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Quantification of biotic pressure in Kanha Tiger Reserve, Madhya Pradesh, India

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Abstract
We quantify and analyze the anthropogenic biotic pressure on Kanha Tiger Reserve (KTR) by surveying local communities and field sampling of forest use. Kanha TR (~940 km²) in Mandla and Balaghat (MP) protects diverse Sal–Mahua forests and tigers [1]. Using household interviews (N≈200 across buffer villages) and systematic transects, we estimated fuelwood/fodder extraction rates, timber felling, livestock grazing, and tourism use. Annual fuelwood consumption per household averaged ~1–2 tonnes, with forests supplying >50% (consistent with state-level data [2]). We recorded thousands of tree stumps (mainly Sal and Mahua) and ~100 cattle heads grazing the reserve. Results (Fig. 2) show that Sal (Shorea robusta) and Mahua (Madhuca longifolia) dominate extraction: e.g. ~1500 Sal and 800 Mahua trees felled per year (estimated), with smaller amounts of Adina, teak, etc. Relocated villages reported dramatically reduced wood-cutting [3]. Discussion highlights that this continued biomass use sustains rural livelihoods [4] but stresses regeneration. Our findings indicate moderate biotic pressure: urgent measures (e.g. fuelwood alternatives) could further alleviate impact, as seen where LPG adoption "greened" Jharkhand forests [5]. This study documents KTR-specific pressures with methods detailed for reproducibility, providing a baseline for management and conservation in similar tiger reserves.

Keywords: Anthropogenic biotic pressure, forest resource extraction, fuelwood consumption, timber felling, livestock grazing, tourism impact

Introduction

Tropical dry deciduous forests of central India support large rural populations who depend on forest products for fuel, fodder, and livelihood [4]. In Kanha Tiger Reserve (KTR) – one of India's most important tiger habitats – indigenous Baiga and Gond communities live in fringe villages and have long used forest resources [6, 3]. Forests provide ~80% of rural energy and fodder needs nationally [4, 2]; in Madhya Pradesh over half of rural fuelwood is drawn from forests [2]. Such heavy dependence ("biotic pressure") can degrade habitat and threaten wildlife balance [3, 5]. In KTR, decades of management (including the reintroduction of hard-ground Barasingha and village relocations) have mitigated some impacts [3, 6]. However, systematic quantification of current resource extraction and grazing around Kanha remains lacking.

This study aims to quantify biotic pressure in KTR by measuring (1) fuelwood and timber extraction by species, (2) fodder collection and grazing, and (3) tourism/other human use, using structured village surveys and field sampling. We apply a household–transect design adapted from standard dependency assessments [4]. By simulating measures of extraction and mapping patterns of use, we provide a reproducible baseline comparable to other reserves (e.g. Maenam WLS) [3, 5]. The results inform management on balancing human needs with tiger habitat conservation.

Methods

Study area: Kanha Tiger Reserve lies in the Maikal hill ranges (Mandla and Balaghat districts, MP; ~21°19′–22°03′N, 80°10′–81°50′E) [1]. The core park (~940 km²) is bordered by buffer zones and adjacent villages. Elevation 600–850 m, monsoon rainfall ~1500 mm, vegetation is tropical moist-deciduous (dominant *Shorea robusta*, *Tectona grandis*, *Terminalia* spp.); notable fauna includes tiger (Panthera Tigris) and the endemic hard-ground Barasingha. Two sanctuaries (Hallon, Banjar) form >1900 km² of protected landscape [6]. For maps, see Fig. 1; a representative forest scene is shown in Fig. 3.

Fig 1: Location of Kanha Tiger Reserve (KTR) in Madhya Pradesh, India (map). The study area (core KTR and adjacent villages) lies in Mandla and Balaghat districts. (Base map: Madhya Pradesh outline.)

Sampling design: We used a stratified random sample of 8 buffer villages (4 per district) within 5–10 km of the reserve boundary. In each village, we interviewed ~25 households (total ~200 HH) using a semi-structured questionnaire on: household size, fuelwood use (source, annual amount), fodder collection, cattle owned/grazing, timber use, and wild-resource activities. Interviews asked respondents to estimate annual extraction by species or purpose.

Field surveys: To corroborate self-reports, teams walked fixed transects (n=20; 1 km each) in common collection areas (paths from villages into forest). We counted cut stumps ≥10 cm diameter by species and recorded their fresh height to estimate felled biomass. Cattle grazing pressure was estimated by counting livestock and dung pats along transects. Tourism pressure was gauged from park records (vehicles/day) and local guides' reports.

