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Barriers to Geohazard Data Integration in Local Development Plans: Evidence from Antipolo City, Philippines

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ABSTRACT

The Philippines ranks among the world's most disaster-exposed countries, yet high-quality national geohazard data does not always translate into enforceable local risk-reduction policy. This study examined how geohazard susceptibility information from the Mines and Geosciences Bureau (MGB) is reflected in the local development plans of Antipolo City, a rapidly urbanizing city in Rizal Province where an estimated 92% of residents live in a barangay rated highly susceptible to rain-induced landslides and 56% to flooding. Using a mixed-methods case study design, the study combined document analysis of the city's Comprehensive Land Use Plan (CLUP) and Local Disaster Risk Reduction and Management Plan (LDRRMP) with a survey and key-informant interviews involving 230 respondents from the MGB, city government, barangay government, and community groups. Results show that both plans cite MGB hazard data and support No-Build Zone designation, but rely on different, outdated datasets applied with inconsistent susceptibility tiers, and that the LDRRMP's own hazard map contradicts its accompanying flood-classification text. Enforcement is further constrained by the coarse resolution of 1:10,000-scale national maps relative to sitio-level planning needs, a shortage of GIS-trained local staff, and social and political resistance to restricting development in long-established, high-risk settlements. The study proposes a governance framework anchored in non-divertible budget allocations to support geohazard data standardization, site-specific technical assessment, local capacity building, and participatory risk communication, offering a transferable model for other rapidly urbanizing Philippine LGUs to convert national geoscientific data into enforceable, locally owned disaster risk reduction policy.

INTRODUCTION

Hazard information is only as useful as the willingness and capacity of local institutions to convert it into enforceable land-use decisions. Communities across the Philippines remain exposed to recurrent flooding and rain-induced landslides driven by a combination of meteorological, hydrological, and human factors, and successive editions of the World Risk Report have placed the Philippines at or near the top of the global World Risk Index for exposure to natural and climate-related hazards. Large-loss events such as Typhoon Sendong in 2011, which triggered flash floods and landslides in Cagayan de Oro and Iligan, resulting in over a thousand fatalities, illustrate how available geoscientific knowledge can still fail to reach local implementation in time to prevent large-scale harm.

In response, national policy has pushed toward embedding geohazard assessment in local planning. The Philippine Disaster Risk Reduction and Management Act of 2010 (Republic Act 10121) decentralizes disaster governance to local government units (LGUs) and requires that land-use and disaster-management plans be grounded in science-based hazard information, while the Mines and Geosciences Bureau (MGB) produces nationwide landslide and flood susceptibility maps under its National Geohazard Assessment and Mapping Program specifically to support LGU planning. In principle, this places the Comprehensive Land Use Plan (CLUP) and the Local Disaster Risk Reduction and Management Plan (LDRRMP) at the center of efforts to translate national hazard science into local resilience. In practice, limited technical capacity, competing development priorities, and weak inter-agency coordination frequently blunt this translation, leaving communities exposed to hazards that have already been mapped.

Antipolo City, in Rizal Province, presents an unusually clear test case for this science-to-policy gap. The city's terrain rises from low-lying floodplains bordering Metro Manila to steep, forested slopes of the Sierra Madre, producing simultaneous exposure to landslide and flood hazards across much of its sixteen barangays. Based on the 2020 Census and the MGB-DENR hazard classification adopted in the city's own CLUP, an estimated 92% of Antipolo's 887,399 residents live in a barangay rated highly susceptible to rain-induced landslides, and 56% live in one rated highly susceptible to flooding, with roughly half the population facing both hazards concurrently. Despite a seemingly adequate legal and technical foundation, it remains unclear whether this national hazard data is operating as a live planning instrument rather than a static reference document.

Beyond diagnosing Antipolo City's specific case, this study contributes to a broader understanding of where science-to-policy translation in disaster risk governance

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succeeds or stalls once a legal mandate and technical dataset already exist. For local planners, the findings identify concrete, document-level inconsistencies that can be corrected without new hazard science. For national agencies such as the MGB, the findings illustrate how a technically sound dataset can nonetheless lose practical value when it is cited across different vintages and tier definitions within a single LGU's own instruments. For the wider field of climate change adaptation and disaster risk reduction research, the case offers a transferable diagnostic approach, comparing a city's own planning documents against each other and against stakeholder-reported barriers, that other rapidly urbanizing, multi-hazard Philippine cities could apply to their own CLUP-LDRRMP pairs.

