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Facing the Tide: How Can Woollahra's Urban Planning Outsmart Flood Risks?

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Abstract

Established, affluent coastal suburbs combine severe flood exposure with extensive private land ownership, yet little is known about how multi-level planning systems perform when private property rights must be balanced against public flood resilience. We developed a quantitative plan-evaluation framework combining Pradhan et al.'s policy–practice–performance dimensions with the coverage and strength criteria of Hislop et al.'s green-infrastructure tool, and applied it through directed content analysis to ten state and local flood planning instruments governing Woollahra (New South Wales, Australia). Seventeen indicators were scored for coverage (0–3) and strength (0–2) and aggregated using transparent, reproducible weights into effectiveness scores on a 0–100% scale. No instrument reached 50% effectiveness (state 18–33%; local 20–42%). Performance was the weakest dimension at both levels, and the strongest instrument, the Woollahra Local Strategic Planning Statement 2020, reached only 42%. Consideration of private landowners, of innovative and nature-based measures, and of the currency of flood data was consistently weak, while statutory enforceability was confined largely to the Local Environmental Plan. The case exposes a cross-scalar governance gap in which strategic intent is not carried into enforceable, current, and landowner-inclusive practice, and we translate the findings into a framework for action to guide planners, policymakers, and coastal communities facing comparable risks.

Keywords: flood risk management; urban planning; green infrastructure; multi-level governance; private property rights; plan evaluation; climate change adaptation; Woollahra

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1. Introduction

Flooding is among the most frequent and damaging natural hazards, and its consequences reach well beyond immediate loss of life. The most comprehensive multi-country assessment to date, which examined more than 300 million hospitalisation records across 747 communities in eight countries including Australia, found that flood events raised the risk of hospitalisation for most major disease groups by roughly a quarter, with elevated risk persisting for up to seven months after the water receded [1]. These findings compound the well-documented risks of waterborne and communicable disease that follow floods [2]. Historical reviews record more than 500,000 flood-related deaths worldwide between 1980 and 2009 [3], and an estimated 1.81 billion people, about 23% of the global population, are directly exposed to inundation depths above 0.15 m in a 1-in-100-year flood [4]. Framed

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in these terms, flooding is a sustained public-health and societal problem rather than an episodic emergency [5].

Climate change is intensifying this problem in cities. Rising sea levels, more intense rainfall, and stronger storm surges are increasing both coastal and pluvial (rainfall-driven) flood risk in urban areas, particularly those developed historically around the waterfront [6–9]. Pluvial flooding in dense suburbs places particular strain on ageing urban drainage systems [10], and global disaster-risk assessments link these trends to escalating losses [11]. Older, low-lying coastal suburbs are especially exposed: much of their built fabric predates contemporary flood standards, and their historical street and lot layouts were never designed for the frequency and intensity of today's climate-driven events [8,12]. This study is concerned specifically with coastal and pluvial flooding in such established urban settings.

1.1. The Governance Tension: Private Property and Public Resilience

Building flood resilience in established coastal suburbs is not only a technical problem of hazard reduction; it is a governance problem about how responsibility and authority are distributed between public agencies and private owners. Box et al. show that flood management in Australia is marked by a persistent misalignment of expectations: public officials assume that private landowners will "protect themselves and their properties," while many residents regard flood management as the responsibility of government [13]. This "shared responsibility" arrangement places much of the burden of resilience on individual owners while leaving the levers of coordinated action with the public sector. Recent work questions the fairness of this allocation, showing that the distribution of responsibility, and of the financial support for property-level resilience, is itself a governance and equity problem [14].

The tension becomes acute where the foreshore is privately held. Extensive private waterfront ownership deprives councils of both the land and the legal instruments needed for continuous, coordinated flood defences, so collective resilience comes to depend on the cooperation of owners whose private incentives may diverge from public goals. Private ownership is therefore not merely the backdrop to this study; it is the central variable that constrains conventional grey-infrastructure responses and shifts reliance onto non-structural, owner-level, and nature-based measures. Understanding how planning systems perform under this constraint is the core concern of the paper.

