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Land-Use Transitions and Land-Based Carrying Capacity in Philippine State Universities and Colleges under RA 11396

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Abstract. Republic Act No. 11396 requires Philippine State Universities and Colleges (SUCs) to classify landholdings into functional cores and align development with projected demand. A comparative case study was conducted for three SUCs representing contrasting site contexts: highland (Central Mindanao University, CMU), lowland (Davao del Sur State College, DSSC), and coastal (Sulu State College, SuSC). LUDIP land-use tables and GIS-derived area inventories were harmonized to RA 11396 cores and analyzed under existing and proposed scenarios. Percentage-point shifts by core were used to identify whether institutions prioritize research expansion, support infrastructure, or production-land conversion, while a land-based carrying-capacity module combined historical enrollment and LUDIP projection series to compute 2031 gross density and academic-core density. The results show distinct transition archetypes. CMU reallocates land toward academic and research functions under relatively low density pressure, indicating a research-enabling expansion pathway. In contrast, DSSC and SuSC exhibit stronger shifts toward allied services and administrative support while facing substantially higher projected gross and academic-core densities, suggesting that future compliance will depend less on horizontal expansion and more on vertical densification and space-efficiency strategies. These findings support an evidence chain linking

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statutory land-use mandates to measurable spatial change and practical capacity constraints in campus planning.

1 Introduction

In the Philippines, Republic Act No. 11396 formalized the role of Land Use Development and Infrastructure Plans (LUDIPs) for State Universities and Colleges (SUCs), anchoring campus land-use planning to a national mandate [1]. The implementing framework disseminated through CHED channels standardizes LUDIP reporting around functional land-use cores and planning templates that make land allocation comparable across institutions while still allowing institutional differentiation [2]. In this sense, LUDIPs serve both as compliance artifacts and as operational planning instruments.

Global sustainability frameworks reinforce why such planning must integrate both environmental limits and service delivery objectives. The 2030 Agenda for Sustainable Development emphasizes integrated planning and institutions' roles in advancing sustainable development outcomes [3], while UNESCO's ESD roadmap highlights the need for governance and planning that support learning systems and institutional transformation up to 2030 [4]. Within higher education research, sustainability is consistently framed not only as "greening operations," but also as integrating the environment, infrastructure, and institutional mission into coherent strategies and measurable commitments [5]. A recurring finding across global surveys is that sustainability implementation in universities is often uneven across institutional subsystems and is frequently constrained by governance, capacity, and measurement limitations [6]. Complementary work on campus environmental management systems likewise shows that implementation success depends on translating broad commitments into specific operational practices and participatory processes [7].

A practical implication is that campus sustainability discourse must be anchored in measurable indicators and defensible constraints. Sustainability assessment tools for universities emphasize structured evidence, comparable metrics, and planning capacity as prerequisites for meaningful benchmarking [8]. At the same time, SDG-oriented work cautions that aspirational sustainability narratives must be linked to institutional conditions that enable change in real settings [9]. Recent reviews of campus sustainability indicators similarly emphasize the need to select indicators that capture both "what exists" (resources, land, infrastructure) and "what must be supported" (people, functions, and growth) [10].

This paper focuses on a specific policy-to-physical-limits question: How do RA 11396-aligned land-use transitions interact with land-based carrying capacity under projected enrollment growth? We address this by linking (i) land-use transitions between existing and proposed LUDIP scenarios and (ii) land-based carrying-capacity screening using student density indicators to a 2031 horizon. The analysis uses three SUC cases with contrasting land contexts: CMU (highland, expansive estate), DSSC (lowland, compact estate), and SuSC (coastal, very compact estate), relying on their LUDIP documents and embedded projection series [11], [12], [13].

2 Materials and Methods

2.1 Study design and case selection

We adopt a comparative case-study design to examine how a common national planning mandate interacts with different physical land contexts. The three cases represent distinct constraint regimes and site contexts, enabling the analysis to separate policy-driven "core reallocation" signals from land-scarcity effects. CMU represents a large, topographically complex but land-abundant highland campus estate; DSSC represents a relatively small lowland estate; and SuSC represents a highly constrained coastal estate (Table 1).