Much of the existing literature on geohazard governance in the Philippines has concentrated either on the technical production of susceptibility maps or on disaster-risk governance at a broad national policy level, with comparatively little attention to how national geohazard data is processed, cited, and applied within a single LGU's planning instruments. This leaves a gap in understanding precisely where the translation from national science to local, enforceable land-use policy succeeds or breaks down, and why. This study addresses that gap by asking three questions: (1) to what extent is official MGB geohazard information formally integrated into Antipolo City's CLUP and LDRRMP, and what specific inconsistencies exist between the two instruments; (2) what institutional, technical, financial, and socio-political barriers most limit the practical application of this data at the barangay level; and (3) what actionable governance framework could close the gap between the availability of geohazard data and its enforceable use in local planning. In answering these questions, this study offers both a diagnostic account of a single high-stakes case and a set of recommendations that generalize to other Philippine LGUs facing similar multi-hazard, rapid-urbanization pressures.

LITERATURE REVIEW

National policy in the Philippines has, on paper, moved decisively toward integrating geoscientific hazard information into local governance. Republic Act 10121 established a decentralized, participatory, and sciencebased disaster risk reduction and management system, positioning the CLUP and LDRRMP as the principal instruments through which LGUs are meant to translate hazard science into land-use and resilience policy (Domingo & Manejar, 2021). The Climate Change Act of 2009 complements this by creating the Climate Change Commission and pushing climate adaptation considerations into planning at every level of government (Roldan, 2022). These domestic laws echo the Hyogo and Sendai Framework's emphasis on prevention over response. Even so, national maps at the city or municipal level are frequently reported as insufficiently detailed for local decision-making (Sinogaya *et al.*, 2024), and disaster risk reduction and climate adaptation considerations often remain difficult to fully mainstream into local plans and budgets (Asuncion *et al.*, 2025).

Case-level evidence from other Philippine LGUs illustrates the specific mechanisms behind this gap. Studies of comprehensive development planning in Nueva Ecija's cities found that disaster risk reduction and climate adaptation considerations were formally present in planning documents but still under-resourced in practice, with land allocation and hazard considerations frequently treated as secondary to other development priorities (Gabriel *et al.*, 2021). Local government capacity constraints, including limited technical staff, tight budgets, and weak inter-agency cooperation, recur across this literature as the primary explanation for why legally mandated integration does not automatically produce enforced, hazard-sensitive zoning (Gabriel *et al.*, 2021). Comparative work outside the Philippines reaches a similar conclusion: decentralized disaster governance systems tend to under-perform not because national mandates are absent, but because the institutional mechanisms connecting national data producers to local implementers are weak or inconsistently resourced (Alcántara-Ayala *et al.*, 2025; Quader *et al.*, 2023).

Antipolo City's own hazard profile has been documented in prior technical work. Early multivariate logistic regression analysis of landslide susceptibility in Antipolo identified slope angle, geology, and land cover as the dominant predictors of landslide occurrence citywide (Victor & Zarco, 2018), and more recent remotesensing-based studies using persistent scatterer interferometry have continued to refine the spatial precision of ground-deformation monitoring in landslide-prone areas of the city (Mabaquiao, 2024). Parallel GIS-based multi-criteria approaches applied to flood hazard elsewhere in the Philippines have similarly identified rainfall, slope, elevation, and drainage density as principal drivers of barangay-level flood risk (Cabrera & Lee, 2019; Gacu *et al.*, 2022). This body of technical work establishes that the underlying geoscience is well studied; it does not, however, establish whether or how this science informs the specific zoning and enforcement decisions embedded in the CLUP and LDRRMP, which is the specific gap this study addresses.

