011 PPP adjusted international prices); and data for all natural resource *rents* (% of GDP), *coal rents* (% GDP), *gas rents* (% GDP) and *oil rents* (% GDP), all from the World Development Indicators.[8] Further variables used in robustness analysis include a dummy for *civil war* that codes the years with over 1000-battle related deaths (the UCDP/PRIO Armed Conflict Dataset) and *rule of law* that is the Worldwide Governance Indicators' variable for quality of contract enforcement,

property rights, the police, and the courts. As *corruption* and *rule of law* are correlated at -0.95 level, they cannot be included in the analysis simultaneously.

3. Environmental and land defenders

3.1. Who are environmental and land defenders?

Environmental and land defenders are defined as "people who take peaceful action to protect environmental or land rights, whether in their own personal capacity or professionally" (Global Witness 2017: 43; UNEP 2018b). The term environmental and land defenders encompasses a broad range of people, including Indigenous people threatened by large-scale resource extractions, dams, agribusiness, and illegal logging, mining or land settling (Lynch et al., 2018), landless peasants (re)claiming farmlands or long-established rural communities facing large-scale 'land grabs' by multinationals (Borras and Franco, 2013), and grassroots and professional environmental advocates. The term covers people that may have very different understandings of their relationship with the environment and legitimate land entitlement. Many rural communities, for example, seek to defend their access to land for the sake of securing agrarian livelihoods. In doing so, they come to defend ways of life that can involve forest clearings to create farmland and assert *de facto* land rights in ways that may seem environmentally destructive and legally tenuous (Ghazoul and Kleinschroth, 2018), even if such processes can (re)create forested and highly biodiverse anthropic rural landscapes (Hecht, 2010). In contrast, park wardens seek to protect particular species and habitats, often through the militarized enforcement of human exclusion rules – 'fortress conservation' – that have evicted rural communities, undermined traditional livelihoods, and historically 're-wilded' the environment in the name of protecting game and 'natural' biodiversity (Duffy, 2016).

The case study literature suggests that defenders fall within five main categories according to their social identities and main motivations (Table 1). These categories are not exclusive, with many defenders being associated with several ones (e.g. Indigenous environmental activist serving as community forest patroller). Defenders in these categories often face similar threats, although there can be specific ones due to their profile and activities. Some defenders are well-connected, organized and have high public profile, including as recipient of international environmental prizes (e.g. Goldman Prize), while others are largely anonymous outside their area of residence and may be isolated within their own community due to their environmental activities (Grant and Le Billon, 2019).

Table 1. Main categories of environmental and land defenders

Categories	Main motivations	Main threats
Indigenous people	Protect territory, culture, and ecology	Colonization and land encroachment, large-scale resource projects, logging and mining
Rural community members, farmworkers, landless peasants	Access and sustain land and livelihoods	Agri-businesses and large-scale resource projects
Environmental activists, social movement activists, artists and public intellectuals	Prevent environmentally destructive activities, promote environmental and social justice	Large-scale resource projects, government crackdown on opposition

Lawyers, journalists, judges	Report and defend environmental and social rights, especially those of marginalized communities	Broad economic and political interests of ruling elites, business owners, and organized crime
Conservation, forestry, and police officers	Enforce environmental and forestry laws	Poaching, illegal logging, mining, land settling, and organized crime

The term 'defender' tends to emphasize the individual over the broader communities and organizations involved in environmental and land struggles. While such individualization can help raise public awareness by literally 'giving a face' to socio-environmental struggles,[9] it can also make individualized defenders a more likely target as perpetrators seek intimidate communities and deter leadership, as well as create tensions within affected communities by singling out particular individuals or their families. The focus placed by many advocacy and media reports on killings, rather than the broad range of pressure exercised on communities, can also exacerbate such individuation. As such, a focus on individual killings and individuals killed risks both misrepresenting and rendering less visible the communities to which the defenders belong. Some academic and policy reports on environmental and land defenders have been cautious in this respect, with for example UNEP (2018b) specifically mentioning 'groups of people' in its definition of defenders, but the logics and practices of advocacy and media often individualize these struggles.

Overall, the concept of environmental and land defenders is best applied to people tying together community, territory, environmental protection, and livelihoods. These people are generally aspiring to maintain or (re)create land-use practices that help to sustain anthropogenic yet often highly biodiverse ecosystems that are generally more benign for the environment than agro-industrial practices, hydro-power or irrigation dams, and extractive activities such as industrial mining or clear-cut logging (Ghazoul and Kleinschroth, 2018).[10]

3.2. What are the patterns of repression of socio-environmental conflicts?

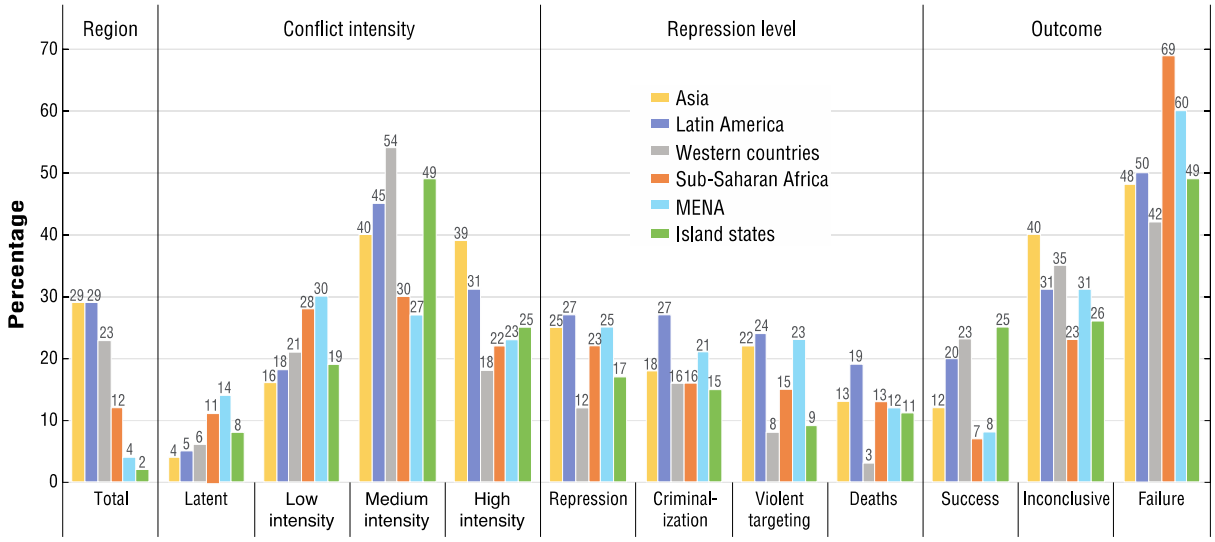
Efforts to more systematically document cases of socio-environmental conflicts have been led by the Institute of Environmental Science and Technology (ICTA) at the Universitat Autonoma de Barcelona (Temper et al., 2015; Scheidel et al. 2020), with cases mostly reported by "activist partners" – including socio-environmental activists and researchers – following a set template. The resulting EJAtlas defines socio-environmental conflicts as "mobilizations by local communities, social movements, which might also include support of national or international networks against particular economic activities, infrastructure construction or waste disposal/pollution whereby environmental impacts are a key element of their grievances."[11]

Out of the 2957 EJAtlas reported cases, 1279 cases (43%) were categorized as 'medium intensity' conflicts, including visible mobilization and street protests, while 847 (29%) cases were categorized as 'high intensity' conflicts involving mass mobilization, arrests and direct forms of violence (Figure 1). Different forms of repression occurred, concurrently or in an escalating pattern, with a criminalization or biased use of the law against defenders being reported in 20% of all cases, a violent targeting of activists in 18% of all cases, and killings in 12% of all cases. Killings were even more frequent when Indigenous people were involved (19% compared to 8%, see Scheidel et al. 2020).

A regional breakdown identifies greater rates of high intensity conflicts in Asia (39%) and Latin America (31%), with more frequent violent targeting of activists (24%) and deaths (19%) in Latin America than in Asia (22% and 13%, respectively). Sub-Saharan Africa and

Western countries (Europe, US, Canada, Australia, New Zealand) have lower reported high intensity conflicts, repression, violent targeting and deaths. However, in contrast to Western countries, Sub-Saharan Africa saw the lowest level of 'success' for environmental and land defenders, along with the Middle East and North Africa region, while Island States (Caribbean, West Indian Ocean, South Pacific), Western Countries, and Latin America saw the highest.

Figure 1. Regional patterns of socio-environmental conflict intensity, repression and outcome



Note: Asia (Central, Northeast, South, Southeast); Latin America (Mexico, Central and South America); Western countries (Australia, Canada, New Zealand, US, Western and Eastern Europe); Sub-Saharan African (West, Central, East, Southern); MENA (Middle East & North Africa); Island states (Caribbean, Western Indian Ocean, South Pacific). Source: EJAtlas (Temper et al., 2015).

