Demining, Development, and Dispossession*

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Abstract

Landmine clearance restores the productive value of contaminated land, promising economic development. However, clearance also sparks competition over the land where war has left ownership claims unclear. What happens to the land once it is demined and who captures the benefits? We address this question in Cambodia, historically one of the most mine-contaminated countries in the world, using a staggered difference-in-differences design on a commune panel from 1992 to 2014. Clearance raises the probability that a commune contains a large-scale land concession to more than five times its pre-clearance level, assigning the land to private companies. At the same time, local development gains as measured by nightlights are small. These averages hide two divergent outcomes, separated by how well local claims to the land were recorded by the time of clearance. Where records of possession are widespread, cleared communes light up by 4.7 percentage points and household consumption rises by roughly a third. Where they are rare, land concessions and disputes rise, while development and household consumption gains are close to zero. Post-conflict reconstruction that recovers land but not the records of who holds it risks dispossessing the communities who depend on it.

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1 Introduction

Landmines constrain the productive use of land long after conflicts end. Their removal therefore promises to generate substantial economic benefits, and demining is the focus of major post-conflict investment in countries such as Cambodia, Mozambique, and Colombia. On average, clearance increases productivity and improves access to markets and trade.[1] Yet the distribution of these benefits is *ex ante* unclear and may depend on who holds the rights to the land. By restoring the value of previously contaminated land, clearance can trigger competition over its control, particularly when armed conflict has left ownership claims unclear. This raises a central question: once land is cleared, who secures the right to use and benefit from it? Does the resulting "peace dividend" (Rohner and Thoenig, 2021) accrue to the local communities that depend on the land, or to other actors?

Cambodia provides an unusually informative setting to study this question because both landmine clearance and the subsequent allocation of land can be observed directly. Decades of conflict had left Cambodia among the world's most heavily mine-contaminated countries and without written records of land ownership. Much of the land was already occupied and cultivated by smallholder farmers, yet following the start of clearance operations in 1991, the government often transferred usage rights over large tracts to private companies through Economic Land Concessions (ELCs). Our granular data cover the timing and location of clearance operations and the boundaries of concessions, allowing us to trace how clearance reshapes the allocation of land and who benefits from its renewed productive value.

We estimate the effects of completed landmine clearances on an annual panel of all 1,621 Cambodian communes over 1992–2014 using a staggered difference-in-differences design.[2] We compare communes before and after clearance with communes that are not yet or never

[1] See Chiovelli et al. (2025) for evidence from Mozambique and Prem et al. (2025) for Colombia.

[2] Communes (*khum*) are the third administrative tier, below 194 districts (*srok*) and 24 provinces (*khett*, excluding the capital Phnom Penh).

cleared, using the imputation estimator of Borusyak et al. (2024), as in Chiovelli et al. (2025). We first show that clearance makes the land safe to work, measured by civilian victimization. We then examine how the land changes hands, tracking concessions, land conversion, land disputes, and migration, and whether these changes translate into development gains and for whom, measured by nightlights and household consumption.

We identify the effects of clearance under the assumption that its timing is unrelated to how land in a commune would otherwise have been allocated or developed. Two features of the institutional context make this plausible: clearance was funded almost entirely by international donors, and neither the early operators nor the planning system that followed them prioritized sites by the productive value of the land (Maxwell, 2001; Mine Action Review, 2016). Mines had not been laid at random, and unexploded ordnance is concentrated on fertile farmland (Lin, 2022), but commune fixed effects absorb mine placement and province-by-year fixed effects absorb broader patterns in removal.[3] Identification comes from differences in clearance timing across communes within a province, with those not yet or never cleared serving as controls. Consistent with this assumption, clearance timing is unrelated to initial economic conditions, pre-treatment estimates are flat, and placebo tests reveal no anticipation effects.

We first show that clearance makes land safer to use. The number of civilian mine victims falls by 93 percent, while the probability that a commune records any victim falls by 8.1 percentage points, equivalent to 39 percent of the pre-clearance mean.

Land that can be worked safely is also more valuable, making it more likely to be acquired by outside actors. Following demining, the government is significantly more likely to claim the land and allocate it to private companies through concessions. The probability that a commune contains a large-scale economic land concession increases by 3.8 percentage points

[3] Clearance operations do not distinguish between mines and unexploded ordnance, and neither do we. We call a commune mined when either is recorded.

on a 0.8 percent base. However, that land is often already occupied and cultivated by local smallholder farmers from local communities.

Whether this post-clearance land reallocation benefits local communities is *ex ante* unclear. Because concessionaires are typically large-scale agricultural enterprises and the existing local land users are predominantly smallholder farmers, such a transition could raise productivity and generate local benefits through wage employment, infrastructure investments, or other economic opportunities. However, fieldwork in two Cambodian villages suggests an alternative interpretation. Lin (2024) argues that, in the absence of formal land tenure, contamination effectively protected land from appropriation by outside elites. Clearing mines removes this barrier, causing local land users to lose access to land that they previously cultivated without receiving compensation. We refer to this process as dispossession. Whether clearance generates local gains through more productive land use or instead facilitates dispossession is ultimately an empirical question.

In contrast to the large effects of clearance on land concessions, we find only limited evidence that clearance improves local development outcomes on average. The probability that a commune exhibits any nightlight activity increases by 1.0 percentage point, but the estimate is not statistically significant. For comparison, using a similar specification, Chiovelli et al. (2025) find that clearance increases the same outcome by 6.2 percentage points in Mozambique.

Although these muted development effects are consistent with the dispossession hypothesis, they do not, on their own, provide evidence for it. Land reallocation and local economic outcomes are jointly determined following clearance, making it difficult to directly establish whether concessions come at the expense of local development.

We therefore test a key implication of the dispossession mechanism. If mine contamination shields local communities from losing control over land, then dispossession following

clearance should be most pronounced where communities lack alternative forms of protection, such as documented land claims. In such areas, clearance should be followed by greater concession expansion and more contestation over land access. By contrast, where communities possess documented claims, clearance should be less likely to trigger concession expansion and should yield more favorable local development outcomes.

To implement this test, we exploit local variation in the extent to which local land claims were recorded after the war. We measure claim documentation using letters of possession, which village and commune chiefs began issuing in 1989, two years before the first clearance operations and twelve years before the 2001 Land Law established the concession program we study. Documentation had to be rebuilt from scratch because private property had been abolished under the Khmer Rouge regime during the war. Although issued by local authorities rather than a formal registry, and therefore lacking the formal credit functions of registered titles (Van Acker, 1999; Diepart and Sem, 2018), letters served as evidence that a household occupied and farmed a parcel of land. Because the 2001 Land Law classified land without evidence of occupation as state land, and mines interrupted the cultivation on which occupation claims rested, a letter was typically the only record of a household's claim.

Consistent with the dispossession hypothesis, we find that the effects of clearance depend strongly on the extent of documented land claims.[4] In communes where letters of possession are rare, clearance is followed by substantial concession expansion but little evidence of local economic development. Land disputes increase by 4.6 percentage points, suggesting that the transfer of land is contested, while household consumption remains unchanged. In contrast, where documented claims are common, clearance produces little concession expansion and instead raises local development. The probability that a commune exhibits nightlight activity

[4] We measure documentation as the share of a commune's farming households holding letters of possession issued before 2002, and classify communes where that share is at least 33 percent as strongly documented, a cutoff that captures the top decile of the distribution. The differences in concessions and development keep their sign across alternative cutoffs.

rises by 4.7 percentage points, household consumption increases by roughly a third, and out-migration attributed to land loss falls.

A key concern is that documented land claims may capture broader differences across communes that influence how they respond to clearance. Our evidence provides little support for this interpretation. The issuance of letters predates most clearance operations and the concession program, and the prevalence of letters neither responds to clearance nor predicts minefield characteristics or the timing of clearance. Documentation also does not reflect household selection based on income, as households holding letters are no richer than those without them.

Any alternative explanation must also account for the full pattern we observe: concession expansion where documented claims are rare and development gains where they are common. Market access is the strongest candidate, as it is the main channel through which clearance raised development in Mozambique (Chiovelli et al., 2025). Yet we find that controlling for market access leaves both the average effects of clearance and the differences by documented claims unchanged. We also show that other explanations, including differences in operator effectiveness, land suitability, credit markets, and state capacity, cannot account for the full pattern we observe.

Our paper demonstrates that in Cambodia, mine clearance generates local development only when households can defend their claims to the land that clearance restores. This perspective contributes to a growing literature that finds substantial average returns to demining in Mozambique (Chiovelli et al., 2025), Colombia (Prem et al., 2025), Laos (Mehrotra, 2025), and Afghanistan (Baehr et al., 2026), and shows that mine contamination suppresses development for as long as it persists (Riaño and Valencia Caicedo, 2024; Lin, 2022; Lekfuangfu, 2022; Merrouche, 2011). While existing evidence establishes that clearance raises economic activity on average, much less is known about who receives these gains. Our contribution

thus lies in tracing both the allocation of land and the distribution of the resulting gains. More broadly, our findings indicate that clearance alone does not guarantee a peace dividend. Whether the benefits of recovered land reach local populations depends in part on the local institutions that govern and document land claims.

We also shed light on which aspects of property rights matter for securing the gains from post-conflict recovery. Our measure of documented claims, the letters of possession, separates functions that are typically bundled together in other forms of measurable property rights. Property rights can raise investment through tenure security, collateral, and gains from trade (Besley, 1995; Besley and Ghatak, 2010). Empirically, secure claims raise investment (Goldstein and Udry, 2008) and free up migration (de Janvry et al., 2015), and access rights improve productivity (Bühler, 2023). Formal titling adds collateral and transferability, yet where it raised investment and labor supply the evidence points to security rather than credit (Galiani and Schargrodsky, 2010; Field, 2007). Because titling often moves all three margins at once, existing evidence rarely varies protection on its own. Cambodia's letters of possession provide an opportunity to separate claim documentation from collateral. Issued by local authorities but never entered into the land registry, they document and protect incumbent claims without conferring the full collateral and transferability rights associated with formal titles. When demining restores the value of land, variation in these letters therefore allows us to examine the protective function of property rights separately from the other benefits that formal titles can provide.

Our study also speaks to the origins of land concessions, where the literature has mostly focused on their consequences (Lowes and Montero, 2021; Méndez and Van Patten, 2022). In Cambodia, concessions move workers into agricultural wage labor and reduce household spending (Anti, 2021). What determines which land receives a concession is less understood. Evidence that links weak tenure security to greater investor interest is at the cross-country

level (Arezki et al., 2015). In Liberia, agricultural concessions expanded where private titles made claims legible, because investors who can identify a titleholder need not negotiate with customary authorities over undocumented land (Christensen et al., 2021). Documentation works the opposite way in Cambodia, where land without a documented claim is state land and can be allocated as a concession. Fieldwork there argues that contamination itself protected land where formal rights were absent (Lin, 2024). We provide systematic evidence that once the mines are gone, that protection passes to documented claims.

2 Background

2.1 Conflict and Landmine Contamination

Cambodia's recent decades of conflict began in the late 1960s with a large-scale US bombing campaign and a mounting rural insurgency. The civil war that followed ended in 1975 with the victory of the Khmer Rouge, whose genocidal regime forced most of the population into collective agricultural labor (Chandler, 2018). Between a fifth and a quarter of the population perished during the regime's four years (Chandler, 2018; Bennett, 2015; Yimsut, 2011).

In 1979, Vietnamese forces overthrew the Khmer Rouge, and remnants of the regime fought on from the border regions for two more decades, a war in which every party laid mines (Kingdom of Cambodia, 2009; International Campaign to Ban Landmines, 2004; Slocomb, 2001). The government sealed the Thai border against infiltration with the K5 barrage, a fortified and mined belt along 829 kilometers of the frontier that absorbed almost 400,000 mines in its first construction season alone (Slocomb, 2001). Year after year, combatants laid defensive perimeters as they retreated to safer ground (Kingdom of Cambodia, 2009). By 1992, the conflict had largely subsided, and the country came under the United Nations Transitional Authority in Cambodia (UNTAC). The mines stayed in the ground, and the

suspicion of contamination alone was often enough to keep land out of safe use long after the fighting ended (Kingdom of Cambodia, 2009).

2.2 Landmine Clearance

Clearance began around the UNTAC transition, funded almost entirely by international donations, and UNTAC identified more than 1,900 potentially contaminated areas (Maxwell, 2001). The Supreme National Council established the Cambodian Mine Action Centre (CMAC) in June 1992, and UNTAC stood up a separate Mine Clearance Training Unit the following month (Geneva International Centre for Humanitarian Demining, 2016). The HALO Trust had started clearing in October 1991, and the Mines Advisory Group (MAG) followed in 1992 (Maxwell, 2001). By 2010, the last year in which clearance is recorded, clearance had reached more than 500 communes across every province (Figure 1).[5]

In the early years, demining was an emergency humanitarian response, with operators choosing sites by the urgency of the threat and their technical accessibility (Geneva International Centre for Humanitarian Demining, 2016; Maxwell, 2001). The government then formalized planning, establishing the Cambodian Mine Action and Victim Assistance Authority (CMAA) in September 2000 (Mine Action Review, 2016) and assigning annual planning to provincial bodies by a 2004 sub-decree (Royal Government of Cambodia, 2004). Under this system, the CMAA identified priority communes nationally on the basis of casualty data. Mine Action Planning Units then prepared annual task lists in several provinces, and Provincial Mine Action Committees reviewed and approved them together with the CMAA (Mine Action Review, 2016; Geneva International Centre for Humanitarian Demining, 2016).[6] Both the early operators and the planning system that followed them ranked

[5] Section H.1 details the organizations involved and the evolution of the program.

[6] The first goal of the National Mine Action Strategy 2010–2019 is to "reduce Mine/ERW [explosive remnants of war] casualties and other negative impacts," and its first sub-objective is to "allocate demining assets to

sites on casualties, threat and accessibility (Maxwell, 2001; Geneva International Centre for Humanitarian Demining, 2016; Mine Action Review, 2016). Socio-economic criteria did enter the later planning framework, but they governed what cleared land was designated for rather than which land was cleared first (Royal Government of Cambodia, 2004, 2010).

2.3 Post-Conflict Land and the Institutional Environment

The land the operators cleared returned to an administrative vacuum. Even before the war, formal ownership title had reached only about a tenth of the country. The French had introduced private ownership and a cadastre under the protectorate, but elsewhere a claim rested on clearing and working the plot, recognized locally and certified by the commune chief (Diepart and Sem, 2018). The Khmer Rouge then abolished property of every kind, stopped cadastral administration and titling, and destroyed the records (Lor, 2003; Diepart and Sem, 2015).

Into this vacuum the state reopened private landholding in 1989, granting ownership of residential land but only possession of agricultural land, which could revert to the state if the land was not occupied (Diepart, 2015; Van Acker, 1999). The accompanying registration campaign quickly outran the administration's capacity to survey and record claims (Van Acker, 1999). Many rural households therefore ended the process with a letter of possession issued by village or commune authority rather than a registered title. Systematic state-run titling arrived only after the 2001 Land Law, beginning in 2002 (Biddulph, 2014).

The 2001 Land Law reset the legal ground on which these claims stood. It refused recognition to ownership regimes predating 1979 and vested in the state the ownership of

the most impacted areas" (Royal Government of Cambodia, 2010). CMAA annual directives came to require that operators allocate at least 75 percent of mine-action assets to a list of roughly 160 designated priority communes (Geneva International Centre for Humanitarian Demining, 2016; International Campaign to Ban Landmines, 2013).

land that had not been duly appropriated privately or was not presently being privately occupied (National Assembly of Cambodia, 2001). At the same time, it made qualifying possession itself a property right, provided occupation had begun before the law came into force and was held openly, peacefully, and continuously.

Where qualifying possession could not be established, the land was state land under the 2001 Land Law. This made documentation especially consequential where mines had interrupted occupation and cultivation: contamination could leave households unable to demonstrate the continuous use on which their claims rested. State land could then be classified as state private land and, once so classified, allocated to private companies.

Economic Land Concessions (ELCs) were the instrument through which the state made such allocations. The 2001 Land Law established their legal framework, granting private companies development rights over blocks of up to 10,000 hectares, with the stated aims of developing idle land, stimulating rural agricultural and industrial activity, and generating employment (Diepart and Schoenberger, 2016; National Assembly of Cambodia, 2001). Local communities frequently contested official claims that concession land was idle or degraded, and documented cases show that concessions displaced existing users, sometimes without adequate compensation (United Nations Cambodia Office of the High Commissioner for Human Rights, 2007; Neef et al., 2013). Figure 2 summarizes the timing of these institutions relative to conflict, mine clearance, and our estimation period.

This framework determines who can control land once clearance makes it accessible again. Where incumbents could document possession, they constrained the state's ability to classify the land as available; where they could not, clearance could turn previously inaccessible land into land the state could allocate. Appendix H provides additional institutional detail on landmine clearance, letters of possession, and Economic Land Concessions.

3 Data

We assemble a yearly panel of all 1,621 Cambodian communes from 1992 to 2014, the window over which our main outcomes are consistently observed. Unless noted otherwise, every source below enters the panel at this commune-year resolution, aggregated on 2014 administrative boundaries (earlier boundaries are not available). Coverage varies across sources and across communes, so the estimation panel is unbalanced for some other outcomes.[7] Each table reports the sample its own outcome supports. Table 1 reports summary statistics. Appendix I outlines the construction details for key variables. Table I.1 defines every variable that enters a table or figure and names its source.

Clearance. Records of landmine clearance operations come from the Cambodian Mine Action Centre and the HALO Trust, accessed through the Open Development Cambodia project. The records cover all operations between 1992 and 2010, including start and end dates, locations, and areas cleared.[8] From them we identify the 551 communes with a recorded minefield and date the year in which each commune's mined area was fully cleared, the treatment in Section 4.[9]

Main outcomes. We obtain geo-coded records of Economic Land Concessions from the Open Development Cambodia project. The records list each concession's date, location, operator, and size. We count official ELCs granted after the 2001 Land Law.[10] By 2014, a concession is present in 229 of the 1,621 communes in our panel.

[7] Coverage is limited for some secondary outcomes due to data availability: victimization enters from 1997 to 2013, household outcomes from 1999 to 2014, land cover from 2000 to 2010, and market access to 2010.

[8] A commune cleared after 2010 would enter the comparison group as untreated, which would bias the estimated effects toward zero rather than away from it.

[9] The clearance records do not distinguish mines from unexploded ordnance, so a recorded minefield can contain either. Both keep land out of safe use, and we treat them as interchangeable.

[10] Some earlier grants exist but are not directly comparable.

We measure local development with nightlights, a standard proxy for economic activity in the development literature (Gibson et al., 2021), including the literature on demining (Chiovelli et al., 2025; Prem et al., 2025).[11] We take the harmonized DMSP series of Li et al. (2020) and correct it for blooming and top-coding following Chiovelli et al. (2026). Our preferred outcome is an indicator for any nightlights.[12] Log nightlights complement the indicator on the intensive margin.