A separate strand of literature examines why, even where geohazard data is technically sound and legally mandated for use, its translation into enforceable local rules often stalls. Fine-grained data voids, mismatches between the scale of national maps and the resolution local planners need, and limited in-house capacity to interpret geological and hydrological data are recurring technical barriers documented in Philippine hazardmapping research (Sinogaya *et al.*, 2024). Site-specific landslide risk assessment methodologies developed elsewhere in the Philippines demonstrate that more granular, ground-truthed hazard information is achievable, but such approaches require technical resources that many LGUs, particularly rapidly urbanizing but comparatively undercapacitated cities, do not routinely have (Cordero *et al.*, 2024). At the same time, social and political dynamics compound these technical constraints: where hazard maps identify high-risk but longestablished or informally settled areas, political pressure often works against strict zoning enforcement, since relocating or restricting development in these areas carries immediate social and economic costs that elected officials are reluctant to impose (Alcántara-Ayala *et al.*, 2025). Broader calls for embedding probabilistic, rather than purely deterministic, risk assessment into Philippine climate change adaptation and disaster risk reduction planning further suggest that even technically updated hazard data will under-perform if it is not paired with governance structures capable of acting on it (Lagmay, 2023).

Community-level engagement research adds a further dimension to this picture. Participatory approaches to hazard assessment have consistently been found to strengthen the practical relevance and legitimacy of disaster planning, but genuine participation, as opposed to one-way information dissemination, remains uneven, with vulnerable groups such as women, older residents, and informal settlers frequently underrepresented in planning consultations (Andaya *et al.*, 2025). This pattern is not unique to the Philippines: comparative research on landslide risk governance in Andean cities similarly finds that land-use policy in hazard-prone areas is shaped as much by social and economic pressure from existing settlements as by the technical quality of the underlying hazard data (Puente-Sotomayor *et al.*, 2020).

Beyond the policy and institutional literature, a distinct body of work addresses the technical role geohazard maps are meant to play once produced. Susceptibility maps of this kind are typically built from detailed geological, slope, and land-cover analysis (Lu *et al.*, 2022) and are intended to guide not only zoning restrictions but also the siting of evacuation centers, relocation areas, and protective infrastructure (Barua *et al.*, 2023). Their practical value, however, depends on LGUs having both current data and the in-house expertise to apply established criteria, such as the Analytic Hierarchy Process, to local hazard mapping decisions (Morales & Vries, 2021), and on planners having the specialized training needed to combine hazard layers with exposure and vulnerability data into a single, locally usable risk product (Milledge *et al.*, 2019). Where this technical capacity is thin, as documented across multiple Philippine LGUs, hazard maps tend to persist as reference documents attached to a plan rather than as the operative basis for its zoning decisions, a pattern this study specifically tests for in the case of Antipolo City's CLUP and LDRRMP. Housing-resettlement research in Albay similarly shows that even where a hazard map is technically sound, decisions about who is relocated and where can be shaped as much by administrative convenience and social considerations as by the hazard classification itself (Abante, 2021), reinforcing the need to examine implementation and enforcement, not just data availability, as this study does.

Taken together, this literature establishes three things clearly: that Philippine national policy and hazard science provide a credible technical and legal foundation for local geohazard integration; that this foundation frequently fails to translate into consistent local enforcement because of technical-resolution mismatches, capacity gaps, and socio-political resistance; and that most existing Philippine case studies address these barriers either in general policy terms or through purely technical hazard-mapping improvements, rather than through a document-level comparison of how a single city's own planning instruments handle the same underlying hazard data. This study fills that specific gap by directly comparing how Antipolo City's CLUP and LDRRMP each define, apply, and map MGB susceptibility data, and by pairing that document-level analysis with survey and interview evidence on the institutional, technical, and socio-political barriers that stakeholders themselves identify as limiting enforcement. The study is organized around an Input-Process-Output-Outcome framework, in which MGB hazard data and the national regulatory mandate constitute the Inputs; interpretation, formal document integration, and risk communication constitute the Process; updated plans, ordinances, and communication materials constitute the Outputs; and improved disaster risk governance and community resilience constitute the intended Outcome.

MATERIALS AND METHODS

This study used a mixed-methods case study design, combining qualitative document analysis and key informant interviews with a quantitative cross-sectional survey, to examine how MGB geohazard data is reflected in Antipolo City's land-use and disaster-risk planning instruments. The design paired a descriptive component, identifying the extent, tools, and frequency of geohazard-data use in the CLUP and LDRRMP, with a causal-comparative component examining whether perceptions of planning effectiveness differed significantly across respondent groups.