Table 2. Number of conflicts and characteristics across key sectors

Sector involved in conflict	Number of conflicts	High intensity conflicts	Death(s) as conflict outcome	Success among conflicts with death(s)	Success among conflicts without death(s)
Biodiversity conservation	116	29%	13%	7%	21%
Biomass and land conflicts	447	32%	21%	5%	17%
Dams and water management	396	32%	13%	4%	16%
Fossil fuels and climate justice	526	25%	9%	9%	14%
Extraction	617	33%	19%	14%	17%

Note: Extraction includes extraction of minerals and building materials. Source: EJAtlas (Temper et al., 2015).

Looking at the main sectors involved (Table 2), the percentage of high intensity conflicts was lowest in the fossil fuels and climate justice sector (25%) and highest in extraction (33%), while biomass and land conflicts (21%) were the most deadly. Conflicts involving deaths were less likely to be successful (9%) than those without deaths (16%) for these five sectors, though not as much for extraction conflicts (14% and 17%, respectively) suggesting greater determination by defenders opposing projects in that sector.

3.3. How many defenders are killed and where?

Systematic efforts to document killings at the global level include those of Frontline Defenders, the International Rangers Federation, and Global Witness.[12] Information for these datasets is mostly collated from national-level organizations, such as that of the *Comissão Pastoral da Terra* (CPT) in Brazil, global human rights databases such as HuriSearch, and media reports. The objectives of these data collection efforts have been to raise awareness of the killings, honour the memory of the defenders, support their struggles, enhance their protection, promote corporate and government policy change, and pursue accountability. Comprehensively identifying killings of environmental and land defenders across the world, however, is a major challenge, notably as a result of lack of local monitoring, investigation and reporting, suppression of information by authorities, difficulties to reach local reporting organizations, and contexts of broader conflicts making it challenging to identify specific cases of defenders killings.

Killings only represent the 'tip of the iceberg' in terms of the harms of repression and other forms of violence associated with resource extraction and land dispossession (Butt et al., 2019). In 2018, former UN Special Rapporteur on Human Rights and the Environment John Knox estimated that "for every 1 killed, there are 20 to 100 others harassed, unlawfully and lawfully arrested, and sued for defamation, amongst other intimidations" (UNEP, 2018b). A review of violence linked to 34 large-scale mining projects and activities by Canadian mining companies in 14 Latin America between 2000 and 2015 documented 44 deaths, 4 disappearances, 15 sexual assaults, 403 injuries, 537 arrests, detentions and charges, and 195 warrants and legal complaints (Imai et al. 2016). Thus, for every death or disappearance, nine people were physically injured or sexually assaulted, and 17 people faced judicial measures or 'criminalization'. Looking at landless peasant struggles in Brazil between 1986 and 2006, there were three reported death threats and a murder attempt for every person assassinated (Girardi, 2008). As Rasch (2017, 132) observed, growing resistance within natural resource conflicts "goes hand in hand with an increased use of penal law and anti-terrorist legislation as a way of disqualifying social protest as well as an intensification of the use of violence and the surge of human rights violations".

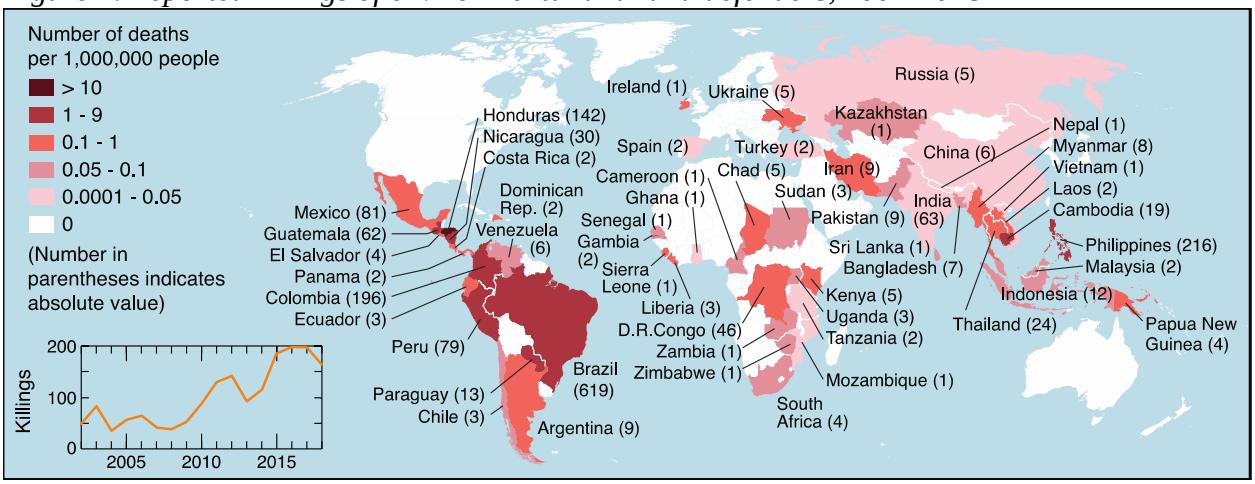
To sum-up, killings represent only a small proportion of coercive actions against environmental and land defenders, and they should only be considered as a partial indicator of the level repression, given that other forms of repression may be more intense in some countries than others. Furthermore, the physical and psychological effects of repression are only two forms of harms experienced by communities affected by resource-based projects, others including exposure to pollutants, loss of land and livelihoods, or socio-cultural conflicts (see Watts, 2005; Butt et al., 2019).

The Global Witness dataset identifies 1734 reported killings of environmental and land defenders that took place in a total of 53 countries between 2002-2018. This conservative estimate points to a sharp rise in annual killings between 2009 and 2015 (see Figure 2), coinciding with the primary commodity boom but possibly in part related to increased reporting. Six countries accounted for 77% of reported killings: Brazil (n=619), Philippines (n=216), Colombia (n=196), Honduras (n=142), Mexico (n=81), and Peru (n= 79). The five most deadly countries in terms of killings per capita were Honduras, Nicaragua, Colombia, Guatemala, and Brazil. Honduras was an extreme outlier, with per capita killings four times higher than Nicaragua, the second deadliest country for defenders (see Middeldorp and Le Billon, 2019).

Regionally, 72% of reported killings were concentrated in Latin America, 21% in Southeast and South Asia, and 5% in Africa, suggesting even sharper regional differences than those reported through EJAtlas (see Figure 1).

The number of women defenders killed over the 2002-2018 period represent 9% of the total of killings (n=150), with a growing proportion of women defenders killed since 2010. Women defenders were mostly killed in Brazil (30%), Philippines (19%), Colombia (15%) and Honduras (9%), and correlate closely with the number of males killed (annual counts at county level for males and females have correlation at 0.75 level). A reported 276 Indigenous defenders were killed during the 2014-2018 period, representing 32% of total defenders killed in that period. Most of these killings took place in the Philippines (25%), Colombia (22%), Mexico (10%) Nicaragua (10%) and Brazil (9%). Based on reported killings in 2014 and 2015, the age of defenders killed varied between 11 and 75 years old, with the vast majority of killed defenders being in the 35-65 age bracket (65%) rather than being youths (32%) or elders (3%), thus pointing at a likely targeting of active social leaders.

Figure 2. Reported killings of environmental and land defenders, 2002-2018



Source: Global Witness database (2019).

3.4. Who are the perpetrators?

While defenders killed are generally well-identified once reported by the media or human rights organizations, people behind the killings are frequently not. Partly because of that, the perpetrators are rarely prosecuted. Global Witness (2014) documented only ten convictions for the murders of seven defenders, out of 908 cases identified between 2002 and 2013, with a further 34 perpetrators under arrest and facing charges. In Colombia, out of 122 defenders killed between July 2010 and June 2016, 102 killings were investigated, nine led to a verdict and only eight in a conviction (Global Witness, 2018).

The anonymity and/or impunity of perpetrators often result from the *modus operandi* of killings (e.g. hired gunmen), participation or complicity and cover-ups by authorities and local elites in the killings (e.g. direct responsibility in killings), corruption or pressure on the judicial system (e.g. bribes, clientelism), fears of reprisal against potential whistle-blowers, and a lack of investigations (e.g. social marginality of defenders, remoteness of location, limited means of police and prosecutors). Killings generally either result from shootings or beatings by government armed forces, police, corporate security personnel or mobs and thugs during public events such as mass protests, occupation, and blockades; or from targeted murders by 'hitmen'

and taking place at the home of the defender or in the street. Some targeted killings also take place during or shortly after protests, for example to kill leaders who otherwise benefit from community-level protection. If individual killers, and the people who hire them, are rarely formally identified, there is generally more information on the category of perpetrators and sectors involved, including in the GW dataset.