Secondary outcomes. Casualty records come from the Office for the Coordination of Humanitarian Affairs (OCHA) and from the Cambodia Mine/ERW Victim Information System (CMVIS), and cover all recorded incidents since 1979. Because casualties among soldiers and deminers reflect operational exposure that can rise mechanically with clearance activity, our outcome counts civilian victims only. We classify each casualty by an occupation-primary, land-use-fallback rule, set out in Appendix I. The occupation field is unusable before 1997, so victimization regressions begin in 1997; the land-use fallback classification is available to the end of the casualty records in 2013.

Data on land disputes come from the NGO Forum on Cambodia, whose records document each dispute's location, year, and cause. The records place 231 disputes in 179 of our sample communes between 1992 and 2014.

Land use comes from two satellite sources. Forest cover is the minimum normalized difference vegetation index (NDVI) in a commune and year, computed from NASA's MODIS imagery for 2000 to 2010. The minimum captures whether any part of the commune experienced near-complete vegetation loss, the pattern consistent with large-scale land clearing.

[11] Seven communes show no nightlights in any year and are omitted from the sample, so the estimation panel covers 1,614 communes, 544 of them mined.

[12] The indicator equals one when a commune's mean corrected luminosity in a year exceeds the 33rd percentile of the distribution of positive luminosity values, so the dimmest third of lit commune-years count as unlit. The results are not sensitive to this threshold (Figure C.1). See the data appendix for further details.

The areas under crops and rubber come from the Regional Land Cover Monitoring System (RLCMS) of the SERVIR-Mekong program, which classifies land cover yearly and which we use for 2000 to 2010 (Saah et al., 2020). We exclude rice, which is grown throughout the country and does not mark commercial conversion.

Household outcomes come from the Cambodia Socio-Economic Survey (CSES), a nationally representative repeated cross-section with ten waves between 1999 and 2014. We use household consumption expenditure, averaged to commune-wave means, which yields 3,374 observations across 985 communes. Migration comes from the records of the 2008 population census, which report each migrant's previous district and duration of stay in completed years. We reconstruct a district-by-year panel of departures from these.

Letters of possession. The 2013 Agricultural Census records whether each farming household holds a letter of possession issued before 2002 (Figure A.1). Section 6.1 constructs our measure of documented claims from these records and presents the design it enters.

Other variables. Pre-existing commune characteristics complete the data. The controls of Section 4 comprise commune coordinates, US bombing loads, distances to the nearest road and to the provincial capital, pre-Khmer Rouge population, and soil fertility. Other auxiliary variables used in our analysis, and their sources, are listed in Table I.1.

4 Empirical Strategy

4.1 Specification

Following Chiovelli et al. (2025) and Prem et al. (2025), we estimate the effects of clearance with a staggered difference-in-differences design in which treatment is completed clearance,

comparing communes before and after they are fully cleared with communes that are not yet cleared and communes that were never mined or cleared:

$$Y_{ct} = \delta\, C_{ct} + X_c'\theta_t + \mu_c + \gamma_p \times \tau_t + \varepsilon_{ct}, \tag{1}$$

where Y_{ct} is an outcome in commune c and year t, C_{ct} indicates that commune c has been fully cleared by year t, μ_c are commune fixed effects, $\gamma_p \times \tau_t$ are province-by-year fixed effects, and $X_c'\theta_t$ interacts pre-existing commune characteristics with year fixed effects.[13] The coefficient δ measures the average effect of completed clearance on the outcome. Standard errors are clustered at the commune level. The panel excludes years in which clearance is underway, removing 2,627 out of 37,122 commune-years.

Commune fixed effects absorb every level difference across communes, and province-by-year fixed effects absorb the provincial clearance schedule. Within-province differences in the timing of clearance therefore identify δ. The interacted controls let communes with different pre-existing characteristics follow different trends. We interact year fixed effects with commune latitude, longitude, and their product, with US bombing loads, with distance to the nearest road and to the provincial capital, with pre-Khmer Rouge population, and with soil fertility, in logs where applicable. Over the 1992–2014 sample period the comparison group pools communes that were never mined with mined communes that are not yet cleared, as in Chiovelli et al. (2025) and Prem et al. (2025).[14]

We estimate Equation (1) with the difference-in-differences imputation (DDI) estimator

[13] We estimate at the commune because commune characteristics and household outcomes are measured there. Estimated instead on a regular grid of 10 km cells, each dated by its own last minefield, the average effects are unchanged. Results are available on request.

[14] Whether a commune was ever mined or ever cleared is not part of the identifying variation. Commune fixed effects absorb it, so each commune enters δ only through the change in its own outcomes around the year its clearance completes, and selection would have to work on when a commune was cleared rather than on whether it was. Section 4.2 states that requirement, and the event studies and anticipation placebos of Section 5 test it.

of Borusyak et al. (2024). A conventional two-way fixed effects regression would use communes cleared early as controls for communes cleared later (Goodman-Bacon, 2021). In our setting this comparison is biased, because the returns to clearance accumulate over years. A commune cleared early is still developing while it serves as a control, and subtracting its growth understates the effect for communes cleared later. The imputation estimator never makes this comparison, building the counterfactual for every cleared commune from communes not yet cleared and communes never mined.[15] Two diagnostics accompany each outcome table in Section 5. An event-study generalization of Equation (1) traces the estimated effect year by year around clearance, and an anticipation placebo assigns treatment six years before the actual clearance year and should find no effect (Borusyak et al., 2024).

4.2 Identification Assumptions

Identification requires that, conditional on commune and province-by-year fixed effects and controls, the timing of clearance is unrelated to how a commune's outcomes would otherwise have evolved. If communes with greater economic potential were cleared first, reallocation or development of the land that would have occurred regardless would be attributed to clearance. Identification also requires that outcomes not change in anticipation of clearance.

Two features of Cambodia's clearance program make this plausible, as Section 2 documents. First, international donors funded clearance almost entirely, so its budget did not depend on what the cleared land would earn. Second, sites were ranked on casualties and accessibility, rather than the economic potential of the land.

The central threat to this assumption is placement, which ties contamination to the value of land through two channels. Combatants laid mines along border belts, roads, and defensive

[15] The average effects do not depend on this choice. Table B.1 re-estimates them with the group-time estimator of Callaway and Sant'Anna (2021), the interaction-weighted event study of Sun and Abraham (2021), the intertemporal estimator of de Chaisemartin and D'Haultfœuille (2026), and two-way fixed effects.

perimeters, so minefields sit on land of strategic value (Section 2). The impact fuses of US bombs had higher failure rates on soft, fertile ground, so unexploded ordnance concentrates on the most fertile farmland (Lin, 2022).

To avoid comparing communes with different strategic value or fertility, we never compare mined with unmined communes in levels. Commune fixed effects absorb landmine placement and province-by-year fixed effects absorb the planning schedule of their removal. The CMAA, the national mine-action authority, identified priority communes from casualty data, and provincial bodies prepared and approved the annual task lists (Section 2), so what decided when a site was cleared varied by province and year. Lastly, we account for the selection Lin (2022) documents by interacting bomb loads and soil fertility with year effects, which lets communes with heavier bombing or better soil trend differently in every year. With all three sources accounted for, identification requires only that the timing of clearance within a province is unrelated to how a commune's outcomes would otherwise have evolved.

The state that granted concessions also set clearance priorities, so clearance could have been directed at land already earmarked for reallocation. Were that so, concessions would rise before a commune's clearance completes, and the anticipation placebos of Section 5 would not be flat or decreasing immediately before clearance.

We provide two additional pieces of evidence that support our identification strategy. First, the assignment and timing of clearance are balanced with respect to initial conditions. Neither 1992 nightlights nor soil fertility predicts whether a commune was cleared, or whether it was cleared early or late (Figure A.2). Second, the event studies and placebos we report alongside the results in Section 5 show that there are no differential dynamics before clearance, as the parallel trends and no anticipation assumptions require.

5 Average Effects of Clearance

5.1 Mine Victims

We begin by examining whether clearance makes working and living on the land safer. This is a prerequisite for interpreting the effects of clearance on our two main outcomes of interest, land reallocation and development. Reducing the use risk of land unlocks its economic value and therefore makes it worth acquiring and developing. Civilian victimization serves as a useful proxy for land use risk because farmers are the largest group of mine victims and schoolchildren the second (Figure A.3).

We find that after clearance, the probability that a commune records any civilian victim falls by 8.1 percentage points (Column 2 of Table 2), a reduction of 39 percent relative to the pre-treatment mean among communes with minefields. We record 1.06 fewer civilian victims per commune-year, a reduction of 93 percent of the pre-treatment mean (Column 4), and the log count falls by 0.18 log points (Column 6). Interacting pre-existing commune characteristics with year fixed effects changes these estimates little.

Two mechanisms link victimization to the land's value and development potential. First, clearance reduces mine-related accidents and makes cleared land safer to use and work. Second, because schoolchildren are the second-largest victim group, the reduction in victimization also protects human capital.[16] Our estimated reductions are sizeable and suggest that mines had kept a substantial amount of land out of safe use.

Given that operators ranked sites partly on casualty rates (Section 2), a main concern is that the timing of clearance was itself driven by victimization trends. If clearance timing tracked victimization rather than causing its decline, victimization should already be falling

[16] In Cambodia, perceived mine risk depresses schooling investment (Lekfuangfu, 2022), and in Colombia schooling improves once demining removes that risk (Prem et al., 2025).

in the years before clearance completes. Instead, event-study coefficients over those years are flat, and a joint test of the pre-treatment coefficients does not reject zero ($p = 0.186$; Figure 3, victimization row, left panel). An anticipation placebo that assigns treatment six years before actual clearance likewise finds no effect (victimization row, right panel).

5.2 Reallocation: Economic Land Concessions

Clearance raises the value of the land by restoring its economic potential. This makes the land worth claiming and opens up the possibility of large-scale reallocation. In Cambodia, the state's instrument for allocating land at scale is the Economic Land Concession (ELC), the granting of state land to private companies.[17]

The 2001 Land Law codified the ELC program with the stated purpose of putting unused land to productive use (National Assembly of Cambodia, 2001; Diepart and Schoenberger, 2016). In practice, the same legal machinery allowed land that clearance made accessible and valuable to be reclassified as state property and allocated to concession holders, while the land was often already occupied by smallholder farmers (Lin, 2024; Diepart and Schoenberger, 2016).

We find that once clearance completes, the probability that a commune contains an ELC rises by 3.8 percentage points (Column 2 of Table 3), to more than five times its pre-clearance level. The area covered by these concessions rises by 0.70 log points (Column 4). Estimates of this size, essentially unchanged by the interacted controls, suggest that the state reallocates recovered land at a substantial scale once clearance makes it accessible.

Because every specification includes province-by-year fixed effects, these estimates do not reflect the countrywide growth of the concession program but show concessions being established in cleared communes ahead of uncleared communes in the same province and

[17] Before clearance, only 0.8 percent of minefield communes contained a concession in a given year (Table 3).

year (Figure 3, concession row). Event-study coefficients before clearance are flat, and a joint test of them does not reject zero ($p = 0.383$; Figure 3, concession row, left panel). An anticipation placebo that assigns treatment six years before actual clearance likewise finds no systematic pattern (concession row, right panel).[18]

5.3 Development or Dispossession?

Whether such reallocation leads to local development and benefits for the population in the communes is *ex ante* ambiguous. Concessionaires are typically large-scale commercial agriculture operations and in theory more productive than local smallholder farmers, who make up the majority of existing tenants in most communes. The reallocation we observe following clearance could thus bring efficiency gains, and local communities could benefit from economic opportunities such as wage employment and transfers, which in turn could spur further development.

Previous fieldwork instead suggests that concessions reflect uncompensated dispossession of existing tenants and bring few benefits to local communities. Based on two dozen interviews in Ratanakiri province, Lin (2024) argues that ELCs take land away from existing smallholder farmers with weakly documented holdings. Lin argues that in the absence of formal land rights, contamination itself protected land from being claimed by outside elites and that clearance removes that protection for local farmers who depend on the land. In her and others' readings (Diepart and Schoenberger, 2016), concessions are associated with resource extraction, while any benefits primarily accrue outside the local communes.

Which outcome dominates on average, development or dispossession, is ultimately an empirical question.

[18] Section 4.2 addresses the concern that clearance favored land with higher development potential, and finds no evidence that clearance or its timing was associated with initial economic conditions or soil fertility.

5.4 Economic Development: Nightlights

In contrast to the large effects on reallocation, clearance raises local economic activity relatively modestly (Table 4). The probability that a commune shows any light rises by 1.7 percentage points from a base of 5 percent, and by 1.0 points once pre-existing commune characteristics are interacted with year fixed effects (Columns 1 and 2). Neither estimate is statistically distinguishable from zero, and the estimate is not sensitive to the luminosity threshold that defines a lit commune (Figure C.1). Log nightlights rise by 0.24 log points without the interacted controls and by 0.17 with them (Columns 3 and 4). These effects are small in absolute terms given how rarely communes registered any nightlights before clearance.

The estimated increase in nightlights following clearance is also considerably smaller than in other contexts. Clearance raised the share of lit localities by 6.2 percentage points in Mozambique, more than five percentage points above Cambodia (Chiovelli et al., 2025).[19]

Part of that response could be trade passing through the commune, i.e. indirect effects, rather than direct activity on the land clearance returned to use (Chiovelli et al., 2025). To account for these indirect effects, we report estimates that condition on pre-clearance market access (Table D.1), which shifts the baseline estimates only slightly. Next, adding contemporaneous market access as a mediator reduces the any-lights effect from 1.8 to 1.2 percentage points and log nightlights from 0.225 to 0.169 log points (Table D.1). Trade therefore makes up at most a third of the any-lights estimate and a quarter of the log estimate.[20] The concession estimates do not move when contemporaneous market access enters, so the

[19] The comparison holds the specification fixed, since their estimate conditions on location and geographic controls interacted with year and on province-year fixed effects, as ours does. Mozambican contaminated localities also start from a comparably low base, 6.8 percent lit in 1992 (Chiovelli et al., 2025), so the smaller Cambodian response does not reflect a darker starting point.

[20] See Section D.1 for details on the index construction following Chiovelli et al. (2025), Table D.2 for the effect of clearance on market access itself, and Section D.2 for the two roles market access plays in the specification and the column-by-column comparison.

reallocation of land did not run through trade (Table D.1, Columns 1–4).

Clearance might also have gone first to communes already on a rising path, in which case the estimate would capture that trend rather than the clearance. Yet, event-study coefficients in the years before clearance are flat, and a joint test of them does not reject zero ($p = 0.630$; Figure 3, nightlights row, left panel). An anticipation placebo that assigns treatment six years before the actual clearance year likewise finds no effect (nightlights row, right panel), so communes did not respond in advance of clearance. The effects we measure are therefore a response to clearance rather than a continuation of trends already underway.

Taken together, the large effects of clearance on ELCs and the comparatively small effects on nightlights are consistent with dispossession over development.[21] However, the evidence is not conclusive by itself. Because both concessions and nightlights are jointly determined by clearance, we cannot directly test whether local development is worse under reallocation. Nor do we observe counterfactual development under clearance without reallocation. We therefore next examine which of the two interpretations dominates by testing a key implication of the dispossession hypothesis and analyzing additional outcomes.

6 Documented Claims and the Returns to Clearance

If landmines provide protection from dispossession, reallocation after their clearance should be contested, and concentrated in communes that do not have documented land claims. In contrast, communities that do have other forms of protection should be no more likely to have concessions, and see better development outcomes following clearance. We test this hypothesis by examining whether the effects of clearance on land concessions and nightlights

[21] The pattern holds under four alternative specifications: controlling for time-varying market access, aggregating the outcome to the district so that within-district displacement nets out, absorbing high-letters-by-year trends, and dropping the communes cleared over the longest spans (Table C.1).

diverge by the strength of existing land claims, and by examining additional outcomes, including land disputes, household consumption, migration, and land use.

6.1 Measuring Documented Claims

We measure documented land claims using the letters of possession introduced in Section 2. Village and commune chiefs began issuing these letters in 1989, two years before the first clearance operations began and twelve years before the 2001 Land Law established the large-scale land concessions we measure. Recognition rested with local chiefs rather than a registry. Possession claims were traded and inherited, but could not be mortgaged at the Land Office, so they lacked a registered title's collateral value (Van Acker, 1999; Diepart and Sem, 2018).

A letter of possession is a document in which the village or commune chief recognizes a household's occupancy of a specific plot, the local record of a land claim in a country where no cadastre survived the war (Diepart and Sem, 2018; Grimsditch and Henderson, 2009). With no cadastre to consult, the state only encounters these local records when it allocates land. A concession can be granted only on land registered as state private land, and that classification presupposes no recognized private claim (National Assembly of Cambodia, 2001; Royal Government of Cambodia, 2005). A commune's stock of letters therefore limits how much of its land the state can classify as its own and grant to other parties.[22]

We measure a commune's documented claims from the 2013 Agricultural Census as the share of its farming households holding letters of possession issued before 2002, and thus before the systematic titling that followed the 2001 Land Law. The census was taken after the clearances we observe, so this share counts the letters households still held in 2013 rather than a register compiled in 2001. However, it records that the certificate predates the 2002

[22] That limit is statutory, and possession rights in Cambodia are enforced unevenly in practice (Rudi et al., 2014). Whether the letters in fact obstructed reallocation is therefore an empirical question.

Land Law, the same law that opened undocumented land to concessions. Clearance could still have changed who was left to count by 2013. We show below that it did not, so the split turns on documentation rather than on when a commune was cleared. We classify communes where that share is at least 33 percent as having a high share of letters and the rest as having a low share of letters, the labels under which the two groups appear in every table.

Documentation was relatively rare as the median commune holds letters for under one percent of its farming households, and the 33 percent cutoff selects the top decile of communes. We choose this cutoff as the baseline because a lower cutoff would count communes holding only a handful of letters as documented, and a higher one would leave too few communes to estimate a separate effect. Nevertheless, the results that follow keep their sign across alternative cutoffs. We estimate two group-specific effects rather than a coefficient on a continuous interaction because the imputation estimator identifies average effects of clearance on the treated communes in each group, not an interaction parameter (Borusyak et al., 2024).

6.2 Empirical Strategy

To estimate how concessions and the returns to clearance divide across communes based on their documented claims, we extend Equation (1) by a single interaction:

$$Y_{ct} = \delta_1 \left(C_{ct} \times \mathbb{1}\{S_c = 1\}\right) + \delta_2 \left(C_{ct} \times \mathbb{1}\{S_c = 0\}\right) + X_c'\theta_t + \mu_c + \gamma_p \times \tau_t + \varepsilon_{ct}, \qquad (2)$$

where $\mathbb{1}\{S_c = 1\}$ indicates a commune with a high share of letters. The fixed effects, the interacted controls, the imputation estimator, and the clustering all carry over unchanged from Section 4. The coefficients δ_1 and δ_2 measure the effect of completed clearance in communes where letters are common and where they are rare, respectively.