Antipolo City, in Rizal Province, was selected as the study site because its topography, ranging from low-lying floodplains near Metro Manila to steep, forested terrain in the Sierra Madre foothills, produces simultaneous citywide exposure to both landslide and flood hazards, while its population has grown rapidly enough to place sustained pressure on hazard-sensitive land. Document analysis focused on the sections of the CLUP (2010-2020) and LDRRMP (2021-2025) addressing zoning, land-use restriction, and disaster risk reduction, together with the city's Zoning Ordinance and relevant barangay development plans. Field data collection, comprising interviews, surveys, and document review, was conducted from October 2025 to March 2026.

Respondents were drawn from four stakeholder groups using two complementary sampling strategies. For the MGB, City LGU, and Barangay Official groups, purposive snowball sampling was used, since qualified key informants (senior technical and administrative staff with direct responsibility for geohazard data or planning) were limited in number within each office and best identified through existing professional networks. The sample sizes for the MGB (n = 4) and City LGU (n = 9) groups reflect the small pool of eligible respondents occupying relevant positions in these offices and represent a near-census of individuals directly involved in geohazard planning and data management at the city level. For barangay officials, 57 were selected to proportionally represent the sixteen barangays, ensuring input from those with direct roles in DRRM committees. For the Community Resident group, simple random sampling was used instead, since any resident of a target high-risk barangay could meaningfully report on hazard awareness and local experience, and random selection produced a more representative community sample than a referral-based approach would. The community sample was calculated to exceed the minimum threshold for descriptive analyses, achieving a 95% confidence level with a margin of error of approximately 7.5%, based on the high-risk barangay population frames. In total, 230 respondents took part: 4 from the MGB Regional Office (CALABARZON), 9 from the City Planning and Development Office and City Disaster Risk Reduction and Management Office, 57 barangay officials and Barangay Disaster Risk Reduction and Management Committee members, and 160 community residents from high-risk barangays (Table 1).

Table 1: Distribution of Stakeholder Groups and Survey Respondents (N = 230)

Stakeholder Group	Frequency (f)	Percentage (%)
Mines and Geosciences Bureau (MGB)	4	1.74
City LGU (City Planning & Development Office / City DRRM Office)	9	3.91
Barangay LGU (Barangay Chairpersons / BDRRMC)	57	24.78
Community Residents	160	69.57
Total	**230**	**100.00**

Three complementary data-collection methods were used. First, document analysis applied Presence Analysis to quantify the frequency of key hazard-related terms across the CLUP, LDRRMP, Zoning Ordinance, and barangay plans, and Contextual Analysis to assess whether MGB hazard data was merely appended to these documents or actively translated into specific zoning codes, No-Build Zone designations, and budget lines. Second, a semi-structured interview guide was used with senior MGB, City LGU, and barangay officials to trace the flow of geohazard data from national production to local applications and to surface institutional barriers to its use. Third, a cross-sectional survey using 5-point Likert-scale items was administered to all four respondent groups to measure perceived integration, compliance, and enforcement challenges.

Descriptive statistics, including weighted means and standard deviations, were computed for all Likertscale items. Mean scores were converted into qualitative descriptors using an equal class interval of 0.80, derived from dividing the five-point scale range by the number of categories (Table 2), so that each qualitative descriptor carried equal mathematical weight and no descriptor was arbitrarily favored. To test the causalcomparative component of the design, independent-samples t-tests and one-way Analysis of Variance (ANOVA) were used to compare mean perception scores across respondent groups and training backgrounds, and Pearson Product-Moment Correlation was used to examine relationships between continuous socioeconomic variables (for example, age and years of service) and survey scores. All inferential tests were evaluated at the 0.05 level of significance, with effect sizes (Cohen's d for t-tests, eta-squared for ANOVA) reported alongside p-values, using the Statistical Package for the Social Sciences (SPSS). Because the MGB (n = 4) and City LGU (n = 9) groups were considerably smaller than the Barangay (n = 57) and Community (n = 160) groups, inferential results involving these two smaller groups were interpreted with caution and treated as illustrative rather than generalized. Qualitative interview data were analyzed using thematic content analysis, with transcripts coded for recurring themes that could explain the patterns observed in the survey results.

All respondents participated voluntarily and gave informed consent after being briefed on the study's purpose, and formal communication and permission were secured from the City Disaster Risk Reduction and Management Office and from each participating barangay prior to data collection. Interview and survey responses were treated confidentially and reported only in aggregate or de-identified form.