Many studies point to patterns of repression associated with resource-based sectors (De Meritt and Young 2013; Vadlamannati et al., 2019). Killings generally occur as part of escalating processes of disputed resource exploitation, social mobilization, and repression (Bebbington and Bury, 2013; Dunlap, 2019), with direct physical forms of violence being widely documented as part of land control strategies (Peluso and Lund, 2011; Grajales, 2011). Out of the 859 killings reported by GW during 2014-2018, 31% involved land conflicts, including those with landless peasants making claims on disputed lands controlled by established farmers and land speculators. Agribusinesses were associated with 14% of the killings, mining and extractive activities with 20%, logging in 9%, water and dams with 7%, poaching with 8%, and other sectors (e.g. fishing, wind farms) with 5%.[13]

Based on 346 killings for which the GW dataset reported the category of perpetrators (identified for killings in 2015, 2017 and 2018), about a third were directly perpetrated by government authorities (police n=59, army n=58, government officials n=8), to which can be often be added paramilitaries (n=31), armed militias (n=17), mobs supporting incumbent party (n=2), and private security guards (n=11). Militarized opposition forces – guerrillas – were associated for 9 killings. Many killings were carried out by 'hitmen' (n=52) or criminal gangs/organized crime (n=46), as well as people directly involved in environmental or land exploitation (i.e. land owners/speculator (n=30), poachers (n=26), land settlers (n=11), loggers (n=4), and miners (n=1)). This suggests that environmental and land exploiters relatively rarely directly perpetrate killings (and are identified as such). Rather, exploiters pursuing land-based projects in the face of local resistance often combine repressive state security forces and private security firms, as well as criminal organizations, paramilitaries and vigilante groups - especially in areas where the state lacks or outsources territorial control (Cruz, 2011). In Brazil, syndicates of local landowners and land speculators have hired assassins (e.g. murder of Sister Dorothy Stang, see Campbell, 2015), and are part of larger political forces such as the Ruralist Democratic Union opposing landless peasant movements through legal reforms and paramilitary groups (Hammond, 2009; Mendes, 2018).

Whereas some governments and corporations use their own security personnel to exert deadly repression, notably in the context of public street protests and blockades, more insidious forms of repression – including targeted killings – are generally subcontracted through middlemen to hired gunmen or criminal gangs (Global Witness, 2014), making it more difficult to identify the full network and trace the chain of command. Criminal organizations and illegal business entrepreneurs also commit murders for their own commercial interests, notably among poaching gangs, illegal loggers and miners. Killings among (neighbouring) community members occur in the context of local land conflicts, including between traditional residents – especially Indigenous populations – and newly settled populations (e.g. *colonos* or *mestizo* in Nicaragua, see Sylvander, 2018). This can give way to complex situations involving 'cycles of violence' – including feuds and revenge killings – in which land settlers, Indigenous populations, and large-scale agribusinesses confront each other; situations that can be further complicated, and deadlier, when narcotics trafficking and (counter)insurgency are also involved (e.g. in Colombia, Honduras, Myanmar, and the Philippines). Finally, there are many degrees of responsibility and

forms of complicity involved, from carrying-out the killing itself, to recruiting the killers, ordering and paying for the killing, knowingly promoting and/or investing in a resource project that could possibly result in a killing, and benefiting from the project without having taken part in the decision (e.g. pension fund holders; commodity consumers).

4. What are the main determinants of killings?

Contemporary killings of environmental and land defenders are part of a long history of colonialization and resource exploitation (Totten et al., 2002; Lynch et al., 2018; Butt et al., 2019). Propelled by accumulative economic regimes (Moore, 2015) and often underpinned by racial and socio-economic hierarchies (Virdee, 2019), resource exploitation drastically accelerated after the onset of the Second World War (Krausman et al., 2009). The globalization of mass consumption and economic emergence of China in the late 1990s further increased global commercial demand for land and natural resources, thereby pushing extraction frontiers and exacerbating conditions for socio-environmental conflicts, especially in resource-rich countries with populations resisting the burdens of pollution, displacement, cultural and livelihood loss, and social inequalities (Escobar, 2006; Muradian et al., 2012). In this context, many local communities are having to assert and defend their rights in the face of powerful political and commercial alliances between government authorities, local economic elites, and primary commodity companies (Temper et al., 2015). The frequent absence of effective conflict prevention and resolution processes (e.g. Free, Prior and Informed Consent by Indigenous groups) and the use of deceptive and coercive tactics by project proponents are often, but not always, leading to further resistance and conflict escalation (Conde and Le Billon, 2017). As a communication revolution enabled many defenders to become more connected and their struggles more visible (Kirsch, 2014), the perceived need of resource extraction proponents to 'silence' defenders and deter their supporters can increase, but so can the potential for backlash and even greater mobilization (Bob and Nepstad, 2007; Aytaç et al., 2018).

Killings are in part facilitated by patterns of impunity for perpetrators, generally associated with the lack of independent and effective judiciary and media reporting, tight and unaccountable networks between political, economic and military elites, social 'habituation' to homicides on the part of authorities – including as a result of recent wars, and state tolerated/encouraged vigilante activity (Cruz, 2011; Hill and Jones, 2014). Deadly conflict escalation also often results from high uncertainty in the capacity and behavioral norms among protesters, corporate actors, and security forces in a context of contentious politics (Leitner et al., 2008), a situation characterizing intermediary political regimes falling between 'full' autocracies and democracies (Davenport, 2007; Pierskalla, 2010). In such contexts, government authorities and corporations are frequently unwilling to follow the praxis of negotiated conflict settlement, while some defenders and their movements refuse to back down on the premise that sustained contestation will further erode abuses of power, even if at the cost of deadly repression. The cases study literature suggests that likelihood of killings of environmental and land defenders thus seem particularly acute in middle-income countries with semi-authoritarian regimes, a recent history of armed conflicts and/or high homicides rates, and a high prevalence of conflicts around resource exploitation projects, as seen in Latin America (see Bebbington and Bury, 2013; Temper et al., 2015; Jeffords and Thompson, 2016; McNeish, 2018; Middeldorp and Le Billon, 2019). Butt et al. (2019) have shown that weak rule of law – based on the World Justice Project index - correlates with higher rates of environmental and land defender killings, echoing more

general findings that the most significant variable increasing political killings besides civil war is a lack of judicial independence (Hill and Jones, 2014).

Building on our literature review and the descriptive analyses in Section 3, we identify factors that could be influencing defender killings levels (see Table 3). For each of these factors, we report at least one source, which is italicized if it explicitly relates to killings of environmental and land defenders. These factors fall into four groups depending whether the characteristics refer primarily to the country, location, project, or defender involved. Most of the country characteristics are tested in Section 5.

Table 3. Main potential co-variates and hypotheses on killings of defenders

Level	Sources
Country characteristics	
Economic	
1) Per capita income: projects are more likely to be resisted in middle-income countries, as local communities in low-income countries may more easily accept projects in the hope of escaping poverty or be more easily co-opted/bought-off, while local communities in high-income countries are more likely have access to institutional means of opposition and face less lethal repression	*Jeffords and Thompson, 2016*
2) Foreign direct investment into resource sectors: primary sector FDI is less hindered by low physical integrity rights in host countries than other sectors, while higher levels of investment into land and resource-based projects results in more killings	Blanton and Blanton, 2009; Clark and Kwon, 2018; Vadlamannati et al., 2019
3) Natural resource dependence: higher levels of natural resource rent dependence – such as from forests and minerals – increase the stakes at play in resource conflicts and make repression less costly for states, increasing killings	Demeritt and Young, 2013
4) Landholding inequality: a combination of high concentration of land ownership and landlessness is likely to increase grievances and the risks of killings	Thomson, 2016
Political	
5) Political regime type: there is a greater risk of targeted killings in anocracies, i.e., in regimes that are neither strongly authoritarian nor strongly democratic	Fein, 1995
6) Contentious politics: as people make claims through direct challenges to dominant interests, higher levels of public protests increase risks of killings	Tarrow, 2013
7) Shift to anti-environmental government: a shift from a progressive to an anti-environmental populist government increases risks of killings	*Middeldorp and Le Billon, 2019*
Institutional	
8) Rule of law: weak rule of law increases killings, notably as a result of lack of protection for human rights, including environmental rights, and poor resource governance	*Butt et al., 2019*
9) Corruption: high levels of corruption increase the likeliness of killings through higher grievances and impunity resulting from corrupt practices in the awarding of lands and resources, resource management, policing and judicial processes	Kolstad and Soreide, 2009*; Butt et al., 2019*
Conflictual	
10) Armed conflict: conflict increases the chance of defender killings because of weapons availability, patterns of killings, and greater economic stakes as resources get to be newly allocated	Hill and Jones, 2014
11) Homicide rate: defender murders follow the pattern of more general homicide rates, reflecting structural and cultural factors	*Jeffords and Thompson, 2016*
Demographic	
12) Population size: countries with larger populations are more likely to see protests and killings	*Jeffords and Thompson, 2016*