1.2. Cross-Scalar Flood Governance in Australia

In Australia, the authority to manage flood risk is divided across levels of government. State governments establish the legislative framework and issue planning policies and ministerial directions, while local councils carry out the detailed implementation of land-use planning, including zoning and development control [15,16]. We use the term cross-scalar governance to describe the vertical coordination required across these state and local tiers for flood policy to function as intended.

This division of labour creates characteristic frictions. Strategic intent articulated at the state level must be translated, through several intermediate instruments, into enforceable controls at the local level, and misalignment at any point can blunt implementation. Comparative work on flood-resilience and multi-level governance similarly finds that effective outcomes depend on coordinated policy networks and a clear, shared distribution of responsibility across scales [17,18], with recent studies stressing that different governance levels must perform distinct but coordinated roles [19] and that system-level trust underpins workable polycentric arrangements [20]. Diagnosing where this cross-scalar coordination succeeds or fails is essential to explaining why well-intentioned flood policy often underperforms on the ground.

1.3. Research Gap, Aim, and Contribution

Although multi-level flood governance and the importance of plan quality are both widely discussed, few studies apply a systematic, evidence-based evaluation of planning instruments to the specific setting that concentrates these challenges: affluent, fully developed coastal suburbs where private property rights and legacy infrastructure constrain public action. Existing Australian work tends either to model hazard or to discuss governance in the abstract, leaving the effectiveness of the planning instruments themselves largely unmeasured.

This study asks: how effectively do New South Wales state and local planning instruments, working together, manage flood risk in an established, affluent coastal suburb, and where do the principal cross-scalar governance gaps lie? To answer it, the study pursues three objectives: (i) to develop and apply a transparent, indicator-based framework for evaluating the quality and effectiveness of flood planning instruments; (ii) to diagnose the cross-scalar strengths and weaknesses revealed when state and local instruments are assessed together; and (iii) to translate the diagnosis into actionable recommendations for planning practice.

We adopt and adapt a green-infrastructure (GI) plan-assessment lens for two reasons. First, GI assessment tools provide explicit, transferable criteria (coverage and strength) for judging how thoroughly and how forcefully a plan addresses a given concern [21]. Second, GI is precisely the class of measure most relevant where conventional grey infrastructure is precluded by private ownership and foreshore controls, making a GI-oriented lens substantively, not just methodologically, appropriate to the Woollahra case.

The contribution is threefold. Empirically, the study provides what is, to our knowledge, the first systematic, indicator-based evaluation of flood planning instruments in an affluent Australian coastal local government area, focused on the tension between private property rights and collective resilience. Theoretically, it extends plan-evaluation methods [21–24] into the field of flood risk management and shows how abstract claims about fragmented multi-level governance manifest in measurable plan deficiencies. Methodologically, it offers a transferable framework that other jurisdictions can adapt to audit their own flood planning. The remainder of the paper provides background on flood risk and its management (Section 2), describes the study area (Section 3) and methods (Section 4), reports the evaluation results (Section 5), discusses their implications (Section 6), and concludes with a framework for action (Section 7).

2. Background

2.1. Defining Flood Risk

We adopt the definition of flood risk set out by the Intergovernmental Panel on Climate Change (IPCC) [6] not as a novel contribution but as the conceptual foundation that structures the evaluation reported here. In this framing, flood risk arises from the interaction of three components: the flood hazard (the frequency and magnitude of events), the exposure of people and assets within the flood-prone area, and the vulnerability of the affected system (for example, the design and maintenance of infrastructure or the presence of early-warning systems) [6,8]. Characterising flood risk through hazard alone is insufficient, because outcomes also depend on exposure and vulnerability; reducing either can offset an increase in hazard.

These three components are the analytical pillars of our assessment. Rather than asking only whether an instrument recognises the flood hazard, we ask whether it also addresses exposure and vulnerability, the dimensions where planning, as distinct from engineering, has the greatest influence. This structuring choice is what allows a planning instrument, rather than a flood model, to be evaluated on its own terms.