Table 2: Interpretation Scale for Weighted Mean Scores

Value	Score Range	Qualitative Description
1	1.00-1.80	Strongly Disagree
2	1.81-2.60	Disagree
3	2.61-3.40	Neutral
4	3.41-4.20	Agree
5	4.21-5.00	Strongly Agree

RESULTS AND DISCUSSION

Antipolo City's hazard exposure is citywide rather than confined to a few isolated barangays. Crossreferencing the 2020 Census with the MGB-DENR hazard classification adopted in the CLUP shows that 13 of the city's 16 barangays (81%) carry an overall High landslide susceptibility rating and 8 of 16 (50%) carry an overall High flood susceptibility rating, with 6 barangays, Calawis, Cupang, Inarawan, Mambugan, San Jose, and San Roque, rated High for both hazards simultaneously. Translated into population terms, an estimated 820,281 residents (92% of the city's 887,399 residents) live in a barangay rated highly susceptible to landslides, and 494,129 residents (56%) live in one rated highly susceptible to flooding, with approximately 428,101 residents (48%) exposed to both hazards concurrently. Figure 1 maps this distribution across the city using the MGB's four-tier susceptibility classification.

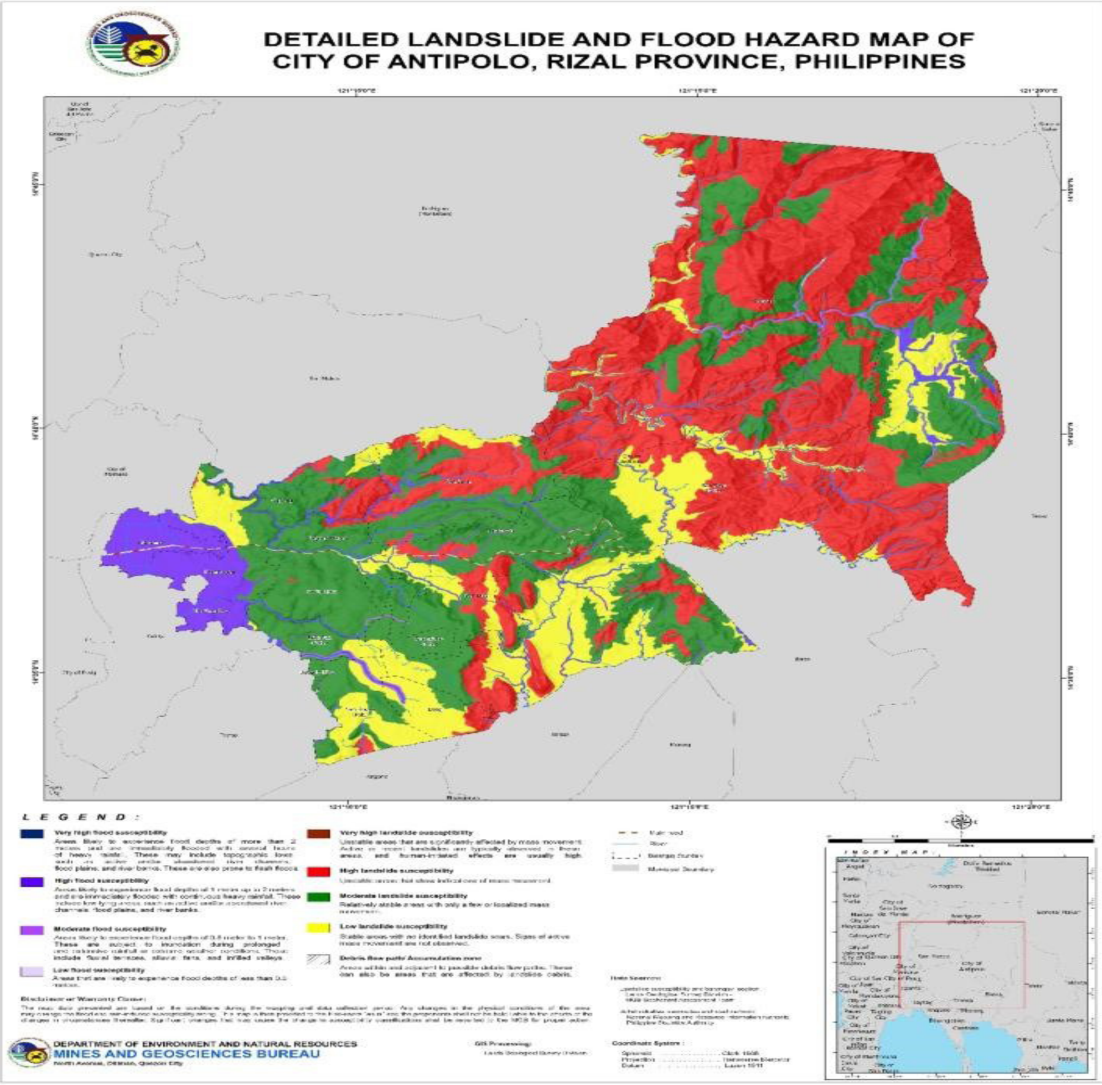

Figure 1: Geohazard Susceptibility Map of Antipolo City, Rizal, Compiled from MGB (2025), OpenStreetMap, and Philippine Statistics Authority Sources

Presence Analysis of the city's planning documents found that hazard-related terms appear in the CLUP, LDRRMP, Zoning Ordinance, and barangay plans, but with limited frequency for instruments of this scale and consequence: the terms geohazard, landslide, and flood/flooding appear approximately 4, 44, and 48 times, respectively, across the reviewed documents. This indicates that hazard considerations are present in the city's planning language but are not consistently treated as a primary organizing concern for land use, zoning, or development approval, appearing instead as background environmental constraints layered onto planning decisions made on other grounds.

Contextual Analysis of how this data is actually used revealed a more specific structural problem: the CLUP and LDRRMP do not draw on the same MGB dataset, and neither consistently applies MGB's own fourtier susceptibility rating(Very High, High, Moderate, Low). The CLUP's zoning provisions are anchored to the 2012 DENR-MGB Geohazards Assessment and Mapping of Antipolo City, while the LDRRMP references a 2014 mapping program updated by MGB