2.2 Data sources and harmonization

Land allocation data were extracted from the institutions' LUDIP reporting tables for existing and proposed scenarios, structured by functional land-use cores used in CHED-aligned LUDIP practice [2]. The three primary documents are CMU's Draft LUDIP, DSSC's LUDIP, and SuSC's LUDIP [11–13]. Baseline enrollment and 2031 enrollment projections were taken from the same institutional planning records and harmonized to a consistent baseline-to-horizon format for density computations (Table 4).

To reduce duplication risk and maintain analytical boundaries, the dataset used here is limited to (i) total land area per campus; (ii) existing and proposed land shares by functional core; and (iii) baseline and 2031 projected student headcounts. Human-capital variables (e.g., faculty counts) and computational workflow details are intentionally excluded from this paper.

2.3 Land-use transition indicators

For each campus c and core category k, we compute land-share percentages under existing and proposed scenarios, then compute the percentage-point shift:

$$\Delta S_{c,k} = S_{c,k}^{proposed} - S_{c,k}^{existing} \tag{1}$$

Area in hectares is estimated from total campus area A_c and each core share $S_{c,k}$:

$$Area_{c,k} = A_c \times \frac{S_{c,k}}{100} \tag{2}$$

These computations allow parallel interpretation in relative (shares) and absolute (hectares) terms. Share values used in Tables 2–3 follow the reported LUDIP core allocations.

2.4 Land-based carrying capacity indicators

We treat carrying capacity here as a screening metric, not a full facilities capacity model. Two density indicators are computed for baseline and the 2031 horizon: (1) gross land-based density (students per total campus hectare), and (2) academic-core density (students per hectare of land allocated to the academic core in the proposed scenario), which reflects how instructional and academic functions might be spatially stressed if academic land is treated as the limiting "mission-critical" area.

Similarly, campus-quality literature emphasizes that spatial form and land allocation are enabling conditions that must be aligned with functions and services rather than treated as outcomes on their own [14]. For this reason, we interpret high densities as signals of planning attention (space efficiency, vertical expansion, shared facilities) rather than as definitive evidence of underperformance.

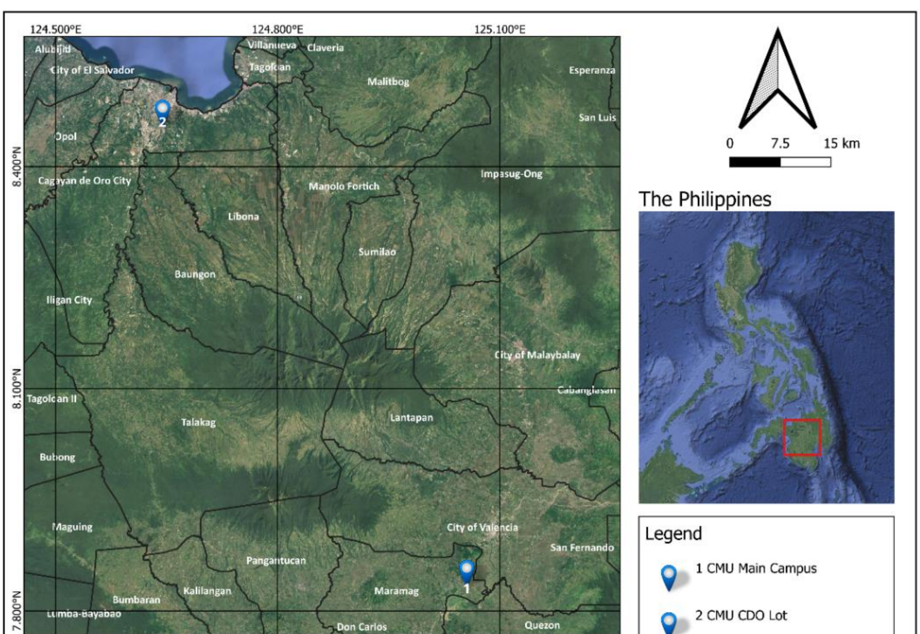
2.5 Validity checks and limitations

Two checks were applied. First, core shares were verified to sum to approximately 100% for each campus and scenario (minor deviations may result from rounding). Second, density values were cross-checked against reported totals and shares, with any small differences interpreted as rounding or reporting precision effects. The main limitation is that the analysis does not include floor-area ratios, building heights, classroom-laboratory scheduling, or service capacity; therefore, conclusions are framed as planning implications and plausible constraints rather than deterministic capacity limits.