2.2. The Practice of Flood Risk Management in Australia

Flood risk management (FRM) proceeds from the premise that risk cannot be eliminated, only analysed, reduced, and continually re-evaluated [25]. Australian practice has evolved over roughly eight decades from reactive, recovery-focused responses toward integrated, risk-based, and increasingly planning-led approaches. In New South Wales (NSW), major floods and subsequent reviews progressively formalised this shift, and by the late twentieth century, FRM had moved decisively toward prevention, resilience, and community involvement rather than reliance on structural works alone [8,26,27]. Major events, including the 2011 Brisbane floods, and the inquiries that followed reinforced this trajectory [28].

Since the 2000s, national best-practice guidance has matured through successive editions [27,29,30] and is reflected in current NSW flood risk management guidance [31], while land-use planning has become central to managing flood-prone development [32]. Non-structural measures (development controls, early-warning systems, and community programmes) now sit alongside engineered defences [33,34], and cities including Sydney have begun to adopt green-infrastructure solutions such as bioswales, raingardens, and permeable surfaces to manage stormwater while delivering ecological co-benefits [35,36]; integrated catchment-management approaches have similarly shaped Australian water governance [37,38]. The relevant trajectory for this study is therefore the growing reliance on planning instruments, rather than structural works, to carry the burden of flood resilience in built-up areas.

Progress, however, has been uneven. Because states set the legislative and policy framework while councils implement zoning and development control, responsibilities can become misaligned across levels, producing inconsistent practice and gaps between policy intent and on-the-ground outcomes [16]. Figure 1 summarises this multi-level FRM arrangement in Australia.

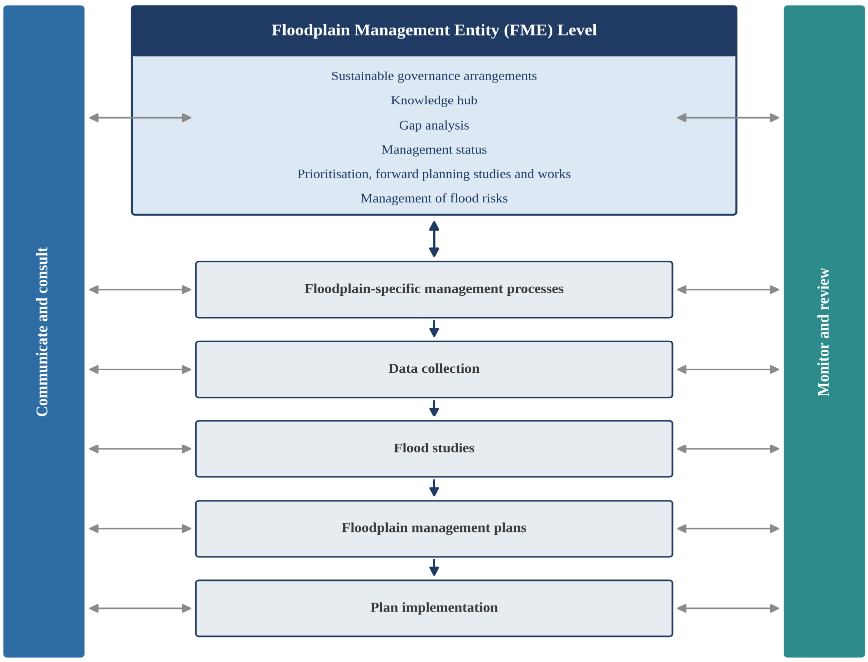

Figure 1. The flood risk management framework in Australia, showing the division of responsibilities across levels of government (adapted from [39]).