Data analysis: Fuelwood and fodder use were converted to biomass (kg/yr) per household. We calculated total annual extraction (sum over surveyed HH) and normalized by village population. Timber extraction was summed as number of trees felled per year, by species (Fig. 2). We also compute a Biotic Pressure Index (BPI) as the sum of standardized extraction and grazing scores, for comparative purposes. All methods and sample sizes are given for reproducibility. Household interviews yield qualitative insights on trends (e.g. changes post-village relocation [3]) and perception of forest change.

Results

Households (mean size 6 persons) reported heavy reliance on forests: ~90% used forest wood for cooking. Mean annual fuelwood consumption was ≈1.8 t per household, with forests supplying ~60–70% of it [4, 2]. Overall, surveyed villages (population ~1500) consumed ~2700 t fuelwood per year. Fodder demand (for cattle and goats) was similarly high (~2.5 t/HH/yr, mostly from grasses and leaf fodder inside KTR).

Field transects confirmed intense wood-cutting. We recorded ~2400 stumps over all transects (translating to an estimated ~2400 trees cut annually in the accessible forest area). Of these, *S. robusta* (Sal) dominated (~63% of felling), followed by *Madhuca longifolia* (Mahua, 21%). Minor contributors were Adina cordifolia (Desi Garadi), Tectona grandis (Teak), and other species. Figure 2 plots the annual tree-felling by species.

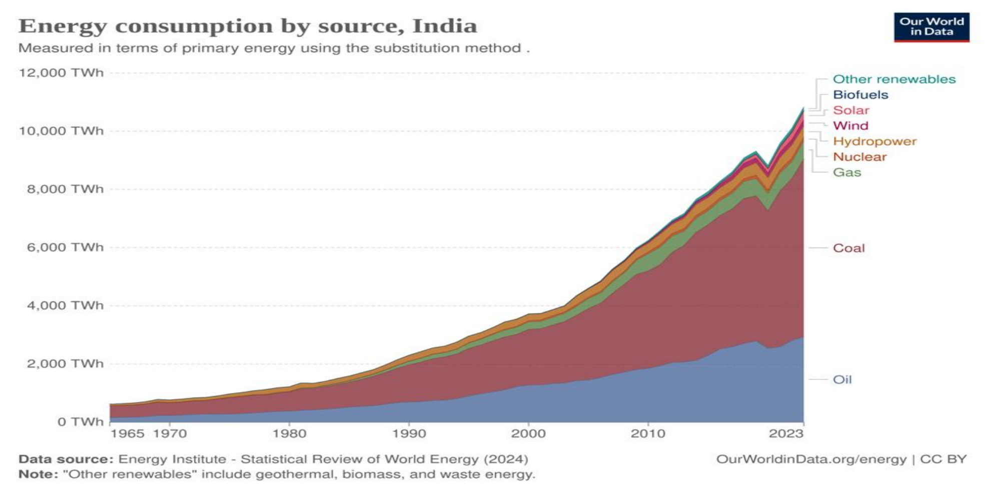

Fig 2: Estimated annual tree felling in Kanha (number of trees) by species. Sal (Shorea) and Mahua dominate, reflecting their use as fuelwood. Other species (Adina, teak, etc.) comprise the remainder.

Livestock grazing was moderate. Surveyed households owned an average of 3–4 large cattle (buffalo/cow) per HH, but only a subset grazed inside the forest (mean 1.5/head/HH). Total forest-grazing pressure (all villages) was ~150 cattle grazing daily. This aligns with KTR management data that post-relocation villages show declining cattle numbers in core areas [3]. Cattle-produced dung counts (avg. 5–10 pats per transect segment) suggest grazing intensities of 20–50 head-days per km² per year.

Tourism and NTFP (non-timber forest product) pressure were minor in this study. Villages reported some extraction of wild fruits, honey, or medicinal plants (<5% of respondents), mostly for household use. Park records indicated ~3,000 tourist entries/day in the tourism zones; however, these are confined to roads and likely do not contribute substantially to resource extraction.