3 Results and Discussion

3.1 Campus land resources and context

The three campuses differ not only in total land area but also in their geographic settings, which shape their planning options under RA 11396 (Table 1). CMU represents a highland, land-abundant estate; DSSC represents a more compact lowland setting; and SuSC represents a highly constrained coastal campus context. Figure 1 locates the three study sites and illustrates the geographic basis of the comparative design. This spatial contrast is important because the same statutory land-use transition may produce very different planning consequences depending on available estate area, surrounding development, and the feasibility of horizontal expansion.



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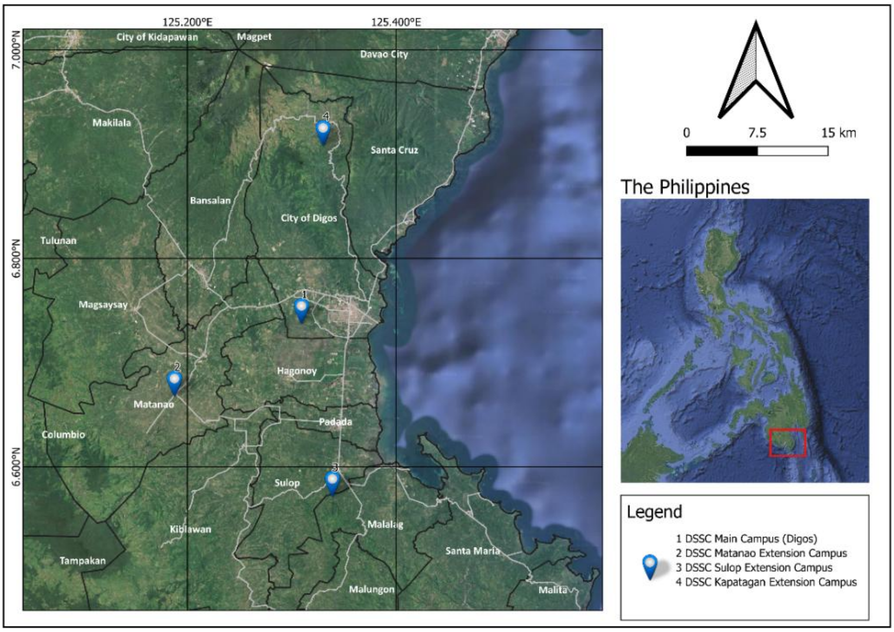

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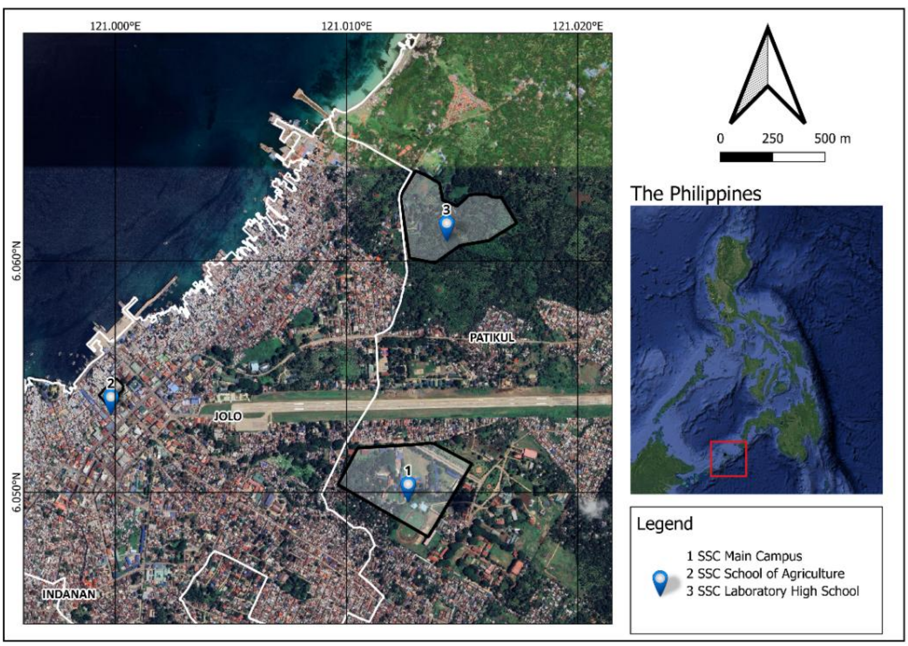

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Fig. 1. Geographic locations of the three case SUCs: (a) Central Mindanao University (CMU), Bukidnon — highland estate; (b) Davao del Sur State College (DSSC), Davao del Sur — lowland estate; and (c) Sulu State College (SuSC), Sulu — coastal estate.