13)	Age structure: large youth cohorts ('youth bulge') increase anti-state political violence and state repression	Nordås and Davenport, 2013
14)	Share of rural population: countries with a large proportion of rural populations are more likely to see harsh repression, including killings	*Christensen, 2018*
15)	Share of Indigenous population: Indigenous groups are more at risk as they live in areas targeted by environmental and land exploiters, are entitled to rights that are often not respected, and often suffer from racist prejudices and other forms of violence	*Butt et al., 2019*
Location characteristics		
16)	Weak state presence: the absence of state institutions increases the risks of killings	Prem et al., 2019
17)	Remoteness: hard to reach and isolated locations increase the vulnerability of defenders and risk of impunity, while governments and possibly companies are more prone to use lethal repression as they fear less backlash mobilization than in more populated areas	*Christensen, 2018*
18)	Political party in power: regional support for the political opposition, including by project-affected local communities, increases the punishing behaviour of the state and risk of killings	*Middeldorp and Le Billon, 2019*
19)	Proximity with resource projects: resource projects increase risk of killings in communities located in the vicinity of the project	*Christensen, 2019*
Project characteristics		
20)	Size of projects and companies: while large-scale operations are likely to face greater resistance, larger companies have more expertise to prevent and reduce conflicts, and face greater reputational risks. Mid-size projects and companies are more likely to result in killings	*Haslam and Tanimoune, 2016*
21)	Type of sector/commodity/mode of production: some sectors, commodities and modes of production are more likely to be associated with killings than others	*Haslam and Tanimoune, 2016*; *Butt, 2019; Prause and Le Billon, 2020*
22)	Foreign ownership: Domestic companies are less likely to engender resistance and more likely to find ways to compromise, while foreign companies will be less associated with 'national interest' and be backed by the state through repression	*Haslam and Tanimoune, 2016*; Wegenast and Schneider, 2017
23)	Environmental impacts: greater environmental impacts will likely result in greater resistance and greater risk of killing	*Conde and Le Billon, 2017*
24)	Commodity prices: high or rising commodity prices are likely to result in increased project activities, as well as possibly in demands for a greater share of revenue on the part of communities leading to conflicts and killings	*Bond and Kirsch, 2015*; Vargas, 2019
Defender characteristics		
25)	Indigenous communities: defenders that have or claim Indigenous status, and associated rights, are more likely to be murdered	*Butt et al., 2019; Scheidel et al. 2020*
26)	Landless peasants: these defenders are more likely to be murdered as they represent a direct threat to poorly accountable large-landholders and to dominant elites through their claims for land reforms	*Borras and Ross, 2007*
27)	Political opponents: defenders associated with political opposition movements are more likely to be killed as the ruling or incumbent party seeks to punish the opposition and show it as being unable to protect their supporters	*Middeldorp and Le Billon, 2019*

Note: sources are in *italic* when specific to environmental and land defenders.

5. A country-level analysis

Table 4 shows the main results for the multivariate negative binomial regressions, and further results are provided in Appendix 2 and 3. The tables report incident rate ratios. A ratio above 1 indicates that the independent variable is positively associated with the number of environmental and land defender killings and a rate below 1 indicates a negative relation. In Table 4, Models 1-4 include all countries in our dataset and Models 5-8 the countries in which there were at least one environmental and land defender killing during the study period. Models 1 and 5 include the variables measuring economic, political, institutional, conflictual, and demographic factors that we hypothesize to have impact on the number of killings (see Table 3), except for the homicide rate that is missing for a vast number of observations. In Models 2 and 6 we add the dummy for countries for which we know that the number of environmental and land defender killing is underreported. Models 3 and 7 look at the impact of different types of protest movements, and in Models 4 and 8 we add the homicide rate in the estimations.

Of the **economic factors**, higher levels of *FDI* and *mineral rents* are clearly associated with a higher number of environmental and land defender killings, as are *forest rents* in the full sample. When it comes to *per capita income* level, we find strong evidence for the poorest countries having lowest number of such killings and some evidence that income level's impact diminishes for the richer countries (see joint significance test statistics). Although the rate ratios keep their direction in the estimations using the restricted sample, the results for the per capital income are not significant at the conventional level. In terms of substantive impacts, using Model 2 (Table 4; also used in the following calculations of substantive impacts) and holding all the other variables in the estimation at their means, going from one half standard deviation below the average to the average, that is from $8,000 to $18,000, would increase the expected number of environmental and land defender killings by 0.4 killings.[14] For the next half standard deviation, the increase is 0.1 killings. The impact of per capita income plateaus around $46,000, slowly decreasing after that. For forest rents, one standard deviation increase from the mean corresponds to an increase of 0.3 killings, for mineral rents to an increase of 0.2 killings, and for FDI to an increase of 0.6 killings. These are substantial changes considering that the average number of environmental and land defender killings is 0.6 in our data.

When it comes to **political factors**, we find evidence for the hypothesised curvilinear relationship between *regime type* and number of environmental and land defender killings: strong autocratic and democratic countries tend to have fewer killings, and the number of killings is highest when the *regime type* takes the value 15 (score 5 on the original polity2 scale) which commonly is thought to be the threshold for a democratic country[15]. When it comes to substantial effects, holding all other variables in the model at their means, a five-point increase in *regime type* from the most autocratic (score of 0) corresponds to 1.2 more killings. An increase from 6 to 15 (scores corresponding to anocracy) produces a similar increase in the number of killings. For democracies, going from the score 16 to 20, the number of killings is expected to reduce by 0.2 killings. We also find evidence that countries with more mass movements (*protests*) are more likely to experience a higher number of environmental and land defender killings, with one standard deviation increase from the mean increasing the number of killings by 0.3 killings. The relationship, however, seems to depend on what types protest occur in the country: protests related to political processes tend to be linked with a higher number of killings while protests related to land and farm issues are not (Models 3 and 7). There is some evidence suggesting that protests against policy brutality are linked to *fewer* killings.