The untreated counterfactual is imputed once, from all not-yet-cleared and never-mined

communes, so the two coefficients differ only in which cleared communes they average over. Because each effect averages over its own set of cleared communes, their difference is identified by comparisons across communes rather than by the within-commune timing that identifies the effects of clearance themselves (Borusyak et al., 2024). We report the two effects side by side, and the last row of each table gives the p-value on their difference.

The coefficients δ_1 and δ_2 identify the role of documented land claims under two conditions. The letters share that assigns communes to the two groups must not respond to clearance itself, and no other commune trait may both correlate with the share and shape outcomes on its own. On the first condition, issuance began with the 1989 registration drive, two years before the first clearance operations and twelve years before the 2001 Land Law that codified the concession program (Figure 2), and the split uses only the stock of letters issued before 2002.[23] Clearance and documentation were also administered by different actors. Provincial authorities and operators ranked sites for clearance (Section 4.2), and the national priority list rested on casualty data rather than on local documentation. Neither fact rules out that clearance and documentation evolved together after 1992, or that clearance changed which households remained to be counted in 2013, so we test independence in both directions. Conditional on province fixed effects and the commune controls, the high-letters indicator predicts neither the characteristics of minefields nor the timing of their clearance, and the clearance measures entered jointly do not predict that indicator (Table E.1).

The second condition fails if the letters share stands in for some other commune trait that raises concessions or development on its own. A high share could mean that village and commune chiefs completed more of the documentation their residents sought, or it could mark state capacity, a commune's economic activity in 1992, or the value of the land. Land value is a particular concern because contamination was not located at random. Unexploded

[23] The average commune finished clearance in 2006, four years after the cutoff.

ordnance concentrates on the most fertile farmland (Section 4.2). If letters were also more common on fertile ground, larger gains in high-letters communes would reflect more valuable land returning to use rather than better-documented claims to it. Each reading predicts a correlation, and Figure E.1 shows that the letters share rises with proxies for state capacity but is unrelated both to nightlights in 1992 and to the land-value index. The administration that the capacity proxies measure is the same as the one that completed the letters, which is why the two move together. Capacity does not substitute for documentation, however (see the discussion in Section 6.6).

The letters track what local authorities managed to complete rather than what households demanded. When the government reopened private landholding in 1989 and asked households to register their land, 4.2 million demands were lodged within months, and by 1995 the cadastral administration had issued only 448,678 certificates (Van Acker, 1999). Demand was close to universal and local variation in the letters was driven instead by the local capacity of an administration whose records the Khmer Rouge had destroyed (Section 2). That administration also made registration expensive. A file passed through a chain of some nine signatures, from local to national level (Van Acker, 1999). The official fee was five dollars a plot, but the payment demanded at each step could bring the real cost to three or four hundred dollars (Diepart and Sem, 2018). The letters we measure are the paper of that chain's first stage, issued where a chief gave a household its own record of the attestation the district office required (Diepart, 2015).

The measure could also fail if households whose claims the registration process completed were wealthier farmers on better land. Figure E.2 tests for these differences in two steps, first comparing letter-holding households with undocumented households within the same commune, and then relating the commune averages of the same characteristics to the letters share, conditional on province fixed effects and the full control set. Holding area, parcel size,

livestock, and a composite wealth index show no differences across communes, and those estimates barely move when the controls enter. Within communes, letter holders are very slightly better off, by 0.013 to 0.053 standard deviations on holding area, livestock, and the wealth index.[24]

6.3 Effects of Clearance by Documented Claims

Figure 4 shows that the effects of clearance differ between communes where documented claims are common and communes where they are rare. First, clearance leads to large-scale reallocation of land only where few claims are documented. The probability that a commune contains any concession rises by 4.1 percentage points where letters are rare, against a small and insignificant rise where letters are common. Where few documented claims stand in the way, clearance moves the land from the existing local tenants to commercial operations.[25] Table F.1 reports the corresponding coefficients, with the p-value on the difference between the two groups in its last row.

The commune aggregates show the land changing hands, not whether the people who occupied it agreed to the transfer or were paid for it. Where cleared land goes to concession-holders over the claims of existing users, the allocation should be contested, and concessions are the leading recorded cause of land disputes (Figure H.1). Contestation appears only where claims are undocumented. The probability that a commune has a recorded land dispute rises by 4.6 percentage points where letters are rare, against 0.1 points where claims are documented (Figure 5 and Table F.3). This is inconsistent with voluntary market transactions between

[24] The wealth index is unit-appropriate on each margin. Within communes it sums within-commune z-scores of holding area, livestock, and tree crops. Across communes it standardizes the sum of commune-mean levels. Weights are equal.

[25] A conventional two-way fixed effects regression on concessions and nightlights that interacts clearance with the letters measure is shown in Table F.5. Since that specification uses communes cleared earlier as controls for communes cleared later, its estimates are biased when returns accumulate over years (Goodman-Bacon, 2021; Borusyak et al., 2024).

existing occupiers and concessionaires.

Second, clearance delivers visible development only where a large share of farmers' prior claims to the land are documented (Figure 4). The probability that a commune shows any nightlights rises with clearance by 4.7 percentage points where the share of letters is high, and by only 0.7 where it is low. Where claims are undocumented, neither the probability of observing nightlights nor log nightlights is statistically distinguishable from zero. The average payoff reported in Section 5.4 is therefore a composite of these two responses.

The Cambodia Socio-Economic Survey observes households directly, so it can say whether they were compensated or profit from other economic opportunities following clearance. Household consumption rises by 47.7 thousand riel where letters are common, roughly a third of the 149-thousand-riel pre-treatment mean in the estimation sample, but does not move where they are rare (Figure 5). Where claims are undocumented, the land changes hands, the transfer is contested, and households are no better off.

The flat consumption response need not mean that households lost out. Concessions are long-horizon investments, and a rubber plantation established after clearance may not yield measurable output inside the window we observe, so a null could record a gestation period rather than a transfer.[26] If the concessions were merely immature, the land itself would show little activity. Yet, where letters are rare the area under crops rises by 0.09 log points and the area under rubber by 0.02, while forest cover falls (Figure 5). Where claims are documented, none of the three margins moves. The land is therefore in production while the households that worked it are no better off.

Households in these communes might still be leaving for opportunity rather than losing access, since a commune whose land is converting to plantation could be exporting labor to the growing cities. The reasons households give for moving distinguish between the two.

[26] A typical rubber tree produces latex within five to seven years (Food and Agriculture Organization of the United Nations, 2001).

The 2008 census records, for every person who moved, the previous district, the years since the move, and the reason for it.[27] Out-migration attributed to lost land falls with clearance by 0.17 log points in communes with a high share of letters (Figure 5).

Across these outcomes, the consequences of clearance diverge along documented claims. Where claims are documented, out-migration attributed to lost land falls, cleared communes light up, and households consume more. Where claims are undocumented, concessions arrive and are contested, and land converts to cropland while forest cover falls. If concessions consolidated idle land, their consequences should not depend on whether prior claims are documented. That concessions, contestation, and conversion concentrate where claims are undocumented is evidence consistent with dispossession.

6.4 Robustness

Our finding that reallocation and development diverge along documented claims is robust to alternative measurement choices, sample splits, and regression specifications.

Cutoff. Since we split communes at a threshold, the choice of that threshold may affect our results. Our results are stable in sign across alternative letters cutoffs (Figure E.3): High share communes have fewer ELCs and more nightlights at every cutoff.

Trade gains. Market access was the channel through which clearance raised development in Mozambique (Chiovelli et al., 2025) and Colombia (Prem et al., 2025), so trade passing through rather than the land itself could explain the response here. That account requires the market-access gain to carry the letters difference. Controlling for market access leaves the

[27] These records yield a district-by-year panel of out-migration by reason. Only migrants who survive to 2008 are observed, which attenuates early departures, and the panel ends with the census year. Standard errors are clustered at the district level because the outcome varies at the district-by-year level.

split on any lights at 4.4 against 0.8 percentage points, and the same pattern holds when the outcome is aggregated to districts, when trends are allowed to diverge by high letters, and when the longest clearances are dropped (Panel B of Table E.2).

Specification. The difference could also reflect how the regression is estimated rather than the letters themselves. Where letters are common, clearance raises the probability of any light by between 3.4 and 5.8 percentage points under a market-access control, under aggregation of the outcome to districts, under high-letters-specific trends, and when the longest clearances are dropped (Table E.2). Where letters are rare it moves that probability by less than one point in all four, and no such estimate is distinguishable from zero. Absorbing high-letters-specific trends is the most demanding of the four, and the gain where letters are common survives it.

6.5 Protection or Collateral?

Documentation could raise the returns to clearance by protecting households' claims against dispossession, or by making the land easier to sell and to borrow against. Cambodia's legal system recognizes two property-rights types that differ along these dimensions. Titles issued under the post-2001 titling program, which we call reform titles, are registered, tradable, and accepted as mortgage collateral at the Land Office. Letters of possession are none of these, since a sale takes effect against third parties through registration (Articles 65 and 69) and only property registered with the Land Registry may be mortgaged (Article 199) (National Assembly of Cambodia, 2001).[28] If marketability drives the returns to clearance, development should concentrate where reform titles dominate. Table 5 therefore re-estimates Equation (2) across three groups of communes: those in the top decile of the reform-title

[28] The comparison the two paper types allow is descriptive rather than causal, because the program's administrators selected which communes to register first (Biddulph, 2014).

share, those within the high-letters group, and those with neither.[29]

Reform titles are outcomes of the 2001 land reform. A state commission adjudicated existing claims parcel by parcel and could propose either private rights for the occupants or retention as State property (Royal Government of Cambodia, 2002). This exercise is nevertheless interesting because reform titles are property rights in the classical sense of Besley (1995) and should predict positive returns.

Yet, where they dominate, neither concessions nor nightlights respond to clearance. Nightlights rise instead where letters are common, in contrast to reform-title communes, where the response is indistinguishable from zero, and concessions arrive in the communes where the letters share is low. Both of those flat responses follow from where the post-2001 program placed its formal titles. It registered uncontested land, which concessionaires also did not want, so reform-title communes had little worth taking. The letters work through the claim they put on record, which the state must confront before it can reallocate the land.

6.6 Alternative Explanations

An alternative can only explain the patterns we observe if it works through the letters, and hence is correlated with them. Communes with documented claims could see larger growth in market access, could be cleared by different operators,[30] could sit on land better suited to the crops concessions grow, could hold formal title outright, or could be administered by a more capable local state. Any of these correlations could plausibly reproduce the patterns without the protection a documented claim provides. We test alternative explanations in Table 6, which correlates each attribute with the letters, entered both as the share of farming

[29] Both cutoffs select roughly a tenth of communes, the letters share by a level rule and the reform-title share by rank, so the two documented groups are equally rare in their own distributions.

[30] In Colombia the returns to clearance differ by whether civilians or the military cleared the land (Prem et al., 2025). Cambodia's three principal operators, the national centre CMAC and the international organizations HALO Trust and MAG, are all civilian, so the margin here is assignment.

households holding them and as the high-low split. We rule out attributes that do not move with the letters and directly test those that do.

Market access. A key assumption of the letter split is that cleared areas with a high share of letters are not also areas with a larger economic potential. Column (1) tests this assumption by correlating the growth of market access with the letters split and the share of letters in a commune. We find that future growth in market access is not significantly correlated with the letters and hence cannot explain the pattern we observe.

Operator and land value. The letters correlate with neither the operator that cleared the land nor the suitability of their land for the concession crops (Columns 2 and 3). Communes with documented claims are no more likely than others to have been cleared by CMAC, the dominant operator in 81 percent of cleared communes (Section G.1). They also sit on soil no more suitable for rubber, sugarcane, and cassava. Rubber accounts for close to half of all concession area, so the comparison largely reflects rubber suitability.

Formal title. Reform titles correlate negatively with the letters. The reform-title share is 13.8 percentage points lower where claims are documented (Table 6, column 4). The deficit follows from the titling program's placement, so the two documents cover different land and the letters are not a proxy for formal titling. In addition, reform titles do not predict economic land concessions or nightlights (Table 5).

State capacity. The capacity of the local administration does vary with the letters. Communes where letters are common score 0.07 units higher on a standardized index of six proxies for the capacity of the local administration, about a seventh of the index's standard deviation

(column 5).[31] This correlation may be mechanical, because the letters were completed by village and commune chiefs, the same administration whose capacity the index measures.[32]

Capacity and documentation move together, so the split could reflect the capability of the administration rather than the claims. A capable administration may raise the returns to clearance directly, or its capacity may matter because it completed, and now enforces, the documented claims of its residents. We therefore re-estimate the letters split separately in communes above and below median capacity (Table G.3). Clearance delivers development only where documented claims meet a capable administration. Where either is missing, concession area expands anyway.

None of the alternatives, then, explains the difference we observe. Trade moves with clearance but not with the letters, the operator and the value of the land do not vary with the letters, and reform titles cover different land. State capacity comes closest, and it raises the returns only where a claim is already on record.

7 Conclusion

What happens to the land once it is cleared of landmines, and who captures the benefits? In Cambodia, demining leads to large-scale reallocation of land, while the average local development gain is small and imprecisely estimated. Who gains from it depends on whether prior claims to the land are documented. Where they are, cleared communes light up by 4.7 percentage points, against 0.7 where they are not, household consumption rises by around a

[31] The index combines the share of households with public electricity in 1998, the share with piped water in 1998, distance to the 2002 transmission grid, distance to the provincial capital, distance to the nearest road, and the presence of a commune (*khum*) office in the 1970s (Anderson, 2008).

[32] We also split the returns by land value and by operator (Appendix G). The land-value split produces no development difference, though concessions concentrate on high-value land (Table G.2). The operator split produces no nightlight response under any operator, though concessions concentrate in CMAC communes (Table G.1), and assignment is in any case uncorrelated with the letters.

third, and out-migration attributed to lost land falls by 16 percent. Where no documented claim stands in the way, concessions arrive on the recovered land and disputes rise with them.

The evidence points to the protection a recorded claim provides against dispossession. Cambodia's 2001 Land Law recognized openly held possession in principle, but it also let the state grant land carrying no documented claim, and a letter of possession is the record that obstructs that classification.

These findings bear on reconstruction now being planned in Ukraine, where demining is among the largest clearance programs undertaken anywhere. Clearance makes land safe wherever it operates, but our evidence warns that safety does not settle who the recovery serves. A program can remove every mine, but its gains can still bypass the communities who depend on it.

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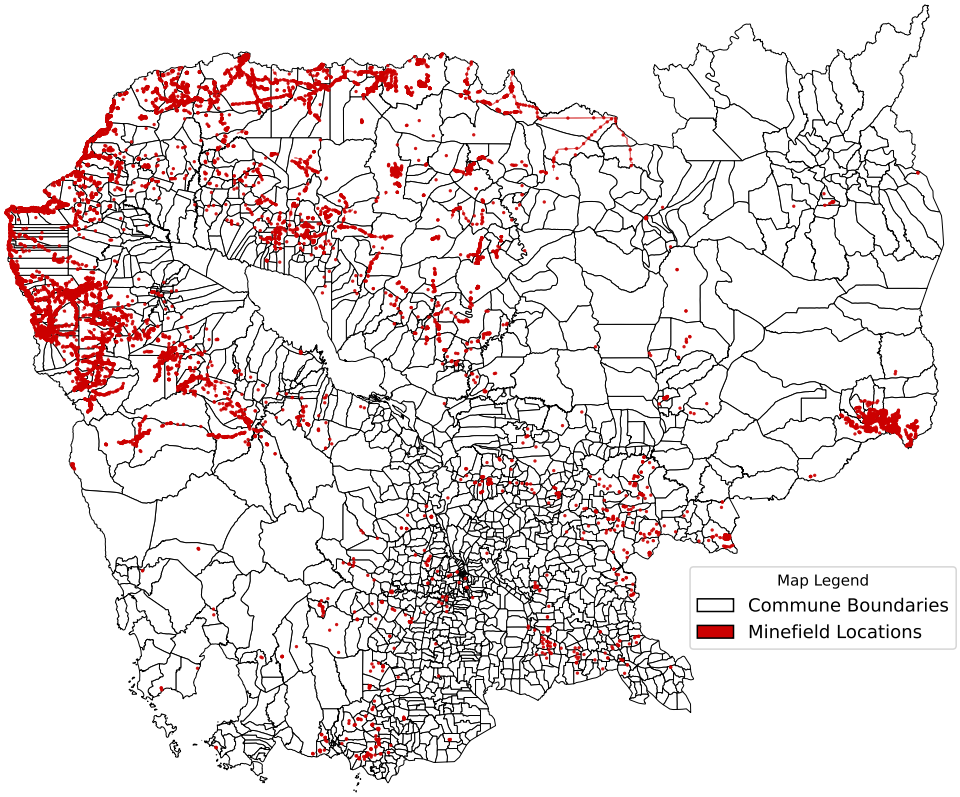
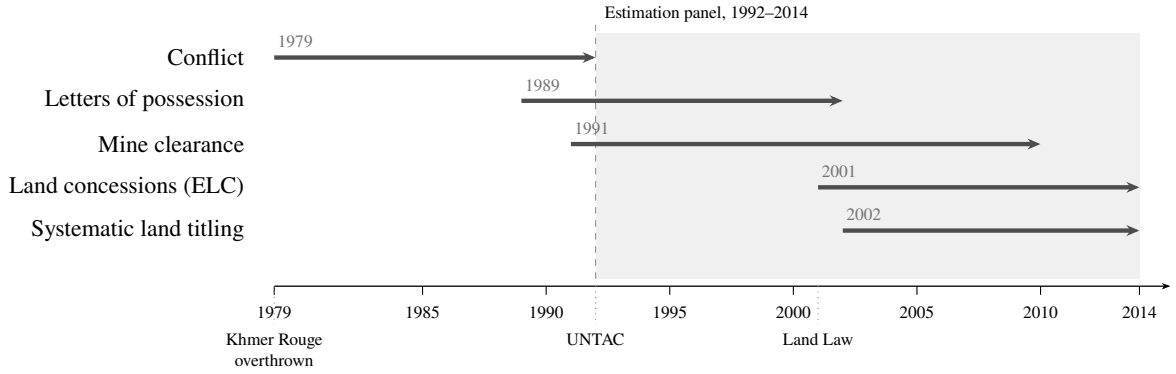
Figure 1: Map – Cleared minefields in Cambodia (2010)