Region IV-CALABARZON in December 2019. Despite these different stated sources, a barangay-by-barangay comparison of both plans' results tables found identical susceptibility ratings for all 16 barangays on both hazards, with only one minor structural difference in how the flood table for Barangay San Jose is presented. This suggests that the LDRRMP's nominally updated dataset does not, in practice, provide planners with any barangay-level information beyond what the older CLUP assessment already provided, undermining the rationale for treating the two plans as independently verified sources.

Neither plan applies the MGB's complete four-class susceptibility scale as defined. The CLUP defines all four landslide classes in its parameter tables but applies only three (High, Moderate, Low/None) at the barangay level, with no barangay rated Very High; its flood susceptibility framework defines only three classes from the outset, omitting Very High entirely, and the CLUP contains no hazard map of any kind; its geohazard information is presented exclusively in tabular form. The LDRRMP defines the full four-tier scale for landslide in its text and includes a hazard map with a matching four-tier legend, but its flood susceptibility text defines only three classes while its accompanying hazard map legend displays four, including a Very High flood category that does not exist anywhere in the LDRRMP's own flood susceptibility text. This internal map-text contradiction means that a planner or enforcement officer consulting only the LDRRMP's flood map would identify a hazard tier that the plan's own governing text never defines or thresholds, an internal inconsistency that a single reconciliation pass against a common dataset would resolve.

Beyond the CLUP and LDRRMP's technical inconsistencies, enforcement of the No-Build Zone is constrained by a resolution mismatch between national mapping and local implementation needs. The city's hazard assessments are based on maps produced at approximately 1:10,000 scale, adequate for citywide or barangay-level planning but too coarse to resolve boundaries at the individual lot or sitio level where actual construction permits and relocation decisions are made. Compounding this technical gap, No-Build Zones in barangays such as Bagong Nayon, Mambugan, San Luis, San Jose, Sta. Cruz, and Cupang overlap with longestablished informal settlements, and the MGB itself has no independent enforcement authority; as a result, these designations function in practice more as planning guidance than as strictly enforced legal boundaries, particularly where settlement predates the 2012 hazard assessment. This finding is consistent with the broader literature identifying social and political resistance, rather than the absence of technical data, as the more persistent barrier to hazard-based zoning enforcement (Alcántara-Ayala *et al.*, 2025).