Table 4. Environmental and land defender killings, 2002-2018

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All countries				Countries with defender killings			
Per capita income (log)	4.178**	4.561***	4.927***	13.352***	2.632	2.686	2.837	6.265*
	(2.45)	(2.59)	(2.71)	(2.71)	(1.49)	(1.52)	(1.61)	(1.73)
	0.014	0.010	0.007	0.007	0.137	0.130	0.108	0.084
Per capita income (log) SQ	0.842	0.822	0.827	0.700	0.834	0.827	0.827	0.783
	(-1.13)	(-1.28)	(-1.24)	(-1.60)	(-1.08)	(-1.12)	(-1.13)	(-0.99)
	0.258	0.199	0.214	0.109	0.280	0.261	0.258	0.323
FDI (asinh)	1.569***	1.598***	1.620***	1.699***	1.499***	1.510***	1.521***	1.636***
	(3.54)	(3.68)	(3.74)	(3.32)	(3.02)	(3.06)	(3.08)	(2.97)
	0.000	0.000	0.000	0.001	0.003	0.002	0.002	0.003
Forest rents (log)	1.272*	1.289*	1.355**	1.260	0.983	0.987	1.020	1.078
	(1.80)	(1.92)	(2.16)	(1.50)	(-0.12)	(-0.09)	(0.14)	(0.46)
	0.071	0.055	0.031	0.135	0.907	0.928	0.891	0.646
Mineral rents (log)	1.154***	1.151***	1.151***	1.090*	1.147***	1.147***	1.144***	1.114**
	(3.46)	(3.42)	(3.41)	(1.74)	(3.30)	(3.32)	(3.27)	(2.16)
	0.001	0.001	0.001	0.082	0.001	0.001	0.001	0.030
Regime type	1.411**	1.397**	1.365*	1.497**	1.489***	1.489***	1.445**	1.426*
	(2.20)	(2.11)	(1.92)	(2.17)	(2.69)	(2.69)	(2.46)	(1.92)
	0.028	0.035	0.055	0.030	0.007	0.007	0.014	0.055
Regime type SQ	0.989*	0.989*	0.990	0.987*	0.986**	0.986**	0.988**	0.989
	(-1.77)	(-1.67)	(-1.49)	(-1.77)	(-2.22)	(-2.20)	(-1.98)	(-1.46)
	0.076	0.095	0.135	0.077	0.027	0.028	0.048	0.145
Protests (log)	1.043*	1.041*			1.038	1.038		
	(1.83)	(1.75)			(1.64)	(1.63)		
	0.067	0.080			0.101	0.104		
Land protests (log)			0.983	0.996			0.994	1.000
			(-1.07)	(-0.23)			(-0.37)	(0.02)
			0.286	0.820			0.710	0.983
Police brutality protests (log)			0.974	0.967*			0.979	0.972
			(-1.57)	(-1.74)			(-1.19)	(-1.42)
			0.116	0.083			0.232	0.156
Political protests (log)			1.049**	1.031			1.043**	1.026
			(2.52)	(1.50)			(2.22)	(1.28)
			0.012	0.135			0.026	0.199
Corruption	1.407	1.397	1.451	1.593	1.160	1.162	1.206	1.226
	(1.20)	(1.18)	(1.30)	(1.47)	(0.47)	(0.47)	(0.59)	(0.59)
	0.229	0.238	0.193	0.142	0.641	0.639	0.556	0.553
Armed conflict	1.155	1.248	1.163	1.044	1.179	1.205	1.173	1.013
	(0.58)	(0.88)	(0.59)	(0.13)	(0.68)	(0.76)	(0.65)	(0.04)
	0.562	0.378	0.555	0.897	0.495	0.448	0.518	0.969
Population (log)	1.951***	2.011***	2.148***	2.170***	1.439***	1.443***	1.508***	1.694***
	(5.09)	(5.29)	(5.49)	(5.21)	(2.69)	(2.72)	(2.92)	(3.32)
	0.000	0.000	0.000	0.000	0.007	0.007	0.004	0.001
Young males	1.140**	1.137**	1.137**	1.126*	1.073	1.070	1.068	1.085
	(2.18)	(2.16)	(2.15)	(1.79)	(1.16)	(1.12)	(1.08)	(1.22)
	0.029	0.031	0.032	0.073	0.247	0.263	0.281	0.222
Population density (log)	1.332**	1.326**	1.314*	1.415**	1.094	1.082	1.081	1.154
	(2.04)	(2.02)	(1.93)	(2.13)	(0.55)	(0.48)	(0.48)	(0.73)
	0.041	0.044	0.053	0.033	0.579	0.629	0.631	0.463
Rural population	1.004	1.006	1.008	1.019	1.003	1.004	1.006	1.025
	(0.26)	(0.45)	(0.56)	(1.11)	(0.23)	(0.27)	(0.36)	(1.37)
	0.796	0.654	0.576	0.265	0.819	0.788	0.720	0.171
Indigenous population (log)	1.101***	1.102***	1.092**	1.107**	1.111***	1.113***	1.106***	1.093**
	(2.78)	(2.82)	(2.50)	(2.37)	(2.77)	(2.82)	(2.63)	(1.97)
	0.006	0.005	0.012	0.018	0.006	0.005	0.009	0.048
Underreporting		0.272*	0.251*	0.866		0.641	0.595	0.712
		(-1.68)	(-1.80)	(-0.14)		(-0.49)	(-0.57)	(-0.34)
		0.093	0.072	0.889		0.627	0.568	0.737
Homicides (log)				1.329				1.360
				(1.53)				(1.64)
				0.126				0.101
Observations	2,433	2,433	2,433	1,828	832	832	832	658
Countries	155	155	155	136	52	52	52	47
Overdispersion test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Joint significance, per capita income (p-value)	0.014	0.010	0.005	0.005	0.315	0.304	0.256	0.094
Joint significance, regime type (p-value)	0.015	0.017	0.025	0.018	0.004	0.003	0.006	0.015
Log likelihood	-788	-787	-784	-629	-756	-756	-754	-614

Table shows incidence rate ratios for negative binomial regressions. All estimations include region and year dummies. z-statistics are showed in parentheses, and p-values are under z-values. Overdispersion test shows p-values for a likelihood ratio test comparing the estimated model to a Poisson model. Joint significance shows test statistics for per capita income variables and regime type variables. *** p<0.01, ** p<0.05, * p<0.1

Our measure for **institutional factors**, *corruption*, has consistently a positive sign (i.e., incidence rate ratio larger than 1.0), but fails to be significant at conventional levels. We find similar results for *armed conflict*, one of our measures for **conflictual factors**. *Homicides* has a borderline significance (Models 4 and 8) and its inclusion in the estimations has some impact on other variables – weakening somewhat the impact of *forest rents*, *mineral rents*, and *political protest*, dissipating the effect of *underreporting*, and improving the overall performance of the model (see log likelihood statistics). These changes, however, are due to change in the sample (see Model 1 in Appendix 2 and 3) as the inclusion of homicides causes 600 observations and 19 countries to drop from the estimation when using the full sample and 170 observations and 5 countries when using the restricted sample.

Several **demographic factors** are related to the number of environmental and land defender killings. Higher shares of *Indigenous population* in a country are positively related to a higher number of killings. There are also more killings in countries with larger *populations*. Share of *young males* and *population density* are linked to a higher number of killings in the all countries sample, but although having a positive sign in the restricted sample, the ratios are not significant at conventional levels. We find no evidence that the share of *rural population* is related to killings. When it comes to substantial impacts, one standard deviation increase from the mean in young male population increases the predicted number of killings by 0.5 killings and by 0.1 for the Indigenous population, holding all the other variables in the model at their means.

Our dummy for underreporting indicates that Ethiopia, Myanmar, Nigeria, and Venezuela have lower number of killings that we would have expected based on the variables included in the analysis. Two of the countries drop when the measure for homicides is included in the analysis (data for Ethiopia and Nigeria is missing), and as the same two countries have no reported killings during the study period, they also drop from the analysis using restricted sample. This most likely explains why the dummy is not significant in the estimations with homicide rate and restricted sample.

As a robustness check, we include logged population as an exposure variable in the estimation to standardize defender killing counts by population size instead of estimating the coefficients for *population* as part of the estimated model (see Models 2 in Appendix 2 and 3). This approach assumes that the risk of defender killing is proportional to the country's population size. The results are in line with results in which population size is considered as a regressor with some variables slightly weakening or gaining in strength. We note in particular that *regime type* loses in strength and significance while *per capita income* gain in both. For the restricted sample, we also run an estimation with country fixed effects that exploits only the within-country variation in the data (Model 3 in Appendix 3). These results differ from the corresponding random effects model results (Model 7 in Table 4) in some ways. First of all, both the effect size and significance level for per capita income level increase, lending support for the hypothesized curvilinear relationship between income levels and killings. Further, the results suggest that changes in forest rents in a country relate to the number of killings: more forest revenues are associated with an increase in killings. We also find that corruption and occurrence of an armed conflict in a country is associated with fewer killings.

Models 3-9 in Appendix 2 add a series of additional covariates as robustness test in the full sample, using Model 3 from Table 4 as the base model. In general, the results are robust to addition of forest cover in the estimation (Model 3), and alternative measures for armed conflict (Model 4) and other types of natural resource rents (Models 8 and 9). Rule of law (as an alternative measure for institutional quality) weakens the impact of regime type although the

regime type and its square term are still jointly significant. Measures for poverty and economic inequality (Models 6 and 7) weaken the impact of some covariates, especially the ones for per capita income, FDI, and Indigenous people, but these are due to changes in the sample rather than inclusion of the variables. Except for the rule of law, none of the additional variables are significant. Models 4-10 in Appendix 3 show the same robustness tests for the restricted sample, using Model 7 in Table 4 as the base model, with similar results as outlined for the full model.

6. Conclusion

The repression of environmental and land defenders is a major concern in environmental politics. Environmental and resource governance models emphasize the importance of local community and civil society participation to achieve social equity and environmental sustainability goals. Yet repression often undermine such participation, including through the assassination of prominent defenders and members of their community and support network. In this study, we first pointed to the rising attention to 'environmental and land defenders' and to the diversity of people associated with this term, from landless peasants to environmental activists and forestry officers. We then identified patterns of repression across regions and sectors, using socio-environmental conflicts reported in the EJAtlas, as well as identified some of the possible determinants of killings of defenders through multivariate country-level statistical analysis, using a dataset of killings by Global Witness. We note that neither of two datasets can be considered as comprehensive or representative, due to limitation and possible biases in reporting. Any conclusions from this study should thus be treated with caution as the overall numbers of conflicts and killings are not necessarily representative of the actual numbers in a particular country or region, and the association between a defender being killed and a specific sector is not always evidence of a direct connection.