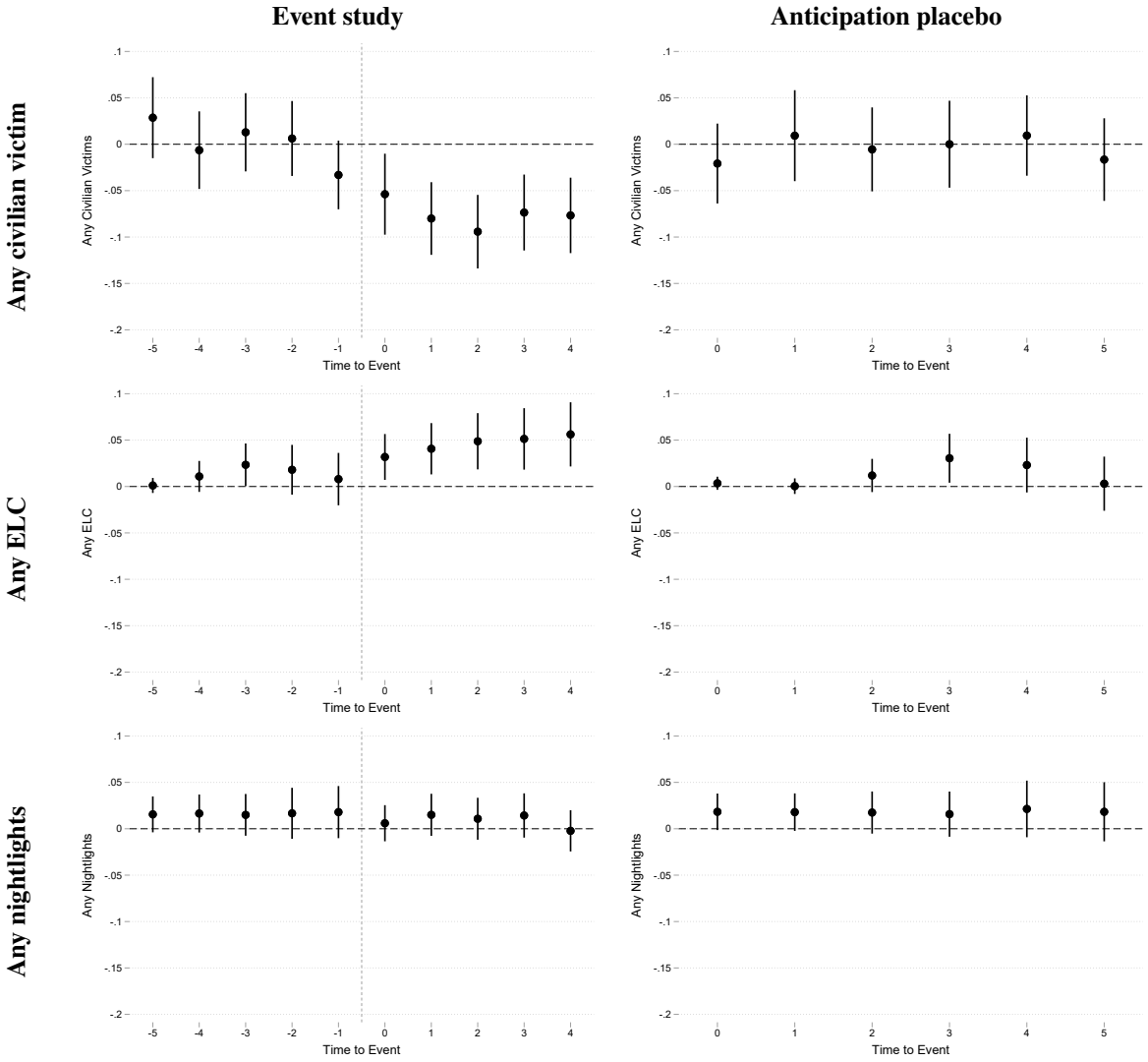
Notes: The map shows the locations of cleared minefields (in red) in our sample, including all clearances completed by 2010. Data on clearance locations are from organizations coordinating mine clearance efforts in Cambodia (CMAC, the HALO Trust, and MAG). The black lines indicate commune borders based on 2014 administrative boundaries.

Figure 2: Timeline – Conflict, land institutions, and clearance, 1979–2014



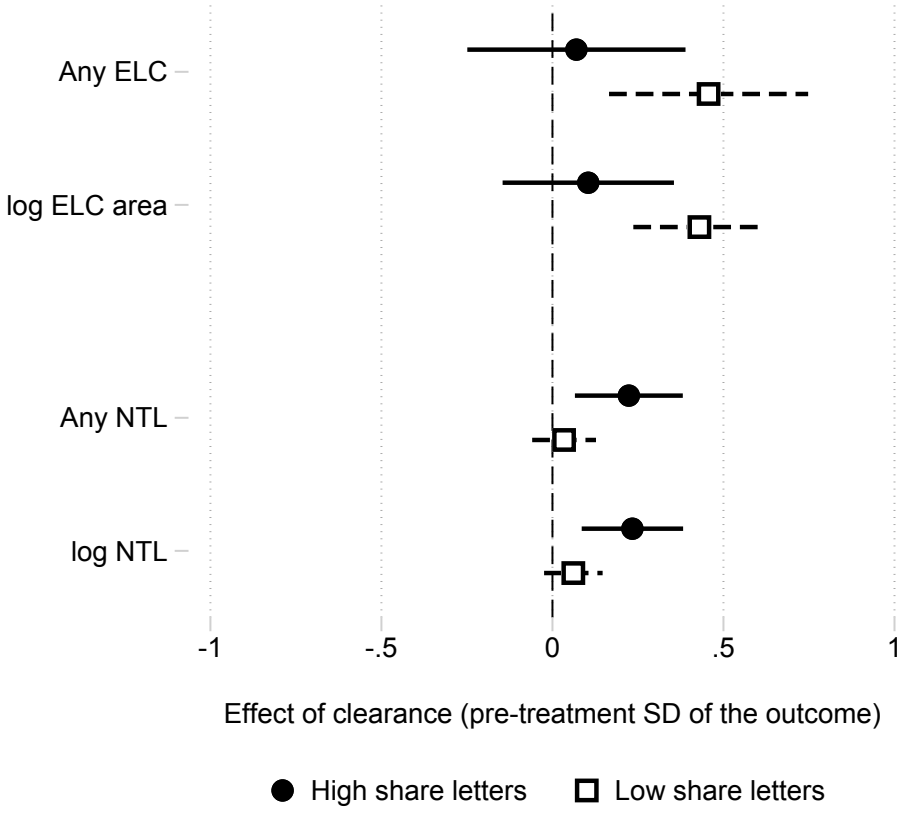
Notes: The figure shows a simplified timeline of key events relevant for our study. The arrows are ordered by start year and the dates are those of Section 2. Conflict runs from the overthrow of the Khmer Rouge by Vietnam in 1979 to the UNTAC transition in 1992, the years over which every party laid mines. Village and commune chiefs began issuing letters of possession in 1989, two years before the first clearance operations, which are recorded through 2010. The 2001 Land Law then opened both the concession (ELC) program and the systematic titling that followed from 2002. The shaded band marks the 1992–2014 estimation panel, so the concession and titling arrows stop at its edge rather than at the end of either program.

Figure 3: Event studies and anticipation placebos



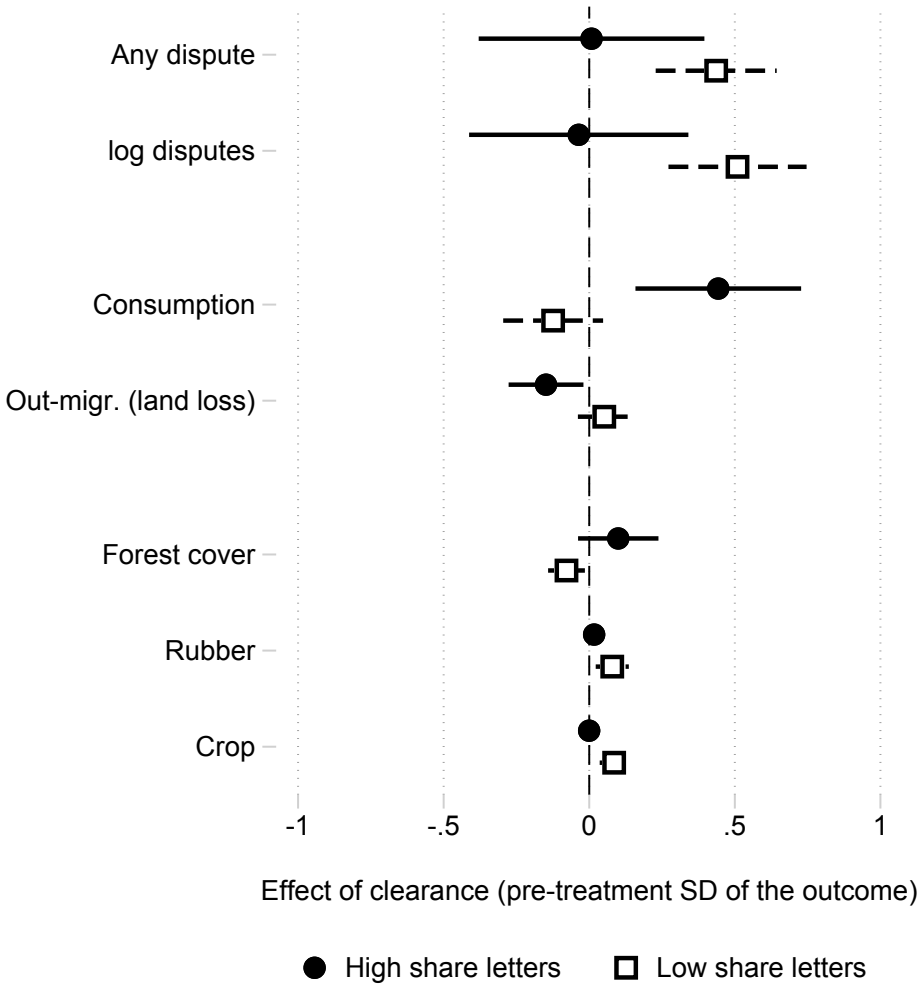
Notes: The figure collects the clearance event study and anticipation placebo for each of the three outcomes, one outcome per row. The left column reports event-study coefficients based on an event-study generalization of Equation 1, following the imputation estimator of Borusyak et al. (2024); joint tests of the pre-treatment coefficients do not reject zero (victimization, $p = 0.186$; ELCs, $p = 0.383$; nightlights, $p = 0.630$). No pre-treatment period is omitted as a reference category. The imputation estimator measures the post-treatment coefficients against imputed untreated counterfactuals, and the pre-treatment coefficients are placebo estimates from untreated observations. The right column reports coefficients from anticipation placebos that shift the treatment to six years before the year in which clearance was completed. All six panels share a vertical axis, so the three outcomes, each an indicator, can be read against one another. The victimization regressions are restricted to 1997–2013, the period the civilian classification and the casualty records jointly cover, while the ELC and nightlight panels extend through 2014. The ELC outcome counts concessions granted after the 2001 Land Law. All specifications include commune and province-year fixed effects as well as pre-existing commune characteristics interacted with year fixed effects: latitude, longitude, their interaction, the log of US bombing loads, log distance to the nearest road, log distance to the provincial capital, the log of pre-Khmer Rouge commune population, and soil fertility. Standard errors are clustered at the commune level.

Figure 4: Reallocation and local development by documented claims



Notes: Clearance effects on economic land concessions and nightlights. High-letters communes are those with a share of farming households holding pre-2002 letters of possession of at least 33 percent, the top decile of the commune distribution; the remaining communes are low-letters. Each estimate is divided by the pre-treatment standard deviation of its own outcome on its own estimation sample, so that four outcomes measured in different units share one axis. For a 0/1 outcome the standard deviation is $\sqrt{p(1-p)}$. Table F.1 reports the same estimates in the outcomes' own units and Table F.2 in standard deviations. Commune and province-year fixed effects included, with the baseline commune characteristics interacted with year. Standard errors clustered at the commune level. Bars are 95 percent confidence intervals.

Figure 5: Land disputes, household outcomes, and land use by documented claims



Notes: Clearance effects on land disputes, household consumption, out-migration attributed to lost land, and land use. The dispute outcomes are an indicator for any recorded land dispute and the log of one plus the cumulative number of recorded disputes. Forest cover is minimum NDVI. Rubber and crop are log area (km^2+1) from RLCMS land cover, which covers 2000–2010, so communes cleared before 2000 have no pre-period in that window and drop out. Consumption is the household total built from the CSES food and non-food expenditure questions, each trimmed at the top 1 percent. Out-migration is the log of one plus the count of moves attributed to lost land, measured at the origin district. Estimates are standardized as in Figure 4, with Table F.3 and Table F.4 reporting the underlying point estimates. Bars are 95 percent confidence intervals. Commune and province-year fixed effects included, with the baseline commune characteristics interacted with year. Standard errors are clustered at the commune level, except for out-migration, which is measured and clustered at the district level.

Table 1: Summary Statistics - Communes

	N	Mean	SD	Min	Max
Clearance					
Ever Cleared	1,621	0.340	0.474	0.000	1.000
Outcomes (pre-treatment means)					
Any Civilian Victims	1,464	0.113	0.237	0.000	1.000
Number of Civilian Victims	1,464	0.680	3.531	0.000	68.000
Any ELC	1,614	0.023	0.082	0.000	0.609
Log ELC Area	1,614	0.456	1.471	0.000	8.648
Any Nightlights	1,614	0.072	0.214	0.000	1.000
Log Nightlights	1,614	-8.248	2.513	-9.210	4.035
Any Disputes	1,614	0.019	0.089	0.000	1.000
Number of Disputes	1,614	0.024	0.129	0.000	2.913
Forest Cover	1,377	-0.048	0.138	-0.200	0.335
Log Crop Area	1,378	0.602	0.884	0.000	4.664
Log Rubber Area	1,378	0.037	0.191	0.000	2.717
Household Consumption (000s riel)	985	207.486	91.934	30.737	612.303
Log Out-Migration (land loss)	1,557	1.652	0.830	0.000	3.974
Letters of possession					
Share of Farmers with pre-2002 Letters	1,621	0.096	0.184	0.000	0.996
High share letters (top decile)	1,621	0.103	0.304	0.000	1.000
Baseline controls					
Longitude	1,621	104.786	0.994	102.380	107.510
Latitude	1,621	12.114	1.001	10.440	14.410
XY Interacted	1,621	1269.254	103.642	1090.458	1535.320
Log Number of Bombs	1,621	4.780	3.275	0.000	12.083
Log Distance to Road (km)	1,621	0.392	1.440	-6.908	3.790
Log Distance to Province Capital	1,621	2.627	2.518	-6.908	4.827
Log Pre-KR Population	1,621	5.142	1.549	-5.632	7.646
Soil Fertility	1,621	0.430	0.428	0.000	1.000

Notes: The table presents summary statistics for our analytical sample, covering the years 1992 to 2014 unless indicated otherwise. Civilian-victim outcomes are defined only for 1997–2013, the period the civilian classification and the casualty records jointly cover. Outcome means are commune-level averages over each commune's years before clearance, and over the full panel for communes never cleared. Crop and rubber are log area (km^2+1) from RLCMS land cover, which covers 2000–2010; covered commune-years that record no crop or rubber enter as zeros. These rows nonetheless cover 1,378 communes rather than 1,621: 87 communes completed clearance in or before 2000, and another 156 began clearance in or before 2000 and completed it by 2010, while the sample excludes years in which clearance is underway. Neither group has a covered year before clearance, so the regressions on these outcomes drop both groups as well. Household consumption is the CSES household total in thousands of riel, its food and non-food components each trimmed at the top 1 percent, averaged over the commune's households surveyed before clearance. Out-migration is the log count of moves attributed to lost land, measured at the origin district and assigned to its communes; the migration panel ends with the 2008 census. Covariates are pre-determined, measured before the start of the sample period. High-letters communes are those with a share of farming households holding pre-2002 letters of possession of at least 33 percent, the top decile of the commune distribution; Low-letters communes are the remainder.

Table 2: Average effects of clearance on victimization

	Any Civilian Victims		Civilian Victims		log Civilian Victims	
	(1)	(2)	(3)	(4)	(5)	(6)
Cleared	-0.088***	-0.081***	-1.123***	-1.063***	-0.192***	-0.176***
	(0.019)	(0.018)	(0.208)	(0.204)	(0.029)	(0.028)
Commune Fixed Effects	✓	✓	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓	✓	✓
Controls × Year Fixed Effects		✓		✓		✓
Observations	23,505	23,505	23,505	23,505	23,505	23,505
Clusters	1,464	1,464	1,464	1,464	1,464	1,464
Dep. Var. Pre-Treatment Mean	0.210	0.210	1.137	1.137	0.305	0.305

Notes: Average clearance effect on civilian victimization, shown without and with baseline commune controls×year. Victim panel restricted to 1997–2013, the period the civilian classification and the casualty records jointly cover, so these regressions cover 1,464 communes against the 1,614 of the land concessions and nightlights tables. Commune and province-year fixed effects included. Standard errors clustered by commune reported in parentheses. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Average effects of clearance on reallocation

	Any ELC		log ELC Area	
	(1)	(2)	(3)	(4)
Cleared	0.037***	0.038***	0.773***	0.703***
	(0.012)	(0.013)	(0.162)	(0.161)
Commune Fixed Effects	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓
Controls × Year Fixed Effects		✓		✓
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Dep. Var. Pre-Treatment Mean	0.008	0.008	0.293	0.293

Notes: Average clearance effect on reallocation. An ELC (economic land concession) is a formal land-allocation instrument by the state and described in Section 2. Shown without and with the baseline commune controls×year. Commune and province-year fixed effects included. Standard errors clustered by commune reported in parentheses. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Average effects of clearance on development

	Any NTL		log NTL	
	(1)	(2)	(3)	(4)
Cleared	0.017	0.010	0.244**	0.169*
	(0.011)	(0.010)	(0.105)	(0.097)
Commune Fixed Effects	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓
Controls × Year FE		✓		✓
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Dep. Var. Pre-Treatment Mean	0.047	0.047	-8.629	-8.629

Notes: Average clearance effect on local development proxied by nightlights, shown without and with the baseline commune controls×year. Commune and province-year fixed effects included. Standard errors clustered by commune reported in parentheses. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Effects of clearance by pre-2002 letters of possession and post-2001 reform titles

	ELCs (1)	log ELC Area (2)	Any NTL (3)	log NTL (4)
Cleared × Post-2001 reform land titles	0.002	0.161	0.003	-0.145
	(0.019)	(0.264)	(0.011)	(0.103)
Cleared × High share letters	0.006	0.183	0.047***	0.525***
	(0.015)	(0.223)	(0.017)	(0.170)
Cleared × Low share letters	0.046***	0.816***	0.008	0.170
	(0.015)	(0.185)	(0.011)	(0.106)
Commune Fixed Effects	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓
Controls × Year Fixed Effects	✓	✓	✓	✓
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Dep. Var. Pre-Treatment Mean	0.008	0.293	0.047	-8.629

Notes: Three-way split of the effects of clearance on land allocation and development by document. Commune and province-year fixed effects included. Standard errors clustered by commune reported in parentheses. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Letters of possession and commune characteristics

	Δ log market access (1992–2010) (1)	CMAC dominant (0/1) (2)	Land value (index) (3)	Reform-title share (4)	State capacity (index) (5)
High share letters (letters split)	0.116	-0.022	0.007	-0.138***	0.068**
	(0.111)	(0.036)	(0.050)	(0.018)	(0.032)
Letters share (pre-2002)	0.263	-0.027	0.003	-0.281***	0.180***
	(0.190)	(0.063)	(0.082)	(0.032)	(0.056)
Communes	1583	1621	1621	1621	1621
Province FE	✓	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓	✓