The specific sitios most frequently cited in barangay development plans as falling within No-Build Zone restrictions include Sitios Tagisan 3 and 4 in Bagong Nayon, Sitio Ruhat 3 in Mambugan, Sitio Patnubay 2 in San Luis, the Seedling and Sitio El Dorado areas of San Jose, and sections of Sta. Cruz along Marcos Highway, and low-lying creek-side sections of Cupang, illustrate why enforcement is uneven even within barangays that carry an overall High susceptibility rating. Because these designations are drawn barangay by barangay from slope, drainage, and soil conditions identified in the 2012 DENR-MGB assessment, their boundaries predate much of the informal settlement that has since occurred around them, leaving city and barangay officials to enforce a restriction against communities that, in several cases, have resided in the area for longer than the restriction itself has existed. This sequencing problem, hazard designation following rather than preceding settlement, helps explain why respondents across the LGU and Barangay groups consistently identified social and political resistance, rather than any remaining technical uncertainty about where the hazard lies, as the more binding constraint on enforcement.

Consistent with this picture, respondents across the MGB, City LGU, and Barangay groups converged on the same underlying explanations for the gap between policy and practice: the coarse resolution of national maps relative to lot-level enforcement needs, a shortage of GIS-trained personnel within city and barangay offices, inconsistent inter-agency coordination between the MGB and city planning bodies, and limited political will to enforce restrictions in politically sensitive, long-settled areas. Financial barriers compounded these technical and political constraints: disaster funds were more often reported as used reactively, after hazard events occurred, than proactively for data updates, community engagement, or preventive infrastructure. Among community residents, awareness of official hazard maps and warning signage was comparatively low, and residents more often reported relying on personal or inherited experience of past floods and landslides than on official geohazard information when assessing their own risk, a pattern that reflects both limited outreach and a documented tendency for participatory risk communication to remain one-directional rather than genuinely twoway (Andaya *et al.*, 2025).

Group-level comparisons in the survey add nuance to this shared diagnosis. Respondents from the MGB Regional Office tended to describe their data products as adequate but underutilized once transmitted to the city, citing weak feedback channels back to the national agency after maps are delivered. City LGU respondents more frequently cited internal coordination gaps between the City Planning and Development Office and the City Disaster Risk Reduction and Management Office as a source of the tier and dataset mismatches identified above. Barangay officials, who are closest to actual enforcement, most frequently cited the lot-level resolution mismatch and social resistance from established residents as the binding constraints, more so than a lack of awareness of the maps themselves. Community residents, finally, reported the lowest familiarity with the specific tier language (Very

High, High, Moderate, Low) used in official documents, even in barangays officially rated High for one or both hazards, suggesting that the technical vocabulary of the CLUP and LDRRMP is not being effectively translated into the plain-language terms residents actually use to describe their own risk. Table 3 summarizes the most frequently cited barriers across these four groups.

These findings collectively motivate a governance framework built around a single premise: technical, administrative, and communication reforms are sustainable only if they are underwritten by dedicated, nondivertible financing (Figure 2). The proposed framework organizes reform into three interlocking workstreams: an LGU-side workstream addressing coordination, capacity-building, risk communication, and social inclusion; an MGB-side workstream addressing barangay-level GIS development, site-specific geotechnical assessment, and independent monitoring; and a joint Data Standardization and Reconciliation workstream requiring both plans to adopt one current MGB dataset as a shared baseline, apply the full four-tier susceptibility standard consistently, and cross-check every hazard map against its own accompanying text before publication. All three workstreams rest on a Budget Integration and Financial Governance foundation, under which climate and disaster risk spending becomes a non-divertible, regular component of the LDRRMP budget, following a 70/30 split between mitigation and quick-response funding tracked through Climate Change Expenditure Tagging, with at least 5% of local disaster funds explicitly reserved for prevention, data updates, and community-facing risk communication.