Table 1. Campus profile and land resources of the three case SUCs.

Campus	Site context	Total area (ha)	Interpretation for planning constraints
CMU	Highland	3080.87	Land-abundant; transitions can be mission-driven rather than scarcity-driven
DSSC	Lowland	79.85	Land-constrained; reallocations compete under limited space
SuSC	Coastal	31.93	Highly constrained; densification and service-space tradeoffs are likely unavoidable

3.2 Existing and proposed land allocations by functional core

Table 2 translates the reported core shares into hectares, while Figure 2 provides a visual summary of how land-use priorities shift from the existing to the proposed scenario across the three campuses. The figure shows that the direction and magnitude of the transition differ substantially across land contexts. In CMU, the transition is characterized by modest but clear gains in academic and RDE allocations alongside a reduction in production land, consistent with a research-enabling expansion pathway within a land-abundant estate. In DSSC and SuSC, the proposed scenarios show stronger movement toward administrative and allied-services functions, indicating that support infrastructure and campus service capacity become more prominent priorities under land-constrained conditions.

Table 2. Existing vs. proposed land allocations (shares and estimated hectares) by functional core.

School	Core	Existing (%)	Existing (ha)	Proposed (%)	Proposed (ha)
CMU	Academic	4.65	143.26	6.83	210.42
	Administrative	0.4	12.32	0.52	16.02
	Allied services	1.5	46.21	1.61	49.6
	RDE	5.42	166.98	7.5	231.07
	Production	88.02	2711.78	83.54	2573.76
DSSC	Academic	12.18	9.72	7.5	5.99
	Administrative	12.91	10.31	14.44	11.53
	Allied services	5.08	4.06	10.06	8.03
	RDE	1.35	1.08	0.62	0.49
	Production	68.48	54.66	67.38	53.79
SuSC	Academic	55.67	17.77	40.35	12.88
	Administrative	17.78	5.67	18.62	5.94
	Allied services	2.09	0.67	13.51	4.31
	RDE	15.92	5.08	16.19	5.17
	Production	8.54	2.73	11.33	3.62

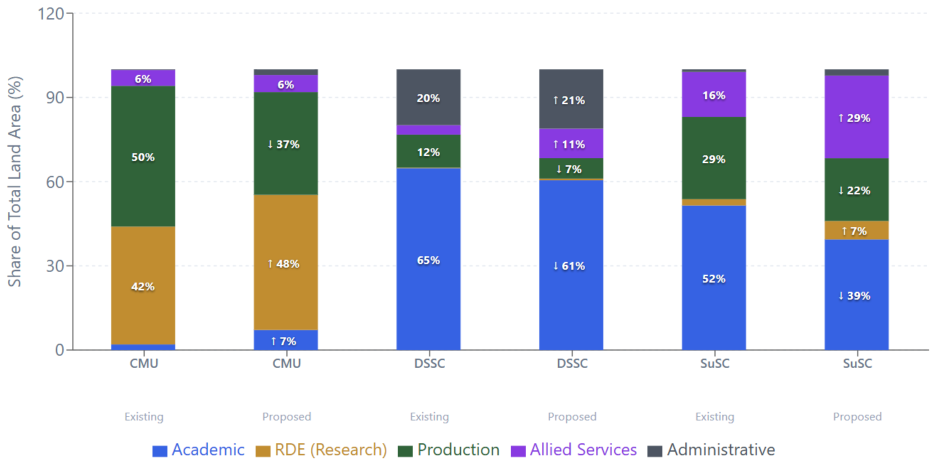

Fig. 2. Land-share transitions from existing to proposed LUDIP scenarios across the five functional cores for CMU, DSSC, and SuSC.

3.3 Land-use transitions and institutional "transition archetypes"

The share shifts summarized in Table 3 and visualized in Figure 2 clarify how campuses interpret compliance-driven planning priorities under different physical constraints. CMU's proposed plan increases academic and RDE shares while reducing production land, which is consistent with a research-enabling expansion logic in a land-abundant setting. DSSC, by contrast, shows declining academic share but notable gains in allied services and administrative land, suggesting that under tighter land budgets, the institution prioritizes enabling and support functions rather than horizontal academic expansion. SuSC exhibits the strongest shift away from academic land and toward allied services, indicating that in a highly constrained coastal estate, support functions and service infrastructure may be treated as urgent planning needs even when academic space must be intensified rather than expanded. By presenting these changes visually, Figure 2 makes the contrast among the three transition archetypes more legible than tabular comparisons alone.