With these caveats in mind, our findings suggest that conflicts were more frequently of 'high intensity' in Asia and Latin America than in the rest of the world, with the violent targeting of activists, including killings, being more frequent in this latter region. About a third of conflicts across the main sectors were of high intensity, especially mineral ores and building materials extraction, with biomass and land conflicts being the ones most frequently deadly. According to the Global Witness database, Indigenous peoples constitute the group most at risk of killings. Threatened by large-scale resource extractions, dams, agribusiness, and land settling (Lynch et al., 2018), they represent nearly a third of reported environmental and land defenders killed. About a third of killings are perpetrated by government or corporate security personnel, while much of the rest is sub-contracted to paramilitaries and hired hitmen. In our country-level analysis, we find evidence that defender killings are more likely in countries with high levels of foreign direct investment, dependent on mineral extraction, or that have large Indigenous populations or experience more frequent protests. There are also more killings in countries that are neither strong democracies or autocracies. We find evidence that middle-income countries have a higher number of killings than poorer countries, and some evidence that fewer killings occur in richer countries. Our results suggest that countries with large shares of young males, high dependence on forest rents, high population density or high homicide rates may be more likely to experience defender killings. Our results are inconclusive when it comes to the association between the killings of defenders and armed conflict or corruption. These findings call for tighter controls on investments taking place in countries with high-risk characteristics, as well as respect for the consent rights of Indigenous communities and stronger protection measures for defenders.

Further research is needed in a number of areas. In terms of documenting repression, potential 'blind spots' with under-reporting should be further investigated, through increased communication with local human rights and civil society organizations in countries with suspected low reporting, as well as extending the range of repression covered beyond killings (e.g. criminalization, threats, injuries) and levels of impunity for perpetrators. In terms of analysis, a broader range of variables could be examined as suggested in Table 3, including through spatially disaggregated analyses better identifying high risk factors and associated areas. In turn, predictive models could be refined and tested as more information, especially geo-referenced ones, is added in estimations. Finally, additional research is needed to assess the impacts of repression on environmental and land struggles in terms of social mobilization and project outcomes, as well as the effectiveness of policy reforms on investment criteria and the protection of affected communities.

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Appendix 1. Summary statistics for the panel data analysis

	# obs.	Mean	Std. dev.	Min.	Max.
Year	2,816	2010	5	2002	2018
Environmental and land defender killings	2,816	0.6	3.8	0	70
Economic factors					
Per capita income ($1000)	2,660	18	20	0.70	115
FDI (% GDP)	2,721	5.1	12.4	-58	280
Forest rents (% GDP)	2,584	2.2	4.4	0	40
Mineral rents (% GDP)	2,584	1.7	4.4	0	47
Political factors					
Regime type	2,775	13.8	6.3	0	20
Protests (monthly rate)	2,816	0.3	0.6	0	11.9
Land protests (monthly rate)	2,816	0.0	0.1	0	3.3
Police brutality protests (monthly rate)	2,816	0.0	0.1	0	1.7
Political protests (monthly rate)	2,816	0.2	0.4	0	7.3
Institutional factors					
Corruption	2,799	0	1	-2.5	1.9
Conflictual factors					
Armed conflict	2,816	0	0	0	1
Homicides (per 100'000)	1,917	7.4	12	0.0	105
Demographic factors					
Population (1'000'000)	2,792	42	145	0.44	1393
Population density (per square km)	2,766	164	576	1.6	7953
Young males (% of all males)	2,781	26.0	4.0	15	37
Rural population (% of total population)	2,781	43.6	22	0	91
Indigenous population (% of 2018 population; time invariant)	2,782	3.4	7.9	0	46
Underreporting (time invariant)	2,816	0.02	0.2	0	1
Variables used in robustness checks					
Forest cover (% of land area)	2,437	31	23	0	99
Civil war	2,816	0.0	0.2	0	1
Rule of law	2,799	-0.18	1.00	-2.6	2.1
Gini	1,831	39	8.4	24	65
Poverty (% of total population)	1,831	15	21	0	94
Resource rents (% GDP)	2,579	9.4	12.8	0	74
Coal rents (% GDP)	2,572	0.2	0.9	0	25
Gas rents (% GDP)	2,572	0.8	3.0	0	46
Oil rents (% GDP)	2,578	4.6	11.0	0	68

Appendix 2. Robustness checks, all countries

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Per capita income (log)	19.499***	5.986***	6.011***	4.955***	6.102***	2.816	2.973	4.352***	6.841***
	(3.12)	(2.97)	(2.74)	(2.70)	(3.03)	(1.27)	(1.37)	(2.61)	(2.97)
	0.002	0.003	0.006	0.007	0.002	0.206	0.171	0.009	0.003
Per capita income (log) SQ	0.646*	0.812	0.751*	0.826	0.859	0.999	0.974	0.752*	0.775
	(-1.95)	(-1.30)	(-1.68)	(-1.24)	(-0.99)	(-0.00)	(-0.14)	(-1.90)	(-1.55)
	0.052	0.194	0.094	0.216	0.323	0.996	0.891	0.057	0.120
FDI (asinh)	1.717***	1.626***	1.498***	1.611***	1.679***	1.299	1.309*	1.718***	1.595***
	(3.40)	(3.68)	(2.93)	(3.69)	(4.02)	(1.63)	(1.70)	(4.23)	(3.57)
	0.001	0.000	0.003	0.000	0.000	0.103	0.090	0.000	0.000
Forest rents (log)	1.285	1.459**	1.299*	1.361**	1.455***	1.547**	1.576**		1.330*
	(1.51)	(2.51)	(1.72)	(2.13)	(2.64)	(2.13)	(2.16)		(1.96)
	0.130	0.012	0.085	0.033	0.008	0.033	0.031		0.050
Mineral rents (log)	1.103*	1.153***	1.122***	1.156***	1.146***	1.294***	1.308***		1.187***
	(1.92)	(3.32)	(2.64)	(3.59)	(3.33)	(4.18)	(4.30)		(3.80)
	0.054	0.001	0.008	0.000	0.001	0.000	0.000		0.000
Regime type	1.582**	1.312	1.325	1.384**	1.249	1.072	1.028	1.337*	1.332*
	(2.36)	(1.55)	(1.63)	(1.97)	(1.32)	(0.33)	(0.12)	(1.91)	(1.69)
	0.018	0.122	0.103	0.049	0.188	0.745	0.901	0.056	0.091
Regime type SQ	0.985**	0.991	0.991	0.989	0.994	1.001	1.003	0.992	0.991
	(-1.97)	(-1.21)	(-1.24)	(-1.58)	(-0.81)	(0.07)	(0.29)	(-1.29)	(-1.37)
	0.049	0.227	0.213	0.115	0.416	0.945	0.772	0.198	0.170
Land protests (log)	0.998	0.979	0.990	0.981	0.986	0.982	0.982	0.987	0.981
	(-0.11)	(-1.45)	(-0.56)	(-1.21)	(-0.91)	(-1.01)	(-1.01)	(-0.82)	(-1.20)
	0.911	0.147	0.573	0.228	0.361	0.312	0.311	0.413	0.231
Police brutality protests (log)	0.967*	0.973*	0.944***	0.976	0.975	0.977	0.978	0.972*	0.976
	(-1.78)	(-1.70)	(-2.78)	(-1.42)	(-1.51)	(-1.23)	(-1.22)	(-1.65)	(-1.43)
	0.074	0.090	0.005	0.156	0.132	0.220	0.222	0.099	0.152
Political protests (log)	1.031	1.046**	1.044**	1.050***	1.048**	1.044**	1.044**	1.038**	1.049**
	(1.51)	(2.38)	(2.18)	(2.59)	(2.46)	(2.09)	(2.10)	(1.97)	(2.52)
	0.132	0.017	0.029	0.010	0.014	0.036	0.036	0.048	0.012
Corruption	1.577	1.219	1.522	1.389		1.642	1.597	1.389	1.481
	(1.41)	(0.73)	(1.41)	(1.14)		(1.58)	(1.49)	(1.20)	(1.32)
	0.160	0.467	0.159	0.254		0.113	0.135	0.229	0.188
Armed conflict	1.187	1.046	1.295		1.072	0.882	0.826	1.270	1.249
	(0.54)	(0.17)	(0.90)		(0.27)	(-0.38)	(-0.57)	(0.99)	(0.82)
	0.592	0.862	0.369		0.790	0.706	0.568	0.324	0.412
Population (log)	2.246***		2.098***	2.221***	2.303***	2.202***	2.336***	2.163***	2.546***
	(5.28)		(5.28)	(5.51)	(5.99)	(3.99)	(3.98)	(6.22)	(4.99)
	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
Young males	1.145**	1.167***	1.112*	1.139**	1.105*	1.090	1.108	1.096	1.140**
	(2.07)	(2.62)	(1.68)	(2.16)	(1.68)	(1.18)	(1.37)	(1.59)	(2.18)
	0.038	0.009	0.093	0.031	0.094	0.237	0.171	0.111	0.030
Population density (log)	1.450**	1.251	1.283	1.306*	1.362**	1.380*	1.394*	1.154	1.219
	(2.18)	(1.54)	(1.63)	(1.86)	(2.16)	(1.77)	(1.79)	(0.95)	(1.32)
	0.029	0.123	0.103	0.063	0.031	0.077	0.074	0.342	0.186
Rural population	1.022	1.017	1.007	1.008	1.010	1.022	1.024	1.008	1.002
	(1.22)	(1.23)	(0.47)	(0.56)	(0.72)	(1.20)	(1.28)	(0.57)	(0.15)
	0.224	0.220	0.637	0.578	0.469	0.229	0.199	0.567	0.881
Indigenous population (log)	1.101**	1.072**	1.124***	1.090**	1.076**	1.044	1.043	1.127***	1.091**
	(2.15)	(1.97)	(3.03)	(2.38)	(2.07)	(0.83)	(0.82)	(3.79)	(2.40)
	0.031	0.049	0.002	0.017	0.038	0.404	0.412	0.000	0.017
Underreporting	0.669	0.204**	0.198*	0.270*	0.188**	0.580	0.531	0.283*	0.260*
	(-0.37)	(-2.04)	(-1.93)	(-1.69)	(-2.16)	(-0.56)	(-0.65)	(-1.70)	(-1.70)
	0.710	0.041	0.054	0.091	0.031	0.575	0.516	0.089	0.090
Forest cover (log)			1.095						
			(0.52)						
			0.606						
Civil war				0.812					
				(-0.59)					
				0.557					
Rule of law					0.386***				
					(-3.00)				
					0.003				
Gini						1.013			
						(0.47)			
						0.637			
Poverty (log)							0.942		
							(-1.04)		
							0.300		
Resource rents (log)								1.099	
								(0.73)	
								0.468	
Coal rents (log)									0.947
									(-1.01)
									0.313
Gas rents (log)									0.965
									(-0.58)
									0.563
Oil rents (log)									0.963
									(-0.80)
									0.425
Observations	1,828	2,433	2,278	2,433	2,433	1,744	1,744	2,428	2,418
Countries	136	155	155	155	155	140	140	155	155
Overdispersion test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Joint significance, per capita income (p-value)	0.002	0.001	0.011	0.005	0.001	0.058	0.074	0.027	0.002
Joint significance, regime type (p-value)	0.014	0.090	0.059	0.031	0.023	0.098	0.060	0.003	0.089
Log likelihood	-630	-785	-695	-784	-780	-623	-622	-792	-778