2.3. Assessing the Effectiveness of Flood Planning

Because flood resilience in built-up areas increasingly rests on planning instruments, the quality of those instruments becomes a determinant of FRM outcomes. A substantial literature on plan evaluation provides criteria for judging the adequacy and likely implementation of plans [21–24]: well-designed plans are clear, evidence-based, internally consistent, and actionable, and these qualities are associated with better hazard-management performance. Hislop et al.'s green-infrastructure assessment tool is part of this tradition; it scores plans on how comprehensively (coverage) and how forcefully (strength) they address defined elements [21]. Recent work extends these ideas to flooding, evaluating how municipal spatial planning improves mitigation [40] and scoring urban flood resilience from heterogeneous indicators [41].

Quantitative FRM assessment in Australia has more often used hydraulic modelling or multi-criteria decision analysis to characterise hazard and exposure [42], and recent policy-evaluation frameworks increasingly model how actors respond to flood policy over time [43]; yet these approaches evaluate places or behaviour, not the planning instruments that govern them. Applying plan-evaluation criteria to flood planning documents therefore fills a distinct gap: it makes the strengths and weaknesses of the policy instruments themselves visible and comparable. The framework developed in Section 4 builds directly on this plan-evaluation tradition.

3. Study Area

Woollahra is an inner-city coastal suburb of Sydney whose land was subdivided and largely developed more than a century ago. It was selected as the case study because it brings together, in one local government area (LGA), the conditions that make flood governance in affluent coastal settings difficult to manage: (1) high exposure to both coastal and pluvial flooding; (2) a built environment that largely predates modern flood controls and is therefore physically vulnerable; (3) extensive private foreshore ownership that constrains public flood-mitigation infrastructure; and (4) a planning and policy framework that operates within the NSW multi-level system, making it suitable for examining cross-scalar governance. These conditions are not unique to Woollahra; they recur across affluent Sydney harbour suburbs such as Mosman, Vaucluse, and Rose Bay, which makes Woollahra a representative case for the broader class of fully developed, high-value coastal areas [15].

Established in 1856 on the former Henrietta Villa site, Woollahra developed as a predominantly residential area shaped by gentrification, land releases, and twentieth-century transport improvements [44]. Many of its properties predate modern flood regulation and are vulnerable to inundation as sea levels rise and extreme events become more frequent [45]. The LGA contains several urban catchments, including Double Bay, Paddington, Rose Bay, Rushcutters Bay, and Watsons Bay [15].

Double Bay illustrates the governance constraint at the heart of the study. Most beachfront properties there are privately owned and protected only by minor, ad hoc measures such as low fencing roughly 1.5 m high, while publicly controlled foreshore land is scarce [15]. This limited public land restricts the scope for coordinated, large-scale adaptation. At the same time, the foreshore building-line controls in the Woollahra Local Environmental Plan 2014 (WLEP 2014) [46] limit hard defences such as seawalls and levees to protect coastal character and reduce ecological impact. The combined effect is that flood management in Double Bay relies on small, site-specific interventions with little capacity for integrated or anticipatory action. Comparable patterns are evident in Mosman, Vaucluse, and Rose Bay, where large private holdings fragment adaptation into individual seawalls or temporary barriers [34]. Figure 2 shows the local setting and the overlap between heritage and flood-affected areas.