DSSC exhibits a different signature: academic share decreases (-4.68 percentage points), while allied services increase (+4.98 percentage points) and administrative services increase (+1.53 percentage points). A plausible interpretation is that, given limited land, DSSC prioritizes enabling functions that reduce service deficits (e.g., circulation, student services, health and welfare spaces), even if it means relying on space-efficiency strategies for academic functions (e.g., multi-story academic buildings, shared classrooms, scheduling improvements). This is not necessarily a negative judgment; it suggests that the campus is using the proposed scenario to correct functional imbalances rather than simply expanding academic land horizontally.

SuSC shows the strongest reallocation away from academic land (-15.32 percentage points) toward allied services (+11.42 percentage points), with smaller increases in production and RDE. In a highly constrained coastal estate, this could reflect an attempt to reintroduce or formalize support functions that are often underprovided in dense, commuter-oriented settings. However, the magnitude of academic share reduction also raises an important planning question: whether academic functions can be adequately supported through vertical densification and space optimization without compromising learning environments. Campus-quality research cautions that spatial allocation should be evaluated in terms of function, accessibility, and experiential qualities rather than treated as a purely numerical optimization [15].

Table 3. Percentage-point shifts in land shares (Proposed − Existing) by core.

Campus	Academic	Administrative	Allied services	RDE	Production
CMU	2.18	0.12	0.11	2.08	−4.48
DSSC	−4.68	1.53	4.98	−0.73	−1.10
SuSC	−15.32	0.84	11.42	0.27	2.79

3.4 Land-based carrying capacity and planning implications for the three cases

Figure 3 visually compares baseline gross density, projected 2031 gross density, and projected 2031 academic-core density across the three campuses, while Table 4 reports the underlying density values. The figure makes the contrast especially clear: CMU remains relatively low-density even under projected growth, whereas DSSC and SuSC experience sharp increases in density, particularly when student numbers are expressed relative to the proposed academic-core land area. A campus may appear compliant in terms of land reallocation on paper, yet still face substantial spatial stress once projected enrollment is introduced.

Academic-core density further sharpens the planning implications. Under the proposed scenario, DSSC's academic-core density reaches 2310.99 students per academic hectare by 2031, while SuSC reaches 1452.25 students per academic hectare. These values should not be interpreted as automatic evidence of failure or poor educational conditions, because academic functions can still be delivered through multi-story buildings, shared-use scheduling, and more efficient space programming. The gap between CMU and the two land-constrained campuses is not marginal but structural. For compact campuses, future compliance with RA 11396 is likely to depend less on horizontal land redistribution and more on built-form adaptation and operational efficiency.

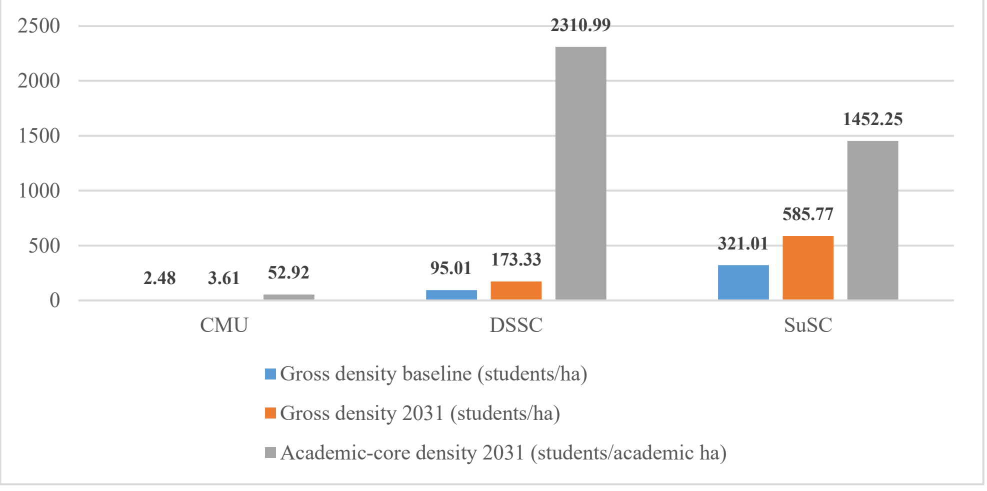

Fig. 3. Baseline versus 2031 gross density and academic-core density across the three campuses.