Table shows incidence rate ratios for negative binomial regressions. All estimations include region and year dummies. z-statistics are showed in parentheses, and p-values are under z-values. Overdispersion test shows p-values for a likelihood ratio test comparing the estimated model to a Poisson model. Joint significance shows test statistics for per capita income variables and regime type variables. In Model 1 the sample is restricted to countries for which data on homicide rate is available. Model 2 includes population as an exposure variable. *** p<0.01, ** p<0.05, * p<0.1

Appendix 3. Robustness checks, countries with environmental and land defender killings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Per capita income (log)	9.468**	3.878**	107.828***	3.817*	2.811	3.453*	1.237	1.303	3.335*	3.932*
	(2.12)	(2.00)	(5.08)	(1.80)	(1.59)	(1.89)	(0.24)	(0.31)	(1.88)	(1.94)
	0.034	0.045	0.000	0.071	0.113	0.059	0.808	0.756	0.060	0.052
Per capita income (log) SQ	0.727	0.867	0.438***	0.752	0.826	0.834	1.062	1.050	0.760	0.768
	(-1.29)	(-0.82)	(-3.35)	(-1.48)	(-1.13)	(-1.09)	(0.27)	(0.23)	(-1.63)	(-1.49)
	0.198	0.413	0.001	0.140	0.257	0.278	0.784	0.819	0.103	0.136
FDI (asinh)	1.639***	1.561***	1.350**	1.479***	1.512***	1.564***	1.248	1.250	1.586***	1.502***
	(2.98)	(3.17)	(2.24)	(2.71)	(3.03)	(3.29)	(1.29)	(1.30)	(3.40)	(2.94)
	0.003	0.002	0.025	0.007	0.002	0.001	0.198	0.195	0.001	0.003
Forest rents (log)	1.109	1.276	2.811***	1.109	1.017	1.077	1.216	1.222		0.961
	(0.58)	(1.48)	(4.65)	(0.63)	(0.11)	(0.49)	(0.97)	(1.00)		(-0.26)
	0.560	0.138	0.000	0.527	0.910	0.623	0.332	0.318		0.794
Mineral rents (log)	1.131**	1.142***	1.254***	1.142***	1.148***	1.139***	1.271***	1.274***		1.185***
	(2.42)	(3.00)	(4.18)	(2.91)	(3.37)	(3.16)	(3.93)	(3.96)		(3.76)
	0.015	0.003	0.000	0.004	0.001	0.002	0.000	0.000		0.000
Regime type	1.521**	1.324	0.975	1.486**	1.473***	1.379**	1.108	1.104	1.336**	1.473**
	(2.23)	(1.58)	(-0.13)	(2.41)	(2.60)	(2.10)	(0.50)	(0.47)	(1.99)	(2.48)
	0.026	0.113	0.893	0.016	0.009	0.036	0.615	0.635	0.046	0.013
Regime type SQ	0.987*	0.991	1.002	0.986**	0.987**	0.990	1.000	1.000	0.991	0.986**
	(-1.77)	(-1.29)	(0.24)	(-1.98)	(-2.11)	(-1.55)	(-0.04)	(-0.01)	(-1.40)	(-2.09)
	0.076	0.198	0.810	0.048	0.035	0.120	0.967	0.988	0.161	0.036
Land protests (log)	1.002	0.980	0.987	0.996	0.992	0.995	0.991	0.991	0.993	0.992
	(0.13)	(-1.37)	(-0.96)	(-0.20)	(-0.49)	(-0.33)	(-0.46)	(-0.46)	(-0.42)	(-0.47)
	0.898	0.172	0.337	0.839	0.621	0.744	0.645	0.648	0.678	0.638
Police brutality protests (log)	0.971	0.972*	0.983	0.952**	0.980	0.979	0.980	0.980	0.974	0.982
	(-1.51)	(-1.68)	(-1.20)	(-2.28)	(-1.11)	(-1.18)	(-1.05)	(-1.05)	(-1.42)	(-0.99)
	0.131	0.092	0.232	0.022	0.265	0.238	0.295	0.293	0.157	0.321
Political protests (log)	1.028	1.035*	1.048**	1.042**	1.044**	1.043**	1.034	1.035*	1.037*	1.042**
	(1.35)	(1.83)	(2.50)	(2.08)	(2.27)	(2.21)	(1.64)	(1.66)	(1.92)	(2.18)
	0.176	0.067	0.012	0.037	0.023	0.027	0.101	0.097	0.055	0.029
Corruption	1.226	0.838	0.488**	1.178	1.175		1.233	1.225	1.176	1.180
	(0.58)	(-0.56)	(-2.12)	(0.46)	(0.50)		(0.62)	(0.60)	(0.51)	(0.52)
	0.563	0.573	0.034	0.644	0.615		0.536	0.551	0.611	0.601
Armed conflict	1.167	1.047	0.561**	1.217		1.160	0.923	0.918	1.253	1.293
	(0.48)	(0.18)	(-2.09)	(0.69)		(0.60)	(-0.27)	(-0.29)	(0.94)	(1.01)
	0.628	0.860	0.037	0.491		0.549	0.784	0.771	0.349	0.313
Population (log)	1.720***		3.717***	1.504***	1.525***	1.579***	1.653***	1.665***	1.610***	1.728***
	(3.22)		(4.97)	(2.79)	(2.91)	(3.29)	(2.89)	(2.81)	(3.69)	(3.11)
	0.001		0.000	0.005	0.004	0.001	0.004	0.005	0.000	0.002
Young males (% of all males)	1.106	1.142**	1.138**	1.034	1.065	1.052	1.037	1.036	1.045	1.082
	(1.53)	(2.20)	(2.02)	(0.50)	(1.03)	(0.84)	(0.50)	(0.47)	(0.73)	(1.30)
	0.125	0.028	0.043	0.619	0.302	0.400	0.619	0.635	0.462	0.192
Population density (log)	1.200	1.046	1.309	1.012	1.084	1.124	1.154	1.154	0.985	1.002
	(0.90)	(0.25)	(0.97)	(0.07)	(0.49)	(0.71)	(0.66)	(0.65)	(-0.08)	(0.01)
	0.370	0.800	0.330	0.942	0.624	0.475	0.512	0.514	0.935	0.991
Rural population	1.028	1.037**	1.006	1.004	1.005	1.007	1.022	1.023	0.999	0.995
	(1.42)	(2.40)	(0.32)	(0.26)	(0.30)	(0.47)	(1.18)	(1.19)	(-0.07)	(-0.30)
	0.157	0.016	0.747	0.797	0.766	0.638	0.237	0.235	0.945	0.767
Indigenous population (log)	1.081*	1.059		1.150***	1.107***	1.092**	1.074	1.076	1.104***	1.116***
	(1.66)	(1.36)		(3.26)	(2.62)	(2.25)	(1.30)	(1.35)	(2.82)	(2.77)
	0.097	0.174		0.001	0.009	0.024	0.194	0.176	0.005	0.006
Underreporting	0.571	0.496		0.359	0.661	0.476	0.775	0.747	0.683	0.786
	(-0.53)	(-0.71)		(-1.07)	(-0.45)	(-0.82)	(-0.22)	(-0.25)	(-0.43)	(-0.25)
	0.596	0.481		0.286	0.649	0.412	0.825	0.800	0.668	0.800
Forest cover (% of land area)				0.804						
				(-1.05)						
				0.294						
Civil war					0.860					
					(-0.40)					
					0.689					
Rule of law						0.583				
						(-1.56)				
						0.119				
Gini							1.007			
							(0.25)			
							0.806			
Poverty (% of total population)								0.995		
								(-0.08)		
								0.935		
Resource rents									1.070	
									(0.47)	
									0.637	
Coal rents										0.926
										(-1.35)
										0.178
Gas rents										0.925
										(-1.23)
										0.220
Oil rents										1.002
										(0.04)
										0.967
Observations	658	832	800	780	832	832	686	686	832	825
Countries	47	52	50	52	52	52	51	51	52	52
Overdispersion test (p-value)	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Joint significance, per capita income (p-value)	0.038	0.033	0.000	0.194	0.268	0.128	0.636	0.623	0.171	0.144
Joint significance, regime type (p-value)	0.010	0.121	0.832	0.009	0.005	0.006	0.057	0.052	0.004	0.013
Log likelihood	-615	-761	-577	-672	-754	-753	-605	-605	-760	-747