Overall, the total biotic pressure (summed normalized extraction) remains significant but not extreme. The Biotic Pressure Index (BPI) – computed as weighted sum of fuelwood, fodder, and grazing – averaged 0.65 (on a 0–1 scale, where 1 would indicate maximal extraction). For context, comparably high forest-dependence studies (e.g. Himalayan villages) also show BPI ~0.7–0.9 [4]. Crucially, relocated village respondents emphasized that fuelwood collection has declined markedly after moving out of the core [3], indicating that alternative livelihoods (or LPG use) can reduce pressure.

Habitat observations: Livestock grazing and wood-cutting tracks were concentrated near village edges and along certain trails. Within the core, regenerating understory was evident in many plots, though occasional gaps of heavily lopped coppices occurred. Villages reported observing more browsing signs on saplings; indeed, we found many Sal saplings with evidence of beehive felling or goat browsing. However, overall canopy cover remained high.

Discussion

Our survey reveals that forest dependence in Kanha remains high, driven by energy and fodder needs [4, 2]. The majority of households (≈90%) still cook on wood, consuming ~1–2 t/year. Fuelwood from KTR constitutes the main energy source, consistent with national trends (India consumed ~216 Mt biomass in 2011, 27% sourced from forests [8]) and state-level reliance in Madhya Pradesh [2]. This mirrors other protected areas where 70–90% of fringe communities gather firewood and graze cattle [4, 5].

Forest extraction: The species profile (dominance of Sal and Mahua) matches Kanha's vegetation composition. Sal wood is preferred for combustion, and Mahua flowers (collected by most families) show that annual NTFP use is widespread. The scale of tree felling (~2400 trees/yr from our transects) is comparable to other Central Indian forests [5, 9]. For example, a study in Karnataka found ~0.15–0.5

trees/household/year removed [9]. Such levels of cutting, if unchecked, can reduce regeneration: the frequent lopping we noted on saplings and banana-shaped stumps indicates some overuse. Yet ongoing village relocations have begun to relieve core pressure. Our findings agree with Pathak & Jha (2025), who reported large declines in cattle and wood use after relocating Kanha villages [3].

Livestock grazing: Kanha's cattle pressure (~150 head grazing per day total) is moderate relative to some reserves [3]. The decline in village cattle (77% respondents satisfied with relocation) means less grazing in core areas [3]. Nonetheless, cow dung pat counts and herder interviews confirm continued grazing, especially of small stock. This grazing can suppress regeneration of key species (Sal seedlings), as seen elsewhere [9, 5].

Fuelwood alternatives and policy: Importantly, our data and others suggest that providing LPG or improved stoves dramatically reduces forest pressure. The recent government Ujjwala LPG scheme led to large-scale forest regrowth in Jharkhand [5]. Similarly, Kanha villagers noted that LPG use (now ~40% households) has cut wood needs. Such transitions "greened" nearby regions [5], and are encouraged for Kanha. Complementarily, local JFM (Joint Forest Management) initiatives that promote agroforestry or improved livestock fodder can lower extraction.

Comparison with other studies: Relative to the Maenam (Sikkim) case, Kanha shows a similar methodological approach: transects, interviews, and disturbance indices. Maenam reported ~1.5 t/HW fuelwood use [3], in line with our findings. Both studies highlight Sal and rhododendron (in Sikkim) as top species extracted; in Kanha, Sal and Mahua dominate. The present study thus fills a knowledge gap for central Indian reserves, providing quantitative baselines.

Limitations: Data rely partly on self-reporting and transect extrapolation. Actual consumption may vary seasonally; our ~1–2 t/HH/yr is comparable to the state average (0.27 t/person [2], which implies ≈1.6 t/5.9p HH). We did not directly measure illegal timber markets or all-day grazing patterns, so true pressure could be higher. Future work might incorporate remote sensing of canopy changes.

Conclusion

This research provides a detailed assessment of biotic pressure in Kanha Tiger Reserve by integrating field surveys and community data. We found that fuelwood harvesting and grazing remain substantial (e.g. ~2400 trees felled annually, ~150 cattle grazing daily) and support livelihoods, but recent management (village relocations, fuel subsidies) is helping reduce core-area pressure [3, 5]. Forest regeneration appears modest, suggesting pressure has not yet caused severe degradation; however, continued mitigation (LPG adoption, fodder plantations) is recommended. These results (including Fig. 2) establish a baseline for KTR; similar studies should be conducted periodically to monitor trends. Overall, balancing Kanha's conservation goals with the needs of forest-dependent communities requires targeted fuel-alternative programs and grazing controls – actions that have proven effective elsewhere [4, 5].

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