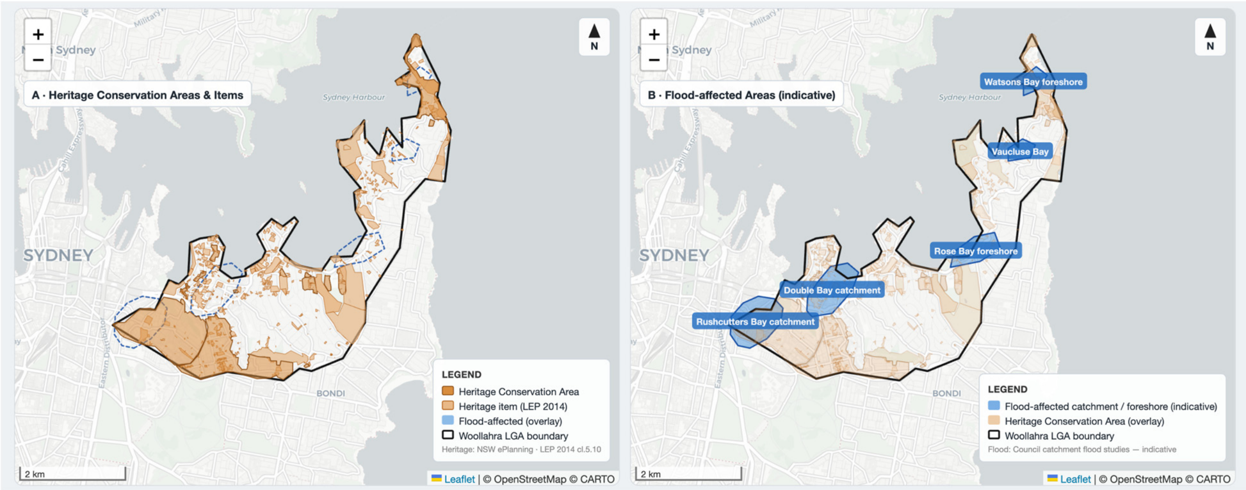

Figure 2. Heritage and flood-affected areas in the study area (developed by author; source: WLEP 2014 [46]).

Flood risk management in Woollahra operates through a vertically integrated system: local planning instruments must be consistent with state policy and, in several cases, require state-agency approval, while the council also undertakes floodplain studies that inform local implementation. This arrangement is intended to align state direction with local application. Figure 3 sets out the hierarchy of the relevant instruments, which are evaluated in the remainder of the paper.

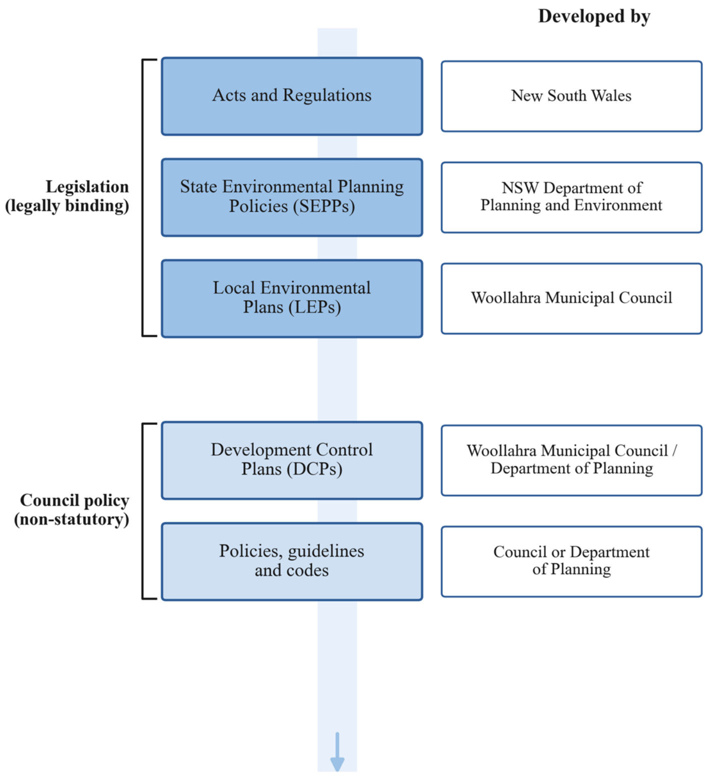

Figure 3. Hierarchy of flood risk management instruments governing Woollahra (developed by author).

4. Methods

4.1. Research Design

The study uses directed (theory-led) content analysis to evaluate the quality and effectiveness of the planning and policy instruments that govern flood risk in Woollahra. Content analysis is well suited to planning research because land-use decisions are made and recorded through texts, and systematic reading of those texts reveals the assumptions and priorities that shape plan-making [47]. Because planning is context-dependent, what is effective in one setting need not be in another [24]; the analysis therefore evaluates how the NSW planning framework performs against the specific demands of an established coastal urban environment. Ten instruments were assessed: four state-level and six local-level (Table 1). Figure 4 summarises the seven-step research process from document selection through to cross-scalar synthesis.