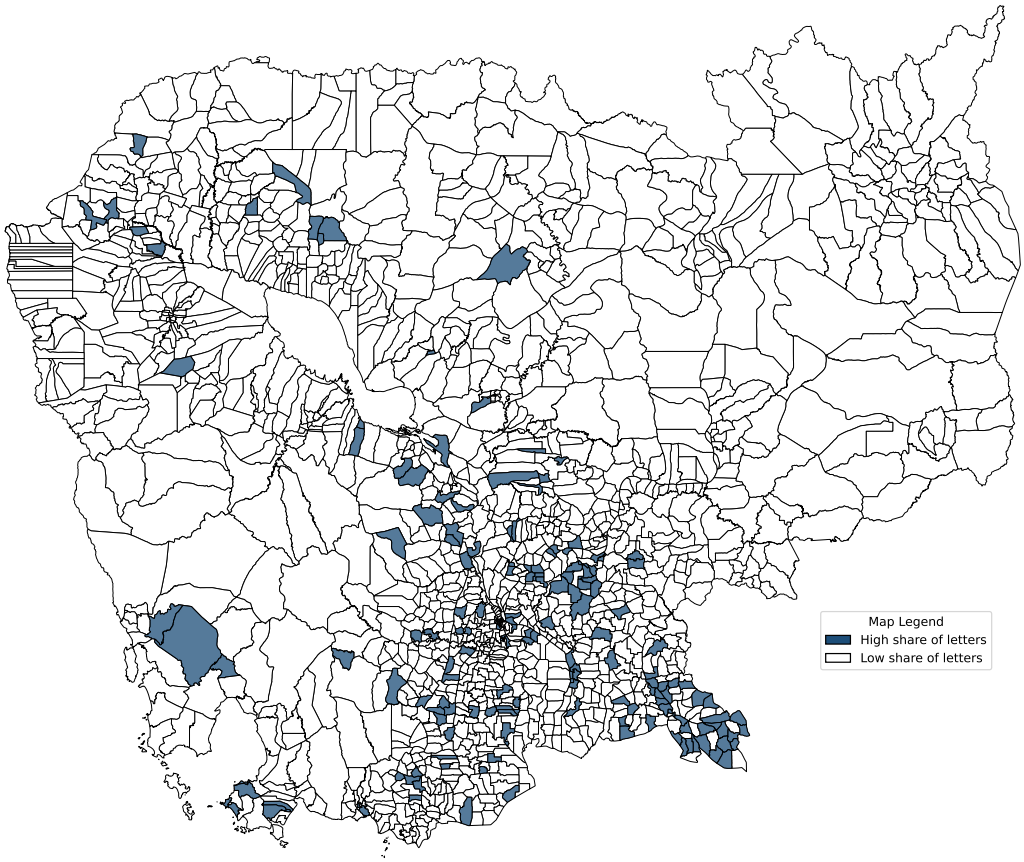
Notes: Each cell reports a separate cross-sectional regression of the column characteristic on the row measure of documented claims. Δ *log market access* is the change in log market access between 1992 and 2010 (Section D.1). *CMAC dominant* indicates that CMAC cleared the largest area in the commune; communes without a clearance record are coded as zero. *Land value* is the standardized index of soil suitability for rubber, sugarcane, and cassava (Anderson, 2008). *Reform-title share* is the commune share of households holding titles from the post-2001 registration program. *State capacity* is the standardized index of six proxies for the capacity of the local administration: the shares of households with public electricity and with piped water in 1998, distance to the 2002 transmission grid, to the provincial capital, and to the nearest road, and the presence of a commune office in the 1970s. All regressions include province fixed effects and the baseline commune controls. Column (5) drops the road- and provincial-capital-distance controls, which are components of the capacity index. Robust standard errors reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Online Appendix

A Additional Figures and Tables

A.1 Additional Maps

Figure A.1: Map – Communes with a high share of letters of possession



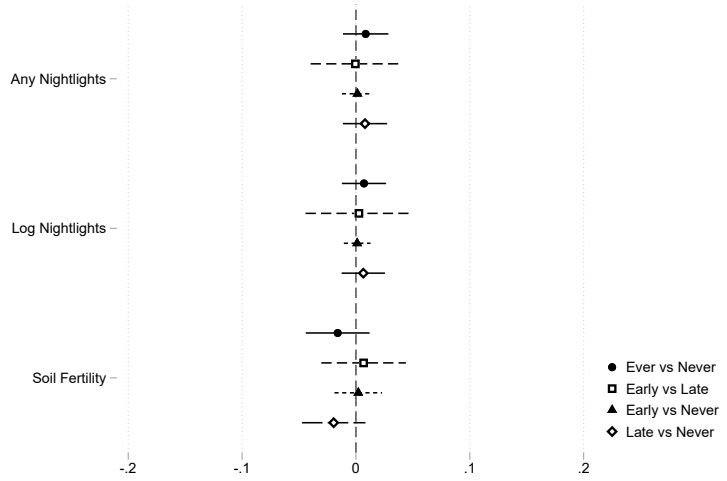
Notes: The map shades the 167 communes where at least 33 percent of farming households held a letter of possession issued before 2002, the high-share group of Section 6.1. The share comes from the 2013 Agricultural Census. All 1,621 communes appear, on 2014 administrative boundaries.

A.2 Balance in Pre-Clearance Economic Conditions

Our difference-in-differences design partly relies on variation in the timing of clearances, which requires the standard common trends assumption. Commune fixed effects absorb differences in levels, so communes cleared at different dates need not have looked alike before clearance. A concern is that large differences in initial conditions are rarely differences in levels alone, as communes that start far apart economically are likely to have been on different paths. Independence between clearance timing and initial economic conditions would therefore be reassuring within our empirical design.

In Figure A.2, we regress an indicator for a commune's clearance timing group on one initial economic condition at a time, within provinces, on the 1992 cross-section. Reassuringly, no initial condition predicts whether a commune was cleared or when it was cleared, and the estimates are tightly bounded around zero. Thus, clearance timing is not driven by differences in initial economic conditions.

Figure A.2: Balance test – 1992 economic conditions and landmine clearances

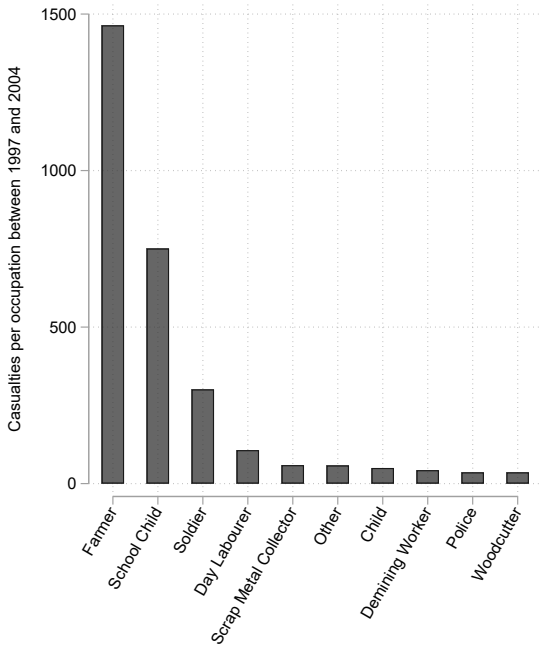


Notes: The figure plots point estimates and 95% confidence intervals. Each estimate comes from a separate regression, on the 1992 cross-section of communes, of an indicator for a clearance timing group on one initial condition, with province fixed effects. The four series are four comparisons, each on its own sample: ever-against never-cleared communes, early against late among the ever cleared, and early and late each against the never cleared, where clearance completed before 2001 is early. The conditions are 1992 nightlights, in levels and in logs, and soil fertility, each standardized on the 1992 cross-section, so an estimate is the change per standard deviation. Heteroskedasticity-robust standard errors.

A.3 Victimization by Occupation

To understand who was most likely to face the risk of mines, we use detailed occupations in the victims data available from 1997 to 2004. Figure A.3 plots recorded landmine casualties between these years by the victims' occupation. We observe that farmers are the largest category and schoolchildren the second. Mines put the people who use the land at risk, implying that civilian victimization is a proxy for the risk taken to work it.

Figure A.3: Who bore the cost of contamination



Notes: The figure plots the total number of recorded landmine casualties between 1997 and 2004 by the victim's occupation, for the ten most frequent occupations. Data sources reported in Table I.1.

B Alternative Estimators

We use the imputation-based estimator of Borusyak et al. (2024) that has been standard in the demining literature (Chiovelli et al., 2025; Prem et al., 2025) and corrects bias in two-way fixed effects (TWFE). Classic TWFE uses already-cleared communes as controls, which subtracts their continuing growth and attenuates estimates. It also weights cohorts by treatment variance, which leans on communes cleared near the middle of the panel and puts little weight on the earliest and latest (Goodman-Bacon, 2021). Whether that reweighting raises or lowers the estimate depends on how effects vary with clearance timing, so the bias is unsigned. The imputation estimator avoids this. It first estimates the outcome on commune and year effects with never-cleared and not-yet-cleared observations, and then uses those estimates to predict the potential outcome of each cleared commune without clearance. The treatment effect is the difference between the average observed post-clearance outcome and the average imputed outcome in the absence of treatment.

Other estimators correct the same bias differently. Here we show that our average effects do not depend on which one we use. We re-estimate the average effects under three estimators that construct the counterfactual differently: the group-time approach of Callaway and Sant'Anna (2021), the interaction-weighted event study of Sun and Abraham (2021), and the intertemporal estimator of de Chaisemartin and D'Haultfœuille (2026). We report the standard TWFE estimator alongside them for comparison.

Every coefficient keeps its sign across the estimators reported in Table B.1. Concessions rise significantly in likelihood and size in every panel, and the nightlights estimates stay null or small throughout. The TWFE estimates run somewhat larger on three of the four outcomes, which is unsurprising given its ambiguous bias. Neither result therefore depends on how the counterfactual is built.

Table B.1: Robustness checks: alternative estimators

	Land allocation		Development	
	Any ELC	log ELC Area	Any NTL	log NTL
	(1)	(2)	(3)	(4)
Panel A: Borusyak, Jaravel & Spiess imputation				
Cleared	0.038***	0.703***	0.010	0.169*
	(0.013)	(0.161)	(0.010)	(0.097)
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Panel B: Callaway & Sant'Anna (2021)				
Cleared	0.032**	0.530***	0.015	0.166
	(0.014)	(0.187)	(0.012)	(0.113)
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Panel C: Sun & Abraham (2021)				
Cleared	0.040**	0.406***	0.011	0.159
	(0.016)	(0.154)	(0.011)	(0.112)
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Panel D: de Chaisemartin & D'Haultfoeuille (2026)				
Cleared	0.038***	0.388***	0.002	0.005
	(0.014)	(0.139)	(0.010)	(0.095)
Observations	29,955	29,955	29,955	29,955
Clusters	1,614	1,614	1,614	1,614
Panel E: Two-way fixed effects (OLS)				
Cleared	0.054***	0.674***	0.014	0.232***
	(0.015)	(0.149)	(0.009)	(0.087)
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Commune fixed effects	✓	✓	✓	✓
Province × year FE (or equivalent)	✓	✓	✓	✓
Baseline controls	✓	✓	✓	✓

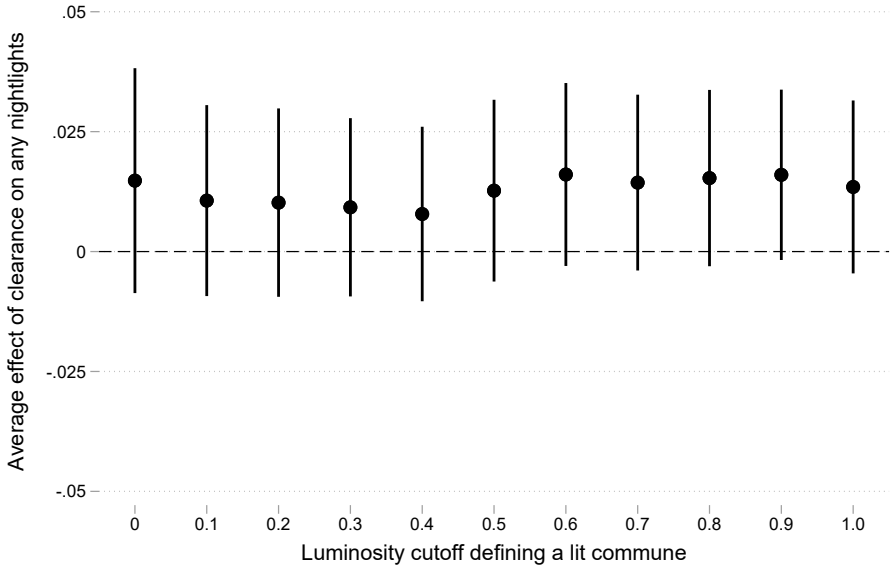
Notes: The table re-estimates the average clearance effects of Table 3 and Table 4 under alternative staggered difference-in-differences estimators. The outcomes are an indicator for any ELC granted after the 2001 Land Law, log(ELC area + 1), an indicator for any nightlights, and log nightlights. Panel A is the baseline (Borusyak et al., 2024), Panels B to D re-estimate the same or a similar specification, as each method requires, with the estimators named in the panel headers, and Panel E is the standard two-way fixed effects estimator. Panel D absorbs group and time fixed effects by construction and cannot include province-by-year fixed effects. It estimates an average cumulative effect per unit of treatment rather than an average post-treatment effect, so its coefficients are not directly comparable to Panels A to C. Its observation count is the number of commune-years entering that average rather than the full estimation sample. The baseline commune characteristics are interacted with year in Panels A and E and enter as covariates in Panels B to D. Standard errors clustered at the commune level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

C Luminosity Threshold and Specification Choice

Here we test the robustness of two design choices. First, we define a commune as lit if its luminosity is above a threshold. This is unavoidable, because satellite luminosity blooms where light from a bright neighbour registers on communes that generate none of their own. A cutoff suppresses it, but any cutoff is arbitrary in both directions: set it too low and blooming enters as development. Set it too high and communes that did develop are recorded as dark. We test the robustness of our result on nightlights by re-estimating the average effect of clearance across a wide range of alternative thresholds. The results are reported in Figure C.1 and show that the estimated effect is stable across the range of cutoffs.

Second, we examine four changes to our base specification in Table C.1 across victimization, ELCs, and nightlights. We control for market access, net out displacement within the district, absorb any trend tied to the letters share, and drop the communes cleared over the longest spans. The average effects hold under every one of them and across all outcomes.

Figure C.1: Robustness checks: luminosity cutoff defining a lit commune



Notes: Average clearance effect on an any-nightlights indicator rebuilt at each luminosity cutoff on the horizontal axis, from 0 (any positive luminosity) to 1 in steps of 0.1. The indicator equals one when the commune's mean corrected luminosity, the bloom- and topcode-corrected satellite reading averaged over the commune, exceeds the cutoff. The paper's own cutoff is the 33rd percentile of the positive luminosity distribution, about 0.217, and lies near the left of the range. Each point is a separate estimate of the average effect using the DDI approach of Borusyak et al. (2024), with commune and province-year fixed effects, baseline controls×year, and commune-clustered standard errors. Bars are 95 percent confidence intervals.

Table C.1: Robustness checks: alternative specifications

	Control Market Access	Aggregate Outcome to District-Level	Control High Letters-Year FE	Drop Top 10% Clearance Duration
	(1)	(2)	(3)	(4)
Panel A: Any civilian victim				
Cleared	-0.084***	-0.044***	-0.081***	-0.064***
	(0.022)	(0.008)	(0.018)	(0.018)
Observations	18,754	23,505	23,505	22,949
Clusters	1,433	1,464	1,464	1,376
Panel B: Any ELC				
Cleared	0.019**	0.027***	0.038***	0.031**
	(0.008)	(0.007)	(0.013)	(0.013)
Observations	27,578	34,495	34,495	32,789
Clusters	1,583	1,614	1,614	1,452
Panel C: Any nightlights				
Cleared	0.011	0.007	0.010	0.012
	(0.011)	(0.006)	(0.010)	(0.010)
Observations	27,578	34,495	34,495	32,789
Clusters	1,583	1,614	1,614	1,452
Commune & Province × Year FE	✓	✓	✓	✓
Controls × Year FE	✓	✓	✓	✓

Notes: Average clearance effect under four alternative specifications, one panel per outcome. Column 1 controls for time-varying log market access; Column 2 replaces the outcome with its district-year mean, so that within-district displacement nets out; Column 3 adds high-letters-by-year fixed effects; Column 4 drops the 167 communes with the longest clearance spells, a tenth of all communes and roughly 30 percent of those ever cleared. Market access is built only through 2010, the last year in which clearances are observed, so Column 1 is estimated on 1992–2010 and its observation count is correspondingly smaller. The victim panel is estimated on 1997–2013, the years the civilian classification and the casualty records jointly cover. Commune and province-year fixed effects as well as baseline controls×year included. Standard errors clustered at the commune level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

D Market Access

Chiovelli et al. (2025) show that landmine clearance in Mozambique improved local economic development partly through increased market access (MA). In our setting, the question is whether differential effects of clearance on MA across communes could generate the differential effects by letters of possession that we document in Section 6.3. Table E.2 addresses that question by re-estimating the split with $\ln MA$ as a control, and Table 6 shows that growth in MA does not move with the letters. Trade could also explain part of the average payoff. Section D.2 takes up that separate question with the effect of clearance on $\ln MA$. The construction below produces two MA measures: a time-varying MA panel ($MA_{c,t}$) and a pre-clearance initial MA cross-section ($MA_{c,0}$).

D.1 Construction Details

Method. We construct MA at the commune-year level for 1992–2010 following the approach of Chiovelli et al. (2025), hereafter CMP. The panel ends in 2010 because the passable network changes over time only as clearance removes minefields from it, and the clearance records that define our treatment extend only through 2010. The transport network is built once from 2002 shapefiles for major roads, paved minor roads, railways, and rivers. Rehabilitation during the sample period upgraded existing major roads rather than adding links (JICA et al., 2006), so the set of connections is stable even as surface quality improved. We connect every commune centroid to its nearest unblocked transport link by a walking leg, and from there route via the network to every other commune. Edges within 50 m of each other are snapped together to repair small geometric gaps in the shapefile layers.[33] Unpaved tracks are excluded as they are not consistently surveyed and would inflate the network beyond what

[33] This smooths instances where two road segments meet visually but are not topologically connected.

carries non-trivial freight.

MA measure. Following CMP, we use the standard approximation

$$MA_{o,t} \equiv \sum_{d \neq o} \tau_{o,d,t}^{-\theta} N_{d,t}, \tag{3}$$

where $\tau_{o,d,t}$ is the least-cost path from origin commune o to destination commune d in year t, $N_{d,t}$ is the destination's economic mass, and θ is the trade elasticity. The destination weight is yearly nightlights at each destination.