Table 4. Baseline and 2031 land-based density indicators.

Campus	Baseline students	2031 students	Total area (ha)	Proposed academic area (ha)	Gross density baseline (students/ ha)	Gross density 2031 (students/ ha)	Academic-core density 2031 (students/ academic ha)
CMU	7,645	11,133	3080.87	210.42	2.48	3.61	52.92
DSSC	7,587	13,839	79.85	5.99	95.01	173.33	2310.99
SuSC	10,250	18,705	31.93	12.88	321.01	585.77	1452.25

3.5 Policy-to-planning implications: when compliance becomes a physical necessity

The combined results suggest a grounded policy-to-physics interpretation of RA 11396. The law encourages systematic campus planning and infrastructure programming, while the implementing framework creates standardized land-use categories that support comparable reporting and prioritization across SUCs [1], [2]. Within that structure, CMU can treat compliance as an opportunity to rebalance land toward academic and research functions without severe estate-scale scarcity. DSSC and SuSC, however, face a more constrained reality: their proposed land transitions expand allied services and administrative enabling spaces while projected densities indicate that these campuses may operate under substantial spatial pressure by 2031. In such contexts, the feasible response shifts away from horizontal land consumption and toward design and operational strategies such as vertical academic buildings, shared facilities, scheduling optimization, and tighter integration of support services.

These findings also have implications for CHED's sustainability monitoring and oversight functions. Because the paper uses standardized land-use cores alongside density-based indicators, the resulting framework can serve as an initial screening tool to identify which SUCs may face the greatest implementation stress under LUDIP compliance. Campuses with low density pressure and large estates may require attention to land rebalancing, sequencing, and mission alignment, whereas campuses with very high projected gross and academic-core densities may require closer monitoring of space adequacy, support-service provision, and non-horizontal development strategies. In this sense, land-share transitions and density indicators can complement broader sustainability monitoring by helping CHED distinguish between institutions whose challenge is primarily land management and those whose challenge is land scarcity under growth.

Beyond campus-level planning, the density indicators and transition archetypes developed here carry direct implications for CHED's sustainability monitoring function. Because all Philippine SUCs are required to submit LUDIP documentation under CMO No. 11 [2], the same percentage-point transition metrics and student-density computations applied in this study can be replicated system-wide from standardized LUDIP reporting tables — without requiring additional data collection. Gross density and academic-core density thresholds can serve as early-warning indicators, flagging which institutions are approaching spatial stress before enrollment peaks, enabling CHED to prioritize technical assistance, capital outlay programming, or vertical construction approvals for the most constrained campuses. This positions LUDIP analytics not merely as a compliance exercise but as a recurring sustainability monitoring instrument aligned with CHED's mandate to ensure quality, equitable, and sustainable higher education across diverse institutional contexts.

4 Conclusion

This paper examined how RA 11396-aligned campus planning interacts with physical land limits by linking land-use transitions (existing to proposed LUDIP scenarios) with land-based carrying capacity screening to a 2031 horizon. Across three Philippine SUCs, land-abundant CMU shows a transition consistent with research-enabling expansion, reallocating land from production toward academic and RDE cores while maintaining low estate-scale density. In contrast, DSSC and SuSC display transitions that expand allied services and administrative support under limited land budgets, while density projections indicate substantial capacity stress by 2031—especially within academic-core land allocations. These results suggest that for land-constrained SUCs, LUDIP compliance is likely to depend less on horizontal land reallocation and more on vertical densification, space-efficiency measures, and integrated support-service programming.

The findings should be interpreted as planning signals rather than deterministic capacity limits, since the analysis does not model building floor area, utilization rates, or service capacity in detail. Future work should connect these land-based indicators to built-form metrics such as floor area, development intensity, and service availability. Even in its present form, however, the paper shows that standardized land-transition and density indicators can support not only campus-level planning but also CHED-level sustainability monitoring by identifying where statutory compliance may be accompanied by meaningful spatial stress.

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