Table 1. State and local flood planning instruments assessed in this study (developed by author).

Policy Instrument (Abbreviation) [Ref.]	Role
State level (New South Wales)	
Coastal Management Act 2016 (CMA 2016) [48]	Guides management of the NSW coastal environment consistent with ecologically sustainable development, protecting social, cultural, and economic well-being.
SEPP (Resilience and Hazards) 2021, Ch. 2 (SEPP RH 2021) [49]	Provides an integrated, coordinated approach to land-use planning in the coastal zone, consistent with the CMA 2016 [48].
Local Planning Directions 2022 (Directions 2022) [50]	Defines and ensures that local development policies meet specified criteria.
Considering Flooding in Land Use Planning Guideline 2021 (Guideline 2021) [51]	Advises councils on land-use planning and development control in relation to flooding.
Local level (Woollahra LGA)	
Woollahra LEP 2014 (WLEP 2014) [46]	Establishes statutory local environmental planning requirements under the EPA Act.
Woollahra Local Strategic Planning Statement 2020 (WLSPS 2020) [52]	Sets a 20-year land-use vision and planning priorities.
Woollahra DCP 2015—Stormwater Chapter (WDCP 2015) [53]	Provides detailed development and design guidance, including stormwater.
Woollahra Development Contributions Plan 2022 [54]	Funds public facilities required by new development.
Woollahra Floodplain Management Studies (Studies) [55]	Define the nature and extent of flooding and underpin floodplain management.
Estuary Planning Levels: Coastal Zone Management Plan (Stage 1) (EPL Report) [56]	Manages foreshore flood risk and protects future coastal development from inundation.

Note. Abbreviations shown in parentheses are used throughout the paper to refer to the instruments listed here; full citations are given in this table and are not repeated at each subsequent mention.

4.2. Theoretical Grounding and Validity of the Framework

The framework integrates two established sources. The three evaluative dimensions (Policy, Practice, and Performance) are taken from Pradhan et al.'s analysis of policy implementation, which distinguishes what a policy commits to (Policy), how it is operationalised (Practice), and what measurable outcomes it secures (Performance) [57]. This three-part structure is valuable for FRM because it separates strategic intent from implementation and results, the very places where flood policy is known to break down [13,16]. The scoring criteria (coverage and strength) are taken from Hislop et al.'s green-infrastructure assessment tool, which judges how comprehensively and how forcefully a plan addresses each element [21].

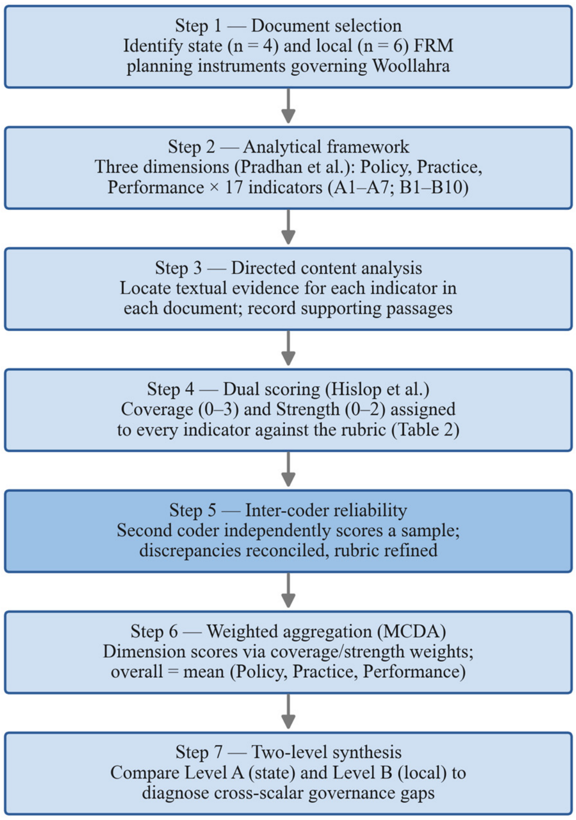

Figure 4. The seven-step research process, from document selection to two-level cross-scalar synthesis (developed by author).