Initial MA. We also construct an initial MA cross-section, $MA_{c,0}$, evaluated on the 1992 network (mines still in place) using 1992 destination nightlights as the weight. This measure is what a commune's MA would have been at the start of the sample given the contaminated transport network, independent of any subsequent clearance or growth. Because it is predetermined, it enters the specifications of Table D.1 interacted with year fixed effects, absorbing any differential nightlights trend tied to baseline connectivity.

Travel cost. Per-edge costs (τ per kilometer) are: major roads 2, minor roads 4, railways 20, rivers 15, and walking 30. Major roads carry the bulk of long-distance transport in Cambodia during the sample period (ADB, 2019; Royal Government of Cambodia, 2002). Cambodia's tertiary and sub-tertiary network through the early 2000s was largely laterite and earth (Johnston, 2002). We therefore penalize minor roads relative to major roads, setting their per-kilometer cost at twice the major-road cost. The World Bank HDM-4 road-user-cost model motivates the size of the penalty: vehicle operating costs rise on deteriorated gravel and earth surfaces relative to well-maintained paved roads, and the maintenance and repair component rises most. The penalty matches CMP's "unpaved" cost and the calibration choices in the transportation-investments literature on developing economies (Jedwab and

Storeygard, 2022). Railways are penalised more heavily than rivers because long stretches of the network were essentially inoperable: bridges and trackbed had been severely damaged during the decades of conflict and rehabilitation was slow (ADB, 2019). Walking is penalised more heavily than in Chiovelli et al. (2025) because the off-road terrain in much of mine-affected Cambodia is also security-affected and physically harder to traverse. River travel is the principal alternative for goods movement along the Mekong–Tonle Sap corridor, so we retain CMP's river cost. Hazards (minefields and ERW polygons) block edges whose path intersects a 100 m buffer around the hazard, in any year before clearance is completed; rivers themselves are not blocked, but mined connections from a commune to a river or to the road network can still block access.

Trade elasticity. Following Chiovelli et al. (2025), we adopt $\theta = 3.8$, a value within the range of estimates from the trade literature for developing economies.

D.2 Market Access and the Average Effects

Here we ask how much of the average effect runs through trade rather than through development of the cleared land itself. Market access enters Table D.1 in two roles. First, we estimate our specification including initial market access, measured in 1992 and interacted with year fixed effects, which controls for the possibility that better-connected communes attract concessions or light up regardless of clearance. Second, we look at contemporaneous market access as the channel through which any trade gains would run. Adding it in the even-numbered columns nets those gains out of the clearance effect. Because contemporaneous market access is itself realized after clearance, this comparison bounds the trade share rather than decomposing it.

Concessions do not respond to trade. Adding contemporaneous market access leaves both

concession estimates essentially unchanged, and market access is itself insignificant in both columns (Table D.1, Columns 1–4). Clearance therefore did not open land to concessions by opening trade.

The nightlights effect is small to begin with, and part of it does run through trade. Clearance raises market access by 7 to 8 percent (Table D.2), and the nightlights effect attenuates once contemporaneous market access is included. The probability that a commune shows any light goes from 1.8 to 1.2 percentage points and loses significance (Columns 5–6), and log nightlights go from 0.225 to 0.169 log points and remain significant at the 10 percent level (Columns 7–8). Trade therefore makes up at most a third of the any-lights estimate and a quarter of the log estimate, and cannot explain the majority of the clearance effect on nightlights.

Table D.1: Robustness to market-access control

	Land Allocation				Nightlights			
	Any ELC		log ELC Area		Any NTL		log NTL	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cleared	0.019**	0.020**	0.566***	0.571***	0.018*	0.012	0.225**	0.169*
	(0.008)	(0.008)	(0.156)	(0.156)	(0.011)	(0.011)	(0.099)	(0.101)
log Market Access (time-varying)		-0.003		-0.071		0.073***		0.800***
		(0.005)		(0.076)		(0.018)		(0.162)
Commune Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
Initial Market Access × Year	✓	✓	✓	✓	✓	✓	✓	✓
Observations	27,578	27,578	27,578	27,578	27,578	27,578	27,578	27,578
Clusters	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583
Dep. Var. Pre-Treatment Mean	0.008	0.008	0.296	0.296	0.041	0.041	-8.697	-8.697

Notes: The table shows average effects of clearance on an indicator for any ELC granted after the 2001 Land Law, log ELC area, an indicator for any nightlights, and log nightlights. Every column includes the baseline commune controls×year and controls for initial (1992, pre-clearance) market access interacted with year fixed effects. The even-numbered columns add time-varying log market access as a regressor and report its coefficient, so that each odd–even pair differs in exactly one thing. Sample: 1992–2010, the years over which market access is observed, since it is time-varying only through mine clearance and the clearance records end in 2010 (Section D.1). Commune and province-year fixed effects included. Standard errors clustered at the commune level. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table D.2: Clearance effects on market access

	log Market Access		Market Access (standardized)	
	(1)	(2)	(3)	(4)
Cleared	0.079**	0.067*	1.171	1.270*
	(0.038)	(0.036)	(0.760)	(0.750)
Commune Fixed Effects	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓
Controls × Year Fixed Effects		✓		✓
Observations	27,578	27,578	27,578	27,578
Clusters	1,583	1,583	1,583	1,583
Dep. Var. Pre-Treatment Mean	-13.644	-13.644	0.097	0.097

Notes: The table reports the effect of completed minefield clearance on market access, constructed with destination nightlights as the weight on the time-varying cost network (see Section D.1). Every column reports the δ estimate from Equation 1, the average effect. Columns 1 and 2 take the log of the index. Columns 3 and 4 divide it by its pre-clearance standard deviation among minefield communes in the estimation sample, so that the effect reads in standard deviations of the index. Sample: 1992–2010, the years over which market access is observed, since it is time-varying only through mine clearance and the clearance records end in 2010. All specifications are estimated using the imputation estimator of Borusyak et al. (2024) and include commune and province-year fixed effects; even-numbered columns additionally include pre-existing commune characteristics interacted with year fixed effects. Standard errors clustered at the commune level. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

E Documented Claims: Robustness

In Section 6, our analysis of heterogeneous clearance effects by the documentation of land claims rests on several assumptions that we test here. We base that documentation on letters of possession, certified by village and commune chiefs rather than registered as title. Section H.2 sets out their origin and purpose. Our comparisons split the effects of clearance between communes with a high and a low share of letters. For these comparisons to be interpretable, three things have to hold. First, the timing of clearance and the letters share must be unrelated (Section E.1). Second, the letters share must not simply be measuring the wealth or market position of the commune (Section E.2). Third, the split should not be sensitive to the threshold that cuts communes into high- and low-share groups, or to how the regression is estimated (Section E.3).

E.1 Clearance and Letters of Possession

If clearance arrived earlier where documented claims were already common, then splitting clearance effects by the letters share would compare communes on their clearance histories rather than on their institutions. In Table E.1, the high-letters indicator, which marks communes where at least 33 percent of farming households hold a pre-2002 letter, predicts neither the extent of mining nor the timing of clearance. The foot of the table reverses the test, entering the contamination and clearance measures jointly as predictors of the indicator, and the F-tests are insignificant in both samples.

Table E.1: Orthogonality of landmine clearance and letters

	Presence		Characteristics		Timing of Demining		
	Minefield	# Mines	log Mine Area	log Mine Perimeter	Start Year	End Year	Duration (Years)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
High share letters	-0.016	-1.541	-0.266	-0.201	-0.684	-0.678	-0.077
	(0.036)	(1.299)	(0.331)	(0.240)	(0.840)	(0.794)	(0.778)
Province Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Commune-Level Controls	✓	✓	✓	✓	✓	✓	✓
Number of Communes	1,621	1,621	551	551	551	551	551
Outcome Mean	0.340	11.012	11.448	8.270	2001.544	2006.152	4.604
Joint test: clearance measures entered together							
Columns (1)–(2), all communes			F(2,1587) = 0.75, p = 0.471				
Columns (3)–(7), ever-mined communes			F(5,514) = 0.92, p = 0.468				

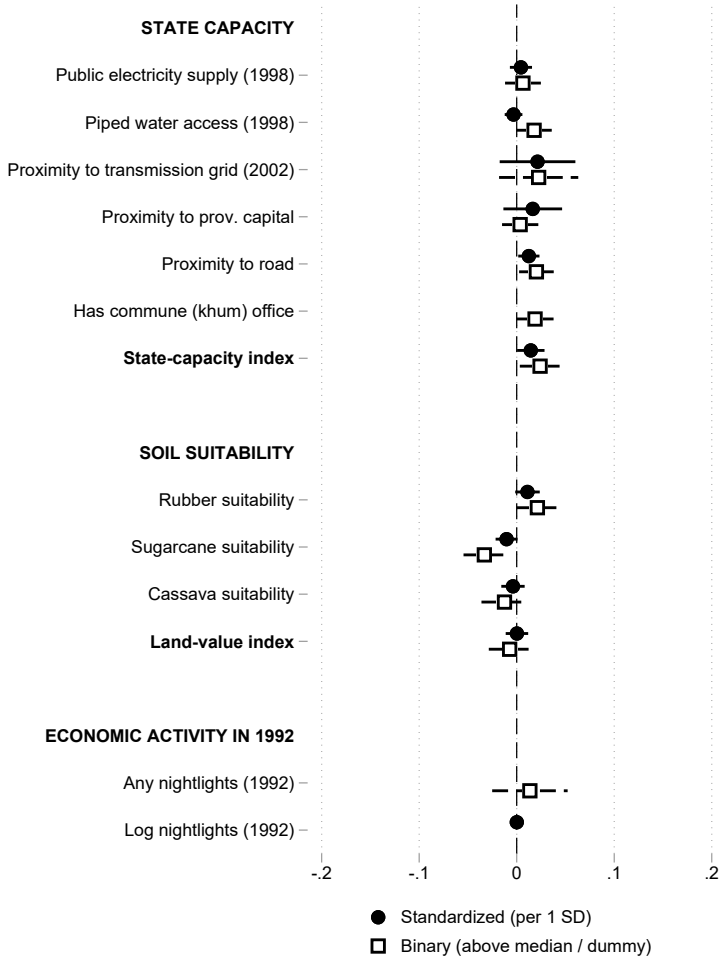
Notes: Each column is a separate cross-sectional regression of one contamination or clearance measure on an indicator for a high share of farming households holding pre-2002 letters of possession, defined as at least 33 percent, the top decile of the commune distribution. An observation is a commune. Columns 1 and 2 use all 1,621 communes and take the presence of a minefield and the number of mines as the outcome. Columns 3 to 7 restrict to the 551 communes that ever held a minefield and take the log of minefield area, the log of minefield perimeter, the year clearance started, the year it ended, and its duration in years. Every column includes province fixed effects and the baseline commune controls: latitude, longitude, their interaction, log US bombing loads, log distance to the nearest road, log distance to the provincial capital, log pre-Khmer Rouge commune population, and soil fertility. The two rows at the foot of the table reverse the regression, reporting F-tests of those measures entered jointly as predictors of the high-letters indicator within each of the two samples. Standard errors are robust to heteroskedasticity. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

E.2 Correlates of Letters

Orthogonality to clearance still leaves open what the letters share is measuring. A commune where many farmers held documented claims could simply be a richer or better connected commune. If so, splitting clearance effects on letters would recover the returns to wealth or to market position under another name. We assess these concerns by regressing a commune's share of farming households holding letters on commune characteristics in categories related to state capacity, soil suitability – which captures land value – and pre-clearance (1992) economic activity. Results in Figure E.1 indicate that the share of farming households with letters rises with the capacity of the local administration, but it is unrelated to the land-value index and to pre-clearance economic activity.

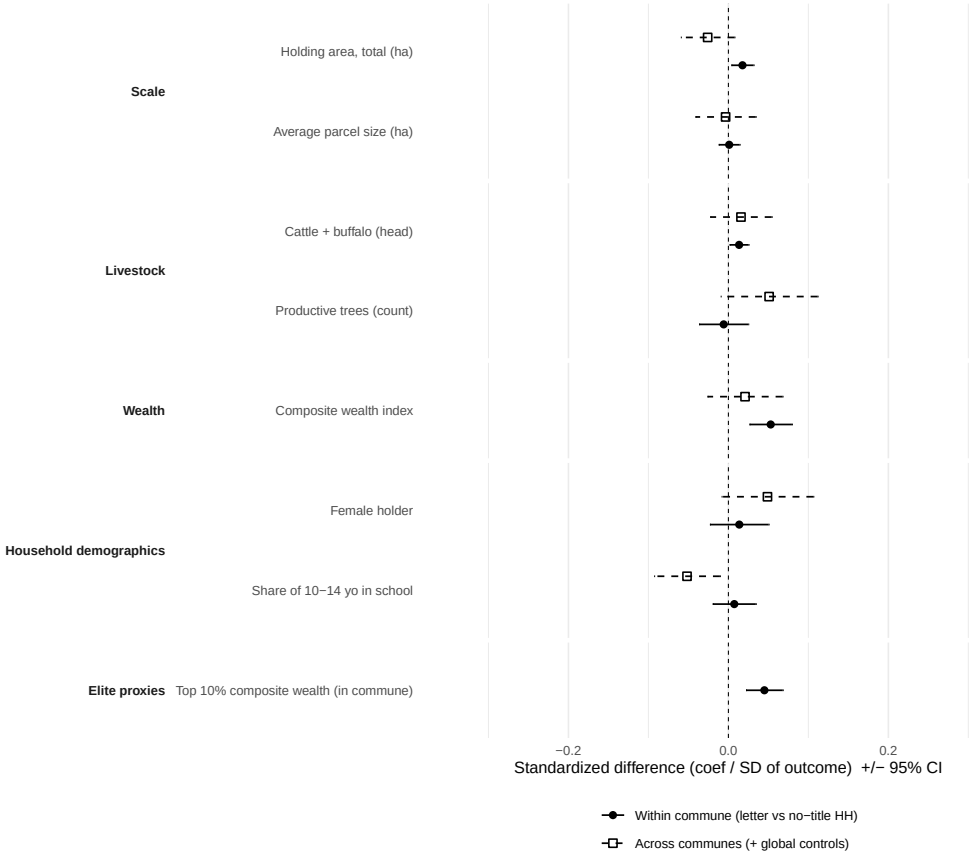
The farmers who held letters could also be different farmers, whatever their communes look like. Figure E.2 compares them with farmers in the same commune who held no documented claim. Within communes, letter holders are very slightly better off than their neighbours, by 0.013 to 0.053 standard deviations on holding area, livestock, and a composite wealth index. Across communes, the letters share is unrelated to these characteristics once province fixed effects and the baseline controls enter. The split is made at the commune level, so differences between households within a commune do not drive the heterogeneity in the effect of clearance by the letters share.

Figure E.1: Letters of possession and commune characteristics



Notes: The figure plots point estimates and 95% confidence intervals from regressions of the share of farming households holding pre-2002 letters of possession on each commune characteristic, one regression per row, so estimates are in units of that share, in the cross-section of 1,621 communes (1,620 in the transmission-grid rows, 1,614 in the 1992 nightlights rows). The standardized series (solid circles) scales each characteristic in standard deviations. The binary series (hollow squares) splits it at the commune median, or uses the indicator itself for the khum-office and any-nightlights rows. Those two rows have no standardized estimate and the log-nightlights row has no binary one, which is why three of the twenty-six positions are empty. Every regression includes province fixed effects and the baseline commune controls: latitude, longitude, their interaction, the log of US bombing loads, log distance to the nearest road, log distance to the provincial capital, the log of pre-Khmer Rouge commune population, and soil fertility. The road- and provincial-capital-proximity rows drop the control that duplicates the regressor. Distances to the transmission grid, the provincial capital, and the nearest road enter with reversed sign, so that higher values mean greater proximity. The state-capacity index combines the six state-capacity rows, and the land-value index combines the three crop suitabilities, each with inverse-covariance weights (Anderson, 2008). The median splits of the two indices are the splits used in Table G.3 and Table G.2. The controls include the road and provincial-capital distances, two of the six index components, so the state-capacity index row measures the index's remaining variation. Robust standard errors.

Figure E.2: Are letter-holders (and high-letter communes) selected?



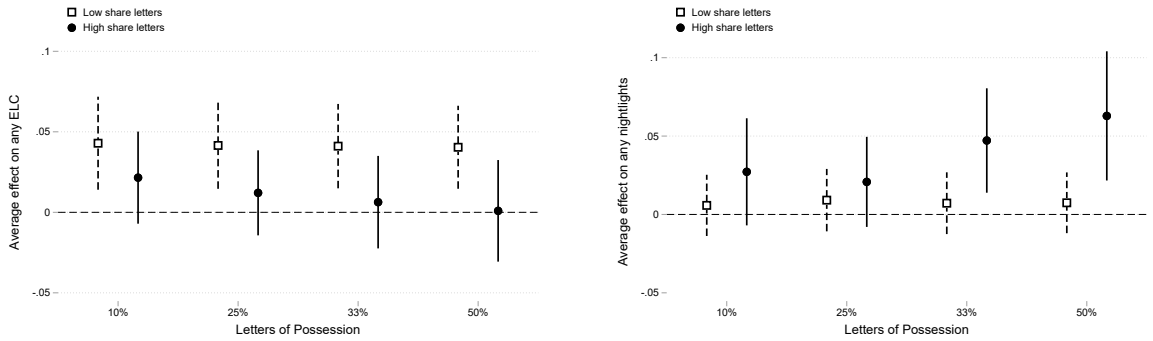
Notes: Standardized differences in household characteristics associated with pre-2002 letters of possession, from the 2013 Agricultural Census. *Within commune* regresses each outcome on an indicator for holding a pre-2002 letter (and no other title) versus holding no documented claim, with commune fixed effects; the coefficient is the letter-holder versus no-title difference in pooled within-sample standard deviations. *Across communes* collapses each outcome to a commune mean and regresses it on the (standardized) commune share of farming households holding pre-2002 letters — the split variable used throughout Section 6 — with province fixed effects and the baseline commune controls (geography, log bombing load, log distance to road and provincial capital, log population, soil fertility); the coefficient is the change in the commune-mean outcome per standard deviation of the letters share. The composite wealth index is the sum of the (within-commune or commune-level, as appropriate) standardized holding area, cattle-plus-buffalo, and productive-tree components. The top-decile wealth indicator is defined within commune and enters only the within-commune series. Bars show 95% commune-clustered confidence intervals.

E.3 Threshold and Specification Sensitivity

The analysis in Section 6 splits communes into two at the top decile of the letters-share distribution. Here we re-estimate the main results for both ELCs and nightlights split at four thresholds between ten and fifty percent, reported in Figure E.3. The sign of our results does not depend on the threshold we set to split communes by their letters share.

In Table E.2, we return to our baseline threshold for defining a commune with a high letters share but vary the estimating specification, as we did for the average effect in Table C.1. The four specifications control for market access, net out displacement within the district, absorb any differential trend between the two groups, and drop the communes cleared over the longest spans. Our results across ELCs and nightlights hold under all four changes in specification.