Table 3: Most Frequently Cited Barriers to Geohazard Data Integration, by Stakeholder Group

Stakeholder Group	Most Frequently Cited Barrier
MGB (National)	Weak feedback channel from LGU back to national data producer
City LGU	Limited internal coordination between planning and disaster-risk offices
Barangay LGU	Map resolution too coarse for lot-level enforcement; social resistance from established residents
Community Residents	Low familiarity with official susceptibility tier language and reliance on personal experience

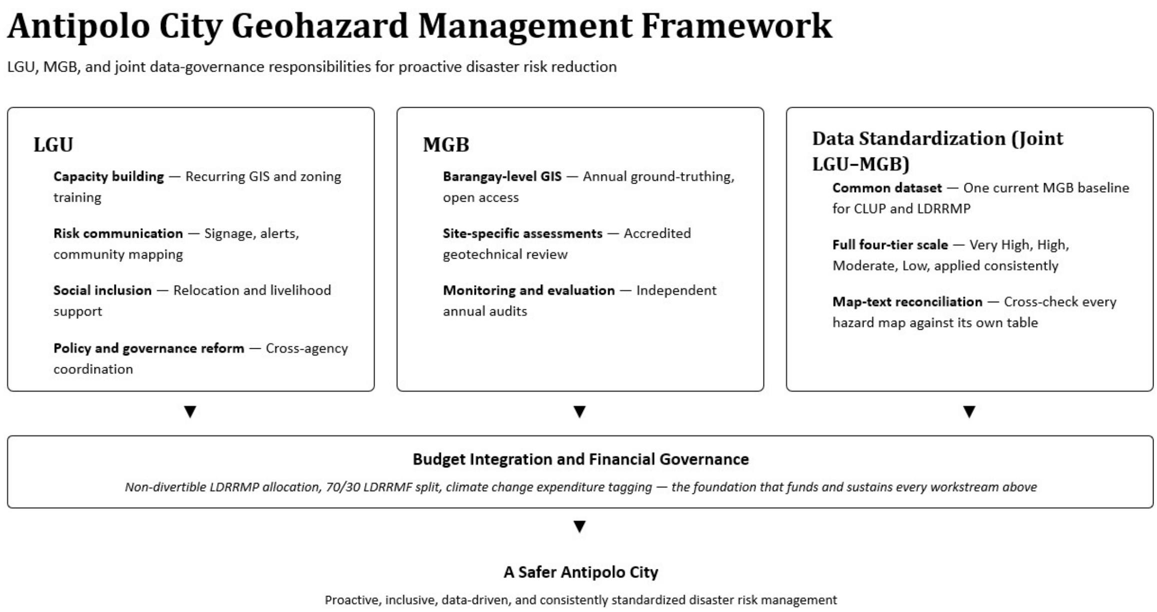

Figure 2: Proposed Geohazard Management Framework for Antipolo City

Read together, these results indicate that Antipolo City's principal constraint is not the absence of geohazard science or of a supportive legal mandate, both of which are already in place, but the absence of a single, reconciled, enforceable data standard shared across its own planning instruments, paired with the local technical capacity and sustained financing needed to act on it at the resolution that actual enforcement decisions require. This distinguishes the present case from accounts in the literature that frame geohazard integration primarily as a problem of data availability (Sinogaya *et al.*, 2024): in Antipolo, the data exists twice over, under two different citations, but has not been reconciled into one authoritative reference that both plans and the officials enforcing them can consistently apply.

CONCLUSION

Antipolo City has a credible legal and technical foundation for geohazard-informed planning, but five interlocking barriers, coarse map resolution, reliance on two outdated

MGB datasets, inconsistent application of the four-tier susceptibility standard, limited political will, and social resistance from long-established communities, have kept this foundation from translating into consistent barangay-level enforcement. Because roughly nine in ten residents live in a barangay highly susceptible to at least one hazard, these are citywide, not marginal, gaps.

The most actionable step is not new hazard mapping but internal reconciliation: adopting one current MGB dataset as the shared reference for the CLUP and LDRRMP, applying the four-tier scale consistently, and cross-checking every hazard map against its own text before the next planning cycle. Paired with the non-divertible budget mechanism proposed here, this could close the study's specific inconsistencies within a single planning cycle.

Two limitations qualify these findings: the MGB (n = 4) and City LGU (n = 9) results are illustrative rather than generalizable, and the cross-sectional data do not independently verify hazard-map accuracy. Even so, closing this gap requires reconciling existing data, not new science, offering a template other rapidly urbanizing Philippine LGUs could adapt.

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