Table shows incidence rate ratios for negative binomial regressions. All estimations include region and year dummies. z-statistics are showed in parentheses, and p-values are under z-values. Overdispersion test shows p-values for a likelihood ratio test comparing the estimated model to a Poisson model. Joint significance shows test statistics for per capita income variables and regime type variables. In Model 1 the sample is restricted to countries for which data on homicide rate is available. Model 2 includes population as an exposure variable. Model 3 includes country fixed effects. *** p<0.01, ** p<0.05, * p<0.1

Supplementary Information

Comprehensiveness of the Global Witness dataset

Global Witness reports and interviews with Global Witness staff by the authors stress that their dataset cannot be considered as exhaustive. Under-reporting is for example likely in Ethiopia (e.g. around 150 people would have been killed in conflicts over an agro-industrial and dam project – Gibe III - in the Lower Omo Valley, see Oakland Institute, 2013; at least 314 people would have been killed by security forces in the repression of Oromo protests triggered in 2015 by fears of land loss by farmers, see Human Rights Watch, 2016), Myanmar (e.g. a single project – the construction of the Kanbauk to Myaing Kalay a gas pipeline in a 'counter-insurgency' context, would have resulted in the killing of 107 people between 2002 and 2009, see HURFOM, 2009), and Venezuela (e.g. hundreds of small farmers and land settlers murdered following the 2001 land redistribution reform, see Romero, 2007; Ellist, 2011; Koerner, 2018). In addition, we note that there was no reported killing for Nigeria despite major conflicts over land and the environment, especially in the Niger Delta, likely in part due to the broader political agendas involved (e.g. Amnesty International (2016) documented the "extrajudicial executions and violence resulting in the deaths of at least 150 peaceful pro-Biafra protesters"). Furthermore, detailed national-level searches were not conducted for all countries and were limited to English, Spanish and Portuguese languages. Moreover, while "clear, proximate and documented connections to an environmental or land issues" is among the verification criteria (Global Witness, 2014: 23), a direct connection between a killing and a specific sector threatening land or environment is not always evidenced – notably for lack of independent judicial process. Finally, the period 2002-2011 was investigated more rapidly and with fewer resources than the more recent period, possibly leading to under-reporting.

We examined the relative comprehensiveness of the dataset in two ways. The first was to compare the databases of Frontline Defenders and the International Rangers Federation with that of Global Witness for the 2002-2018 periods. The Frontline Defenders Memorials database yielded 421 killings, for 'environmental rights', 'extractive industries/mega projects', and 'land rights', or a total of 585 when adding 'Afro Descendant rights', 'Indigenous rights' and 'Peasant communities'. Given that Global Witness directly draws from Frontline Defenders database and specifically verifies for the environmental and land dimensions of killings, we consider the former to be more precise and comprehensive. The International Rangers Federation's Roll of Honour records the deaths of rangers, worldwide, since 2009. The overall figure for 2009-2018 is 871, but only part of these deaths represents killings (e.g. from Aug 1st 2018 to July 31st 2019, 149 rangers died, 45 from killings by poachers, militia and other assailants, 51 died accidents, 27 from diseases and 23 from encounters with the animals they protect, see Willmore, 2019). A breakdown of the causes of deaths could not be obtained from the dataset holders, but the Global Witness database only reported 65 killings for the 2014-2018 period, suggesting a possible under-reporting. This provided a second rationale to exclude killings of wardens (through their association with poaching) from the cross-national analysis. The second was to search for unreported cases within African countries, a region recognized by Global Witness as likely to suffer from under-reporting, adding French as a search language. This identified 21 new potential cases for 2002-2018, 16 of which targeted park wardens, with 23 other cases that could not be directly linked to environmental or land issues (i.e. mostly journalists and human rights activists with broad areas of engagement in the DRC, and members of peri-urban 'shack-dwellers' organizations in South Africa). Outside Africa, cases not reported by GW include the death of Rémy Fraisse in 2014 during an anti-dam protest in France. Overall, worldwide detailed (sub)national searches relying on local languages, media and organizations would be necessary to achieve a more comprehensive global dataset; an endeavour beyond the scope of this study.

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[1] The term Environmental Human Rights Defenders (EHRD) is also used (e.g. Knox, 2017).
[2] According to Frontline Defenders (2019), "[o]f the 321 killings of HRDs reported to Front Line Defenders in 2018, 77% involved defenders working on land, environmental and Indigenous peoples' rights". The difference between Frontline Defenders' figure of 247 and Global Witness figure of 162, is mostly explained by killings linked to Indigenous rights not related to land or environmental issues, and stricter causal verification criteria by Global Witness.
[3] Interviews were conducted by the lead author with representatives from Global Witness, Human Rights Watch, ICCA Consortium, UN Special Rapporteur on Human Rights Defenders, as well as local defenders organizations from Brazil, Cambodia, Ecuador, Liberia, and Guatemala.
[4] This analysis is based on *all* cases reported in EJAtlas by 5 November 2019, 3% of which had ended by 2002.
[5] The STATA command *asinh* was used for the transformation. The transformation is similar to a log transformation, except that it also transfers the negative values. To limit the influence of the extreme values, many of the other covariates have been log-transferred as well using natural logarithm. For all log transformations, if the variable took the value of 0 for one or more observations, 0.0001 was added to the all values in order to avoid taking the log of zero (which is undefined).
[6] *Corruption* is the inverse measure of the dataset's variable Control for Corruption.
[7] We also added figures for Egypt and Iraq, bringing a total estimated number of Indigenous people at 453 millions in 67 countries, and entered a zero for all other countries to keep them in the sample (we note that the International Labour Organization would not release its own country-level estimate of 476 millions in 90 countries).
[8] Due to a large number of missing data, we interpolated values for *poverty* and *gini*.
[9] See for example, the series of reports in *The Guardian*, https://www.theguardian.com/environment/series/the-defenders
[10] Even this characterization can be problematic, however, as the impacts of 'traditional' activities depend on their scale, local contexts, and modes of operation. A large number of 'artisanal' miners operating in riverine areas and using mercury, for example, can harm the environment and human health (see Kitula, 2006).
[11] The EJAtlas documents "social conflict related to claims against perceived negative social or environmental impacts with the following criteria: 1) Economic activity or legislation with actual or potential negative environmental and social outcomes; 2) Claim and mobilization by environmental justice organization (s) that such harm occurred or is likely to occur as a result of that activity; 3) Reporting of that particular conflict in one or more media stories", see https://ejatlas.org/about.
[12] For the International Rangers Federation, see https://www.internationalrangers.org/roll-of-honour/); for Global Witness. see https://www.globalwitness.org/sv/campaigns/environmental-activists/), for Frontline Defenders, see (https://www.frontlinedefenders.org/en/human-rights-defender-memorial).
[13] Some conflicts are only associated with 'Indigenous peoples' (i.e. not with any specific sector), and several sectors can be involved in one killing.
[14] For illustrative purposes, all calculations for substantial impacts use the mean and standard deviation of the non-transformed variable as the starting point (see Appendix 1). For the

predictive count calculations, these values were transformed to the corresponding log-values using natural logarithm (asinh was used for FDI).

[15] See https://www.systemicpeace.org/polityproject.html