Figure E.3: Robustness checks: letters-share cutoffs



(a) Any ELC

(b) Any nightlights

Notes: Clearance effects estimated separately for high- and low-letters communes, with the two groups redefined at each cutoff on the horizontal axis: the share of farming households in the commune holding pre-2002 letters of possession is above or below 10, 25, 33, or 50 percent. The 33 percent cutoff is the paper's headline split, the top decile of the commune distribution. Each outcome is an indicator, so estimates are changes in probability. All specifications are estimated on 1992–2014 using the DDI approach of Borusyak et al. (2024). Commune and province-year fixed effects as well as baseline controls×year included. Standard errors clustered at the commune level. Bars are 95 percent confidence intervals.

Table E.2: Robustness checks: alternative specifications, by documented claims

	Control Market Access	Aggregate Outcome to District-Level	Control High Letters-Year FE	Drop Top 10% Clearance Duration
	(1)	(2)	(3)	(4)
Panel A: Any ELC				
Cleared × High share letters	-0.008	-0.002	0.006	0.008
	(0.009)	(0.010)	(0.017)	(0.015)
Cleared × Low share letters	0.022**	0.029***	0.041***	0.033**
	(0.009)	(0.007)	(0.013)	(0.014)
Observations	27,578	34,495	34,495	32,789
Clusters	1,583	1,614	1,614	1,452
Panel B: Any nightlights				
Cleared × High share letters	0.044***	0.034***	0.038**	0.058***
	(0.011)	(0.012)	(0.018)	(0.017)
Cleared × Low share letters	0.008	0.005	0.008	0.007
	(0.010)	(0.006)	(0.010)	(0.010)
Observations	27,578	34,495	34,495	32,789
Clusters	1,583	1,614	1,614	1,452
Commune & Province × Year FE	✓	✓	✓	✓
Controls × Year FE	✓	✓	✓	✓

Notes: Table C.1 re-estimated with the documented-claims split, so that each cell is a group effect rather than an average. High-share-letters communes are those where the share of farming households holding pre-2002 letters of possession is at least 33 percent, the top decile of the commune distribution; the remaining communes are low-share-letters communes. The four columns are the four specifications of Table C.1: Column 1 controls for time-varying log market access; Column 2 replaces the outcome with its district-year mean, so that within-district displacement nets out; Column 3 adds high-letters-by-year fixed effects, which absorb any differential trend between the two groups; Column 4 drops the 167 communes with the longest clearance spells, a tenth of all communes and roughly 30 percent of those ever cleared. Market access is built only through 2010, the last year in which clearances are observed, so Column 1 ends in 2010 and its observation count is correspondingly smaller. Panel A is estimated on 1997–2013, the years the civilian classification and the casualty records jointly cover, and the other two panels on 1992–2014. Each panel reports the two group estimates side by side. All specifications are estimated using the DDI approach of Borusyak et al. (2024). Commune and province-year fixed effects as well as baseline controls×year included. Standard errors clustered at the commune level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

F Estimates Behind the Coefficient Plots

In the main text, we reported coefficient plots across outcomes for heterogeneity in clearance effects between communes with a high and a low share of farming households holding letters. These were Figure 4 and Figure 5, which report outcomes measured in different units on a single axis by dividing each estimate by the pre-treatment standard deviation of its own outcome. Here, in Table F.1 and Table F.3, we report every estimate in each outcome's own units, while in Table F.2 and Table F.4 we repeat them standardized.

Table F.1: Land allocation and development: estimates in outcome units

	ELCs		Nightlights	
	Any ELC (1)	log ELC area (2)	Any NTL (3)	log NTL (4)
Cleared × High share letters	0.006	0.183	0.047***	0.525***
	(0.015)	(0.223)	(0.017)	(0.170)
Cleared × Low share letters	0.041***	0.749***	0.007	0.137
	(0.013)	(0.172)	(0.010)	(0.098)
Commune Fixed Effects	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓
Controls × Year Fixed Effects	✓	✓	✓	✓
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Dep. Var. Pre-Treatment Mean	0.008	0.293	0.047	-8.629
Dep. Var. Pre-Treatment SD	0.090	1.743	0.211	2.246
P-value on difference	0.060	0.037	0.035	0.038

Notes: The table reports the estimates plotted in Figure 4, in each outcome's own units. Columns 1 and 2 report the concession outcomes and Columns 3 and 4 the nightlights outcomes. High-share-letters communes are those where the share of farming households holding pre-2002 letters of possession is at least 33 percent, the top decile of the commune distribution; the remaining communes are low-share-letters communes. Each row reports the clearance effect for one group, not an interaction. The last row reports the p-value on the difference between the two groups. All specifications are estimated on 1992–2014 using the DDI approach of Borusyak et al. (2024). Commune and province-year fixed effects as well as baseline controls×year included. Standard errors clustered at the commune level in parentheses. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table F.2: Land allocation and development: standardized estimates

	ELCs		Nightlights	
	Any ELC (1)	log ELC area (2)	Any NTL (3)	log NTL (4)
Cleared × High share letters	0.070	0.105	0.223***	0.234***
	(0.163)	(0.128)	(0.080)	(0.076)
Cleared × Low share letters	0.457***	0.430***	0.034	0.061
	(0.149)	(0.099)	(0.048)	(0.044)
Commune Fixed Effects	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓
Controls × Year Fixed Effects	✓	✓	✓	✓
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Dep. Var. Pre-Treatment Mean	0.008	0.293	0.047	-8.629
Dep. Var. Pre-Treatment SD	0.090	1.743	0.211	2.246
P-value on difference	0.060	0.037	0.035	0.038

Notes: Table F.1 re-estimated on standardized outcomes; these are the units of Figure 4. Each outcome is divided before estimation by its pre-treatment standard deviation, reported in the *Dep. Var. Pre-Treatment SD* row, so a coefficient here is the corresponding coefficient of the raw table divided by that standard deviation. High-share-letters communes are those where the share of farming households holding pre-2002 letters of possession is at least 33 percent, the top decile of the commune distribution; the remaining communes are low-share-letters communes. Each row reports the clearance effect for one group, not an interaction. The last row reports the p-value on the difference between the two groups. All specifications are estimated on 1992–2014 using the DDI approach of Borusyak et al. (2024). Commune and province-year fixed effects as well as baseline controls×year included. Standard errors clustered at the commune level in parentheses. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The columns of Table F.3 run on different samples, for three reasons. First, the dispute columns use the full commune panel, the same one the concession and nightlights columns of Table F.1 use. Second, the household survey observes only a subset of communes and covers 1999–2014. The out-migration panel ends with the 2008 census and varies at the district level, which is why Column 4 reports fewer clusters. Third, the land-cover series covers 2000–2010. Covered commune-years that record no crop or rubber enter as zeros, but the 87 communes cleared before 2000 have no covered year before clearance, and another 156 began clearance before 2000 and completed it by 2010. Because the sample excludes years in which clearance is underway, none of their covered years is pre-clearance either, and with no pre-clearance years the imputation estimator cannot form their counterfactuals, so both groups drop from the land-cover columns.

In Figure 4, we report clearance effects separately for high- and low-letters-share communes. As a check under the conventional specification, Table F.5 instead interacts completed clearance with the letters measure, so that the gap between the groups appears as a single coefficient with a conventional standard error. Estimation is two-way fixed effects without controls. Where letters are common, clearance raises the probability of a concession by 5.1 percentage points less (se 0.028) and log concession area by 0.644 less (se 0.278). Panel B replaces the high-share indicator with the continuous share of farming households holding letters, so its coefficients are per unit of that share and not directly comparable in size. The nightlights interactions are imprecise, reaching the ten percent level only for log nightlights in Panel B. Section 4.1 rejects this specification for the paper's own estimates, because it uses communes cleared earlier as controls for communes cleared later and the returns to clearance accumulate over years.

Table F.3: Land disputes, household outcomes, and land use: estimates in outcome units

	Land disputes		Household		Land cover		
	Any dispute (1)	log disputes (2)	Consumption (000s riel) (3)	Out-migr. (land loss) (4)	Forest cover (5)	Rubber (6)	Crop (7)
Cleared × High share letters	0.001	-0.003	47.700***	-0.171**	0.014	0.005	-0.000
	(0.021)	(0.014)	(15.624)	(0.075)	(0.010)	(0.004)	(0.016)
Cleared × Low share letters	0.046***	0.037***	-13.348	0.059	-0.011**	0.021***	0.090***
	(0.011)	(0.009)	(9.422)	(0.053)	(0.005)	(0.008)	(0.027)
Commune Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Observations	34,495	34,495	3,374	24,210	14,523	14,534	14,534
Clusters	1,614	1,614	985	184	1,377	1,378	1,378
Dep. Var. Pre-Treatment Mean	0.011	0.008	149.468	1.469	-0.021	0.074	0.950
Dep. Var. Pre-Treatment SD	0.106	0.074	107.643	1.149	0.140	0.268	1.056
P-value on difference	0.049	0.013	0.001	0.005	0.020	0.070	0.002

Notes: The table reports the estimates plotted in Figure 5, in each outcome's own units, which are logs for out-migration in Column 4 and for the rubber and crop areas in Columns 6 and 7. Columns 1 and 2 report the land-dispute outcomes. Column 3 is the household consumption total in thousands of riel, the variable the mechanism figure standardizes, and Column 4 is out-migration attributed to lost land. Columns 5 to 7 report the land-cover outcomes. High-share-letters communes are those where the share of farming households holding pre-2002 letters of possession is at least 33 percent, the top decile of the commune distribution; the remaining communes are low-share-letters communes. Each row reports the clearance effect for one group, not an interaction. The last row reports the p-value on the difference between the two groups. All specifications are estimated using the DDI approach of Borusyak et al. (2024). Columns run on different panels: 1992–2014 for the dispute columns, 1999–2014 for consumption, and 2000–2010 for land cover. Nine province-year cells are excluded from the consumption column because their fixed effects are not estimable in that sub-sample. Commune and province-year fixed effects as well as baseline controls×year included. Standard errors in parentheses, clustered at the commune except in Column 4, whose outcome varies at the district-by-year level and is therefore clustered at the district level. Column 4's panel ends with the 2008 census. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table F.4: Land disputes, household outcomes, and land use: standardized estimates

	Land disputes		Household		Land cover		
	Any dispute (1)	log disputes (2)	Consumption (000s riel) (3)	Out-migr. (land loss) (4)	Forest cover (5)	Rubber (6)	Crop (7)
Cleared × High share letters	0.008	-0.036	0.443***	-0.148**	0.100	0.017	-0.000
	(0.198)	(0.192)	(0.145)	(0.066)	(0.070)	(0.016)	(0.015)
Cleared × Low share letters	0.436***	0.509***	-0.124	0.052	-0.078**	0.079***	0.086***
	(0.106)	(0.121)	(0.088)	(0.046)	(0.032)	(0.029)	(0.025)
Commune Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Province × Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Controls × Year Fixed Effects	✓	✓	✓	✓	✓	✓	✓
Observations	34,495	34,495	3,374	24,210	14,523	14,534	14,534
Clusters	1,614	1,614	985	184	1,377	1,378	1,378
Dep. Var. Pre-Treatment Mean	0.011	0.008	149.468	1.469	-0.021	0.074	0.950
Dep. Var. Pre-Treatment SD	0.106	0.074	107.643	1.149	0.140	0.268	1.056
P-value on difference	0.049	0.013	0.001	0.005	0.020	0.070	0.002

Notes: Table F.3 re-estimated on standardized outcomes; these are the units of Figure 5. Each outcome is divided before estimation by its pre-treatment standard deviation, reported in the *Dep. Var. Pre-Treatment SD* row, so a coefficient here is the corresponding coefficient of the raw table divided by that standard deviation. High-share-letters communes are those where the share of farming households holding pre-2002 letters of possession is at least 33 percent, the top decile of the commune distribution; the remaining communes are low-share-letters communes. Each row reports the clearance effect for one group, not an interaction. The last row reports the p-value on the difference between the two groups. All specifications are estimated using the DDI approach of Borusyak et al. (2024). Columns run on different panels: 1992–2014 for the dispute columns, 1999–2014 for consumption, and 2000–2010 for land cover. Nine province-year cells are excluded from the consumption column because their fixed effects are not estimable in that sub-sample. Commune and province-year fixed effects as well as baseline controls×year included. Standard errors in parentheses, clustered at the commune except in Column 4, whose outcome varies at the district-by-year level and is therefore clustered at the district level. Column 4's panel ends with the 2008 census. Pre-Treatment Mean reports the mean of the outcome among minefield communes in the years before clearance was completed. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table F.5: Two-way fixed effects estimation, clearance interacted with letters

	ELCs		Nightlights	
	Any ELC	log ELC area	Any NTL	log NTL
	(1)	(2)	(3)	(4)
Panel A: high-share indicator				
Cleared × High share letters	-0.051*	-0.644**	0.057	0.593
	(0.028)	(0.278)	(0.040)	(0.402)
Cleared	0.060***	0.786***	0.010	0.214**
	(0.016)	(0.167)	(0.010)	(0.096)
Commune Fixed Effects	Yes	Yes	Yes	Yes
Province × Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	34,747	34,747	34,673	34,673
Clusters	1,621	1,621	1,614	1,614
Dep. Var. Pre-Treatment Mean	0.028	0.537	0.081	-8.126
Panel B: continuous letters share				
Cleared × Share of letters	-0.095**	-1.287**	0.089	1.087*
	(0.046)	(0.509)	(0.063)	(0.620)
Cleared	0.064***	0.845***	0.008	0.170*
	(0.018)	(0.178)	(0.010)	(0.102)
Commune Fixed Effects	Yes	Yes	Yes	Yes
Province × Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	34,747	34,747	34,673	34,673
Clusters	1,621	1,621	1,614	1,614
Dep. Var. Pre-Treatment Mean	0.028	0.537	0.081	-8.126

Notes: Clearance effects on concessions and nightlights, estimated as a conventional two-way fixed effects regression in which completed clearance is interacted with the letters measure. Panel A interacts clearance with the high-letters indicator that divides communes in the main text, so the interaction reports the difference between communes where letters are common and communes where they are rare. Panel B replaces that indicator with the underlying share of farming households holding a pre-2002 letter, so the interaction reports the change in the clearance effect per unit of the share. The *Cleared* row is the clearance effect where the interacted variable is zero, that is, in communes where letters are rare in Panel A and at a letters share of zero in Panel B. Outcomes are any ELC, log ELC area (log(area + 1)), any nightlights, and log nightlights. Estimated on 1992–2014. The observation counts differ from Table F.1 because the estimator is different. Commune and province-year fixed effects, no control variables, and commune-clustered standard errors. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

G Alternative Explanations

We have taken letters of possession to measure documented claims in a commune. That reading fails if the letters instead stand in for some other commune attribute that produces the same heterogeneity, so we test three: the demining operator, the value of the land, and state capacity. What each test can show depends on how the attribute correlates with the letters (Table 6). An attribute uncorrelated with the letters can produce differences of its own without contributing to the letters difference, while a split on a correlated attribute partly recovers that difference whether or not the attribute raises the returns.

G.1 Operator Identity

If communes where letters are common were cleared by a more effective operator, the returns we attribute to documentation would belong to clearance quality instead. We assign each cleared commune the operator that cleared its largest area and re-estimate the clearance effects separately by operator. CMAC is dominant in 441 of the 544 cleared communes in the estimation sample, HALO Trust in 57, and MAG in 46. Nightlights do not respond to clearance under any operator, with none of the three estimates distinguishable from zero (Table G.1). Concessions do concentrate in CMAC communes, rising by 4.6 percentage points against small and insignificant responses under the international operators. But that difference cannot enter the letters split, because neither the letters share nor the high-share indicator correlates with CMAC clearance (column 2 of Table 6).

G.2 Land Value

Another alternative mechanism for heterogeneity in clearance effects is through land quality. We document that concessions appear after clearance in communes with a low letters share. If

Table G.1: Returns to clearance by demining operator

	ELCs (1)	log ELC Area (2)	Any NTL (3)	log NTL (4)
Cleared × CMAC	0.046***	0.834***	0.013	0.223**
	(0.013)	(0.169)	(0.011)	(0.109)
Cleared × HALO	0.015	0.441	-0.002	-0.022
	(0.019)	(0.425)	(0.019)	(0.166)
Cleared × MAG	0.006	0.017	0.002	-0.045
	(0.032)	(0.323)	(0.013)	(0.138)
Communes (CMAC / HALO / MAG)		441 / 57 / 46		
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Commune & Province × Year FE	✓	✓	✓	✓
Controls × Year FE	✓	✓	✓	✓

Notes: Heterogeneous clearance effects by dominant demining operator, the operator with the largest cleared area in the commune, built from the minefield-level clearance records (CMAC, HALO Trust, MAG). Each row reports the clearance effect for one dominant-operator group, not an interaction. Never-cleared communes stay in the estimation as controls. Outcomes are any ELC, log ELC area, any nightlights, and log nightlights. All specifications are estimated on 1992–2014 using the DDI approach of Borusyak et al. (2024). Commune and province-year fixed effects as well as baseline controls×year included. Standard errors clustered at the commune level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

letters are more common where land value is lower, then the heterogeneity we document may reflect land quality. Close to half of concession areas are used for rubber, while sugarcane and cassava are also common plantation crops for concessions, so to measure land value we combine suitability for the three into a standardized index (Anderson, 2008). First, within provinces letters do not correlate with our land-value index (column 3 of Table 6). Second, we split the effects of clearance in our baseline model at the median of our land value index. In Table G.2, we observe that clearance effects for nightlights do not diverge by land quality while concessions do.

Concessions rise by 7.1 percentage points on high-value land, while there is no effect on low-value land. This means that once clearance makes land safe, concessions are drawn to land valuable for the crops they often deploy. The land-value index predicts where concessions locate, not where clearance raises development.

Table G.2: Returns to clearance by land value

	ELCs (1)	log ELC Area (2)	Any NTL (3)	log NTL (4)
Cleared × High land value	0.071***	1.264***	0.011	0.196
	(0.021)	(0.232)	(0.012)	(0.121)
Cleared × Low land value	-0.005	-0.031	0.009	0.133
	(0.008)	(0.168)	(0.013)	(0.122)
Cleared communes (High / Low)		340 / 204		
Observations	34,495	34,495	34,495	34,495
Clusters	1,614	1,614	1,614	1,614
Commune & Province × Year FE	✓	✓	✓	✓
Controls × Year FE	✓	✓	✓	✓

Notes: Heterogeneous clearance effects split at the median of the land-value index, an inverse-covariance standardized index of commune soil suitability for rubber, sugarcane, and cassava (Anderson, 2008). Each row reports the clearance effect for one side of the median, not an interaction. Never-cleared communes stay in the estimation as controls. Outcomes are any ELC, log ELC area, any nightlights, and log nightlights. All specifications are estimated on 1992–2014 using the DDI approach of Borusyak et al. (2024). Commune and province-year fixed effects and baseline controls×year included. Standard errors clustered at the commune level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

G.3 State Capacity

Communes where letters are common may also have more capable administrations. If so, the returns we attribute to documentation would belong to state capacity instead. We measure the capacity of the local administration with six proxies: the share of households with public electricity in 1998, the share with piped water in 1998, distance to the 2002 transmission grid, distance to the provincial capital, distance to the nearest road, and the presence of a commune (*khum*) office in the 1970s.[34]

We combine these into a standardized index (Anderson, 2008) and split the effect of clearance at its median.[35] This index rises with the letters share within provinces (column 5 of Table 6). A commune with high measured capacity is disproportionately a commune

[34] The electrification and piped-water shares are measured in 1998 and the transmission grid in 2002, after clearance had begun, so these three proxies could themselves respond to clearance. The khum-office indicator is the only proxy measured before both the letters and the clearance program.

[35] We drop the road- and provincial-capital-distance controls because they are components of the index.

with many letters. Hence, splitting on capacity alone recovers part of the letters difference whether or not capacity itself raises the returns.

To separate the two, we hold state capacity fixed while letting the letters share vary. In Table G.3, we re-estimate the effect of clearance split by letters within each half of the capacity index. Concessions appear after clearance in low-letters communes whether capacity is high or low. Thus, land moves to concessions where letters are few rather than where the administration is weak. Nightlights, by contrast, rise only where letters and capacity are both high.

Documentation and state capacity therefore do different work. Letters reduce the concessions that follow clearance, while development also requires an administration able to support it.

Table G.3: Documented claims and state capacity as complements

	ELCs (1)	log ELC Area (2)	Any NTL (3)	log NTL (4)
Above-median state capacity				
Cleared × High share letters	-0.010	-0.208	0.086***	1.038***
	(0.015)	(0.174)	(0.026)	(0.237)
Cleared × Low share letters	0.050***	0.785***	-0.008	0.026
	(0.019)	(0.245)	(0.023)	(0.234)
Communes (High share letters / Low share letters)		103 / 705		
Observations	17,543	17,543	17,543	17,543
Clusters	808	808	808	808
Below-median state capacity				
Cleared × High share letters	0.036	0.821***	-0.040***	-0.554***
	(0.030)	(0.262)	(0.012)	(0.135)
Cleared × Low share letters	0.060***	1.102***	-0.003	-0.042
	(0.020)	(0.227)	(0.013)	(0.119)
Communes (High share letters / Low share letters)		62 / 744		
Observations	16,937	16,937	16,937	16,937
Clusters	806	806	806	806
Commune & Province × Year FE	✓	✓	✓	✓
Controls × Year FE	✓	✓	✓	✓

Notes: The table re-estimates Equation 2 for the letters split within each half of a median split on the state-capacity index. Each panel is estimated on its own subsample, so control communes and year effects come from the same capacity half. High-share-letters communes are those where the share of farming households holding pre-2002 letters of possession is at least 33 percent, the top decile of the commune distribution; the state-capacity index combines six proxies with inverse-covariance weights (Anderson, 2008) and is split at its median. Each row reports the clearance effect for one letters group within that capacity half, not an interaction. Outcomes are any ELC, log ELC area, any nightlights, and log nightlights. All specifications are estimated on 1992–2014 using the DDI approach of Borusyak et al. (2024). Commune and province-year fixed effects as well as pre-existing commune characteristics interacted with year fixed effects are included (latitude, longitude, their interaction, log US bombing loads, log pre-Khmer Rouge population, and soil fertility; road and provincial-capital distances are components of the capacity index and are excluded to avoid bad controls). Standard errors clustered at the commune level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

H Additional Background

This section adds detail on the three institutional elements of Section 2, covering the clearance program, the letters of possession, and the economic land concessions in turn. A final subsection documents the land disputes that concessions generate.

H.1 Landmine Clearance

Beyond the three principal operators, several international humanitarian organizations supported or contributed to clearance operations, including Handicap International, Norwegian People's Aid, World Vision, and CARE (Maxwell, 2001). In September 2000, the government established the Cambodian Mine Action and Victim Assistance Authority (CMAA) to regulate and coordinate mine action nationwide, responsibilities previously assigned to CMAC (Mine Action Review, 2016).

The prioritization of clearance evolved in two phases. In the early post-conflict years, demining was an emergency humanitarian response led by international organizations. Operators tasked sites by the urgency of the threat and their technical accessibility, worked largely independently of the Cambodian state, and were funded directly by external donors (Maxwell, 2001). The need to integrate socio-economic considerations into the planning system emerged around 1996 and 1997, directed at the use of cleared land and its intended beneficiaries rather than at ranking sites by economic return (Geneva International Centre for Humanitarian Demining, 2016). Sub-Decree No. 70 then assigned planning to provincial bodies (Royal Government of Cambodia, 2004). Mine Action Planning Units (MAPUs) prepare the annual clearance task lists, and Provincial Mine Action Committees (PMACs) review and approve them together with the CMAA (Mine Action Review, 2016; Geneva International Centre for Humanitarian Demining, 2016). In this second phase, the national

list of priority communes rested on casualty data (Mine Action Review, 2016). Across both phases, sites were ranked on the threat they posed and on where casualties fell. Neither phase ranked them on what the cleared land would be worth.

H.2 Letters of Possession

Letters of possession are the established local instrument of land documentation in rural Cambodia. They are not registered cadastral titles and cannot be mortgaged at the Land Office (Article 199) (National Assembly of Cambodia, 2001), although microcredit institutions do lend against them (Diepart and Sem, 2018).

The commune chief (*me khum*) stands at the center of the institution, in a certifying role that dates to the French protectorate (Diepart, 2015; Diepart and Sem, 2015). Within the registration system in place from 1989, applications for possession rights required verification by the village and commune chiefs before the cadastral office took them up (Diepart and Sem, 2018; Diepart, 2015). Claims could also rest on purchases authorized or witnessed by the local authorities outside that chain (So, 2010). Because the formal system's cost and opacity stalled most rural households long before a certificate issued (Diepart, 2015; Van Acker, 1999), these locally certified papers remained the countryside's de facto documentation of landholding (Grimsditch and Henderson, 2009).

H.3 Economic Land Concessions

The modern concession economy re-emerged in the 1990s, dominated by forestry (Diepart and Schoenberger, 2016; Diepart, 2015). The 2001 Land Law established the framework for Economic Land Concessions, granting companies development rights over areas of up to 10,000 hectares. The stated purposes were to stimulate agricultural and industrial activity

in rural regions, generate employment, and develop idle land (Diepart and Schoenberger, 2016). Local communities have frequently contested official claims that the land granted to concessions was degraded or idle (Diepart and Schoenberger, 2016; Neef et al., 2013).

Two features of the land regime enabled reclassification at scale. First, the official land titling system, established in 1989,[36] required a multi-step process involving village, commune, and district officials, along with a site survey. This complexity created bottlenecks and opened the door to petty corruption, and many low-income farming families were discouraged from participating (Diepart, 2015).[37] Following the 2001 reforms, the World Bank supported a project to improve land titling and property rights, but progress was slow, and critics argued that the reform disproportionately benefited wealthy investors (Milne, 2013). While the 2001 Land Law established the legal basis for large-scale land concessions, it did little to secure the claims of Cambodia's rural poor (Diepart, 2015).

Second, the 2001 Land Law provided the mechanisms through which land could be reclassified as state private land and allocated to companies under concessions.[38] Several studies document problems in the implementation of these provisions. Scheidel (2016) argues that projected benefits to local communities were frequently overstated. United Nations reports document forced displacement and inadequate compensation for families removed from land designated for concession development (Subedi, 2014; United Nations Cambodia Office of the High Commissioner for Human Rights, 2007). Diepart (2015) highlights a

[36] The formal system is distinct from the letters of possession described in Section 2. Hard titles carry legal ownership rights and can be registered as mortgage collateral, whereas letters of possession document occupancy without conferring state-sanctioned ownership.

[37] Evidence from the 1990s suggests that only around 10% of applications were successfully processed (Van Acker, 1999).

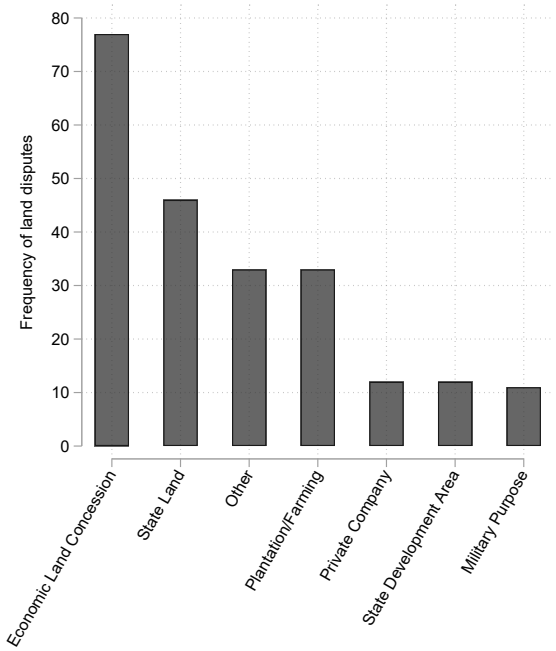
[38] Article 7 of the 2001 Land Law refuses recognition to ownership regimes predating 1979, and Article 12 vests in the State the ownership of land that has not been duly and properly appropriated privately or is not presently being privately occupied (National Assembly of Cambodia, 2001). Officials invoked the land's status as state land in meetings with affected villagers (Neef et al., 2013). Where mines had interrupted occupation and use, land was at particular risk of falling within these provisions, especially where historical claims predate 1979. Article 49 further allows concession beneficiaries to clear the land for industrial agricultural exploitation.

lack of transparency in the attribution of concession contracts and finds that concession areas on the ground exceeded the contracted areas. Logging beyond concession boundaries has contributed to deforestation (Pauly et al., 2022).

H.4 Land Disputes

Concessions are the leading recorded cause of land disputes, ahead of state claims to the land and of the commercial plantations established on it (Figure H.1). This pattern lets recorded disputes stand in for contested reallocation in Section 6.3.

Figure H.1: Causes of land disputes



Notes: The figure shows the 224 land disputes recorded between 1992 and 2014 whose cause the NGO Forum records name, grouped by that cause. The remaining disputes have no cause recorded. Data sources reported in Table I.1.

I Data Sources and Construction

Section 3 names each data source and what it measures. This subsection provides details on their construction.

Administrative units and boundaries. Cambodia is divided into 24 provinces (*khett*, excluding Phnom Penh), 194 districts (*srok*), 1,621 communes (*khum*), and 14,057 villages (*phum*) in the 2014 administrative boundaries published by Open Development Cambodia. We aggregate every source to the commune level on those boundaries.[39] Shapefiles with consistent territorial designations are not available for earlier periods, so the panel uses one boundary vintage throughout.

Clearance records. Where a commune records neither clearance nor a landmine-related incident over the period the data cover, we infer that no minefield was present. Cambodia is not fully cleared today, so the rule assigns untreated status rather than certified safety.[40]

Concessions. The concession records are distributed through the Open Development Cambodia project and were made available through the Cambodian League for the Promotion and Defense of Human Rights (LICADHO).[41]

Nightlights. The blooming correction follows Cao et al. (2019) and removes false light caused by sensor bleed from bright neighboring pixels. The top-coding correction follows Bluhm and Krause (2022) and imputes true brightness for saturated pixels using radiance-calibrated reference data (Chiovelli et al., 2026). A commune counts as lit when its mean

[39] Available at https://data.opendevelopmentcambodia.net/en/dataset/administrative-boundaries-of-cambodia-2014.

[40] See the Landmine and Cluster Munition Monitor Cambodia report at https://the-monitor.org/country-profile/cambodia/impact?year=2023.

[41] Available at https://data.opendevelopmentcambodia.net/en/dataset/economiclandconcessions.

corrected luminosity exceeds 0.22, the 33rd percentile of the distribution of positive luminosity values. We compute that percentile once, on the 1992 to 2014 estimation window, and hold the resulting cut fixed across every year, so that the definition does not move with the panel's end date. We treat luminosity below that cut as unlit rather than as faint light. The blooming correction removes sensor bleed pixel by pixel, but it cannot verify what survives it. A reading in the lower tail of the positive distribution is more likely to record light spilled from a bright neighbour than electrification of the commune itself. Coding those readings as zero ensures that we capture actual development rather than a spurious signal. Roughly 8 percent of commune-years clear the cut, against 12 percent that record any positive light at all. Because any such cut is arbitrary, Figure C.1 re-estimates the average effect at every threshold from any positive luminosity up to a mean corrected reading of one, which retains only the brightest 44 percent of lit commune-years.

Casualty records and the civilian classification. The casualty resource comes from the Cambodia Mine/ERW Victim Information System (CMVIS), established in 1994 by the Cambodian Red Cross and Handicap International (International Campaign to Ban Landmines, 2004) and later managed by the Cambodian Mine Action and Victim Assistance Authority, and is distributed through the Open Development Cambodia project.[42] Unexploded ordnance appears as explosive remnants of war (ERW) in the original files. We classify each casualty by an occupation-primary, land-use-fallback rule. From 1997 to 2004 the records report the victim's occupation, and an incident is non-civilian only when the victim is a soldier, a police officer, or a mine-clearance worker. From 2005 to 2013 the records report only the land use at the incident site, and an incident is non-civilian only when that site is military or an active demining site. Communes absent from the records in a year are assigned zero casualties.

[42] Available at https://opendevelopmentcambodia.net/.

Land cover. The MODIS imagery behind the NDVI series is available at https://modis.gsfc.nasa.gov/data/dataprod/mod13.php.

Variable definitions. Table I.1 defines every variable that enters a table or figure of the paper and names its source. Variables that appear only as descriptive series within a single exhibit are defined in that exhibit's note.

Table I.1: Variable definitions and sources

Variable	Description	Source
Treatment		
Cleared	Indicator equal to one in commune-years after every recorded minefield in the commune has been fully cleared.	CMAC and HALO Trust, via ODC
Documented land claims		
Letters share	Share of a commune's farming households holding a letter of possession issued before 2002.	2013 Agricultural Census
High share letters	Indicator equal to one where the letters share is at least 33 percent. Low share letters denotes the remaining communes. Figure E.3 reports alternative cutoffs.	2013 Agricultural Census
Reform-title share	Share of a commune's farming households holding a title issued under the systematic titling program that followed the 2001 Land Law.	2013 Agricultural Census
Post-2001 Reform Land Titles / High Share Letters / Low Share Letters	Three-way classification of communes by the documentation they hold. A commune falls in the first group if its reform-title share is in the top decile, in the second if it is a high-share-letters commune outside that decile, and in the third otherwise.	2013 Agricultural Census
Outcomes: victimization		
Any Civilian Victims	Indicator equal to one if a commune records any civilian casualty from a mine or explosive remnant of war in a year. Civilian status follows the occupation-primary, land-use-fallback rule of Appendix I. Available from 1997 to 2013.	OCHA; CMVIS, via ODC
Civilian Victims	The number of such casualties in the commune-year.	OCHA; CMVIS, via ODC
log Civilian Victims	log(Civilian Victims + 1).	OCHA; CMVIS, via ODC

Table I.1 continued from previous page

Variable	Description	Source
Outcomes: economic development		
Any NTL	Indicator equal to one if the commune's mean corrected luminosity in a year exceeds 0.22, the 33rd percentile of the distribution of positive luminosity values. Readings below the threshold are coded as unlit because residual blooming makes faint positive values unreliable.	DMSP (Li et al., 2020); authors' correction following Chiovelli et al. (2026)
log NTL	log(mean corrected luminosity + 0.0001).	DMSP (Li et al., 2020); authors' correction following Chiovelli et al. (2026)
Market access (time-varying)	Index built from nightlights and each year's transport network, following Chiovelli et al. (2025) and constructed in Section D.1. Available through 2010. It enters as an outcome in Table D.2 and as a control elsewhere.	Authors' calculations
Initial market access	The commune's market access before clearance, evaluated on the 1992 network. It enters Table D.1 interacted with year fixed effects, so that baseline connectivity cannot drive the estimates.	Authors' calculations
Outcomes: land allocation and contestation		
ELCs	Indicator equal to one in commune-years after an economic land concession granted under the 2001 Land Law is present. Concessions granted earlier are excluded.	LICADHO, via ODC
log ELC Area	log(concession area in hectares + 1).	LICADHO, via ODC
Any Disputes	Indicator equal to one if any land dispute has been recorded in the commune by that year.	NGO Forum on Cambodia
Number of Disputes, log Disputes	Cumulative number of recorded disputes in the commune by that year, and log(that count + 1).	NGO Forum on Cambodia
Outcomes: land cover		
Forest cover	The minimum normalized difference vegetation index (NDVI) recorded in the commune-year. Available from 2000 to 2010.	MODIS/Terra Vegetation Indices
Crop	log(area in km^2 + 1) under crops other than rice, which is grown throughout the country and does not mark commercial conversion. Available from 2000 to 2010.	RLCMS (Saah et al., 2020)
Rubber	log(area in km^2 + 1) under rubber. Available from 2000 to 2010.	RLCMS (Saah et al., 2020)
Outcomes: household welfare and migration		

Table I.1 continued from previous page

Variable	Description	Source
log Consumption	log of commune-mean household consumption expenditure. Available from 1999 to 2014.	CSES
Out-migrants	log(1 + out-migrants from the origin district in a departure year), for departures the migrant attributed to lost land or house. Measured by district and year rather than by commune.	2008 Population Census
Attributes tested as alternative explanations		
CMAC dominant	Indicator equal to one if CMAC cleared the largest area of any operator in the commune.	CMAC and HALO Trust, via ODC
Land value	Inverse-covariance index (Anderson, 2008) of agro-ecological suitability for rubber, sugarcane, and cassava.	GAEZ
State capacity	Inverse-covariance index (Anderson, 2008) of six proxies for the capacity of the local administration: the 1998 shares of households with public electricity and with piped water, the distance to transmission lines in service by 2002, the distance to the provincial capital, the distance to the nearest road, and the presence of a commune office in the 1970s. The three distances enter with a negative sign.	1998 Population Census; ODC
Baseline controls, interacted with year fixed effects		
Longitude, Latitude, Longitude × Latitude	Coordinates of the commune centroid, in degrees, and their interaction.	Commune boundary geodata
log Bombing Load	log number of US bombs dropped on the commune.	Yale Cambodian Genocide Program; Bühler and Madestam (2026)
log Distance to Road	log mean distance to the nearest road, in kilometers.	U.S. Army topographic maps (Series L7016), digitized by Bühler and Madestam (2026)
log Distance to Provincial Capital	log distance to the provincial capital, in kilometers.	Commune boundary geodata
log Pre-Khmer Rouge Population	log commune population before the Khmer Rouge period, proxied by the number of huts per unit area.	Bühler and Madestam (2026)
Soil Fertility	Share of commune area classified as high-fertility soil by Save Cambodia's Wildlife's Atlas Working Group.	Open Development Cambodia