Combining the two is appropriate, and we make the adaptation explicit rather than implicit. Although Hislop et al.'s tool was developed for green infrastructure, its underlying constructs (the breadth of an instrument's coverage and the enforceability of its provisions) are generic properties of any planning instrument and transfer readily to FRM. Pradhan et al.'s dimensions, in turn, were designed for policy-implementation analysis and are domain-neutral. The synthesis yields a tool that assesses not only whether flood policy exists, but whether it is operationalised and enforceable. To support validity in the Australian coastal context, the seventeen indicators (Table A1) were derived from elements that recur in the NSW flood-planning instruments themselves and in the Australian plan-evaluation and FRM literature [16,32,58,59], so that each indicator corresponds to a recognised requirement of good flood planning rather than to an externally imposed criterion.

4.3. Two Evaluation Levels and Cross-Scalar Analysis

Because state and local instruments serve different functions, the framework applies two evaluation levels: Level A for the four state instruments and Level B for the six local instruments. Each level uses an indicator set tailored to its role: seven indicators for state instruments (A1–A7) and ten for local instruments (B1–B10), reflecting the broader, enabling function of state policy and the more operational function of local plans (Table A1).

The two-level design is what makes cross-scalar diagnosis possible. By scoring each level on the same Policy–Practice–Performance structure, the framework allows the strategic intent expressed at the state level to be compared directly with the operational and enforceable provisions at the local level. Where strong state-level Policy scores are not matched by local Practice or Performance scores, the gap localises the point at which cross-scalar coordination fails. This comparison, reported in Section 5.3, is the analytical core of the study.

4.4. Scoring Protocol and Inter-Coder Reliability

Each indicator was scored on two scales. Coverage captures how comprehensively an instrument addresses the indicator and is rated some (1), most (2), or full (3), with 0 reserved for indicators the instrument does not address. Strength captures the clarity and enforceability of the provision and is rated weak (0), medium (1), or strong (2). Table 2 sets out the rubric and the decision rule for each score level so that the assignment is reproducible.

Table 2. Coverage and strength scoring rubric with per-level decision rules (developed by author).

Scale	Score	Label and Meaning	Decision Rule
Coverage	0	None—indicator not addressed	No relevant provision identified in the document.
Coverage	1	Some—partial treatment	Indicator addressed for specific cases or in passing only.
Coverage	2	Most—broad treatment	Indicator addressed across most relevant situations, with minor gaps.
Coverage	3	Full—comprehensive treatment	Indicator addressed comprehensively and applies across the jurisdiction.
Strength	0	Weak—not enforceable	Advisory or informative language only; no obligation created.
Strength	1	Medium—partly enforceable	Directive language, but discretionary or dependent on local interpretation.
Strength	2	Strong—enforceable	Mandatory, legally binding, or clearly enforceable language.

To support transparency and reproducibility, the coding followed an explicit, auditable protocol. The lead author coded all ten instruments against the rubric in Table 2, recording for every indicator the specific passage in the source document that justified the coverage and strength scores assigned. These evidence-linked scores are reported in full in the Supplementary scoring workbook, so that any reader can trace each score back to the underlying provision and re-derive the dimension and overall scores. The co-authors reviewed the framework, the rubric, and the coded results, and the indicator definitions were refined where their wording was ambiguous. Because the assessment rests on documented textual evidence and a published, reproducible scoring matrix rather than on undisclosed judgement, every score can be independently checked against the source instruments.

4.5. Weighting and Calculation

Indicator scores were aggregated into dimension scores using a weighted-scoring rule, a standard technique in multi-criteria decision analysis for combining heterogeneous indicators into a comparable index [42,57]. For each dimension, coverage and strength are combined using dimension-specific weights derived from the assessment matrix (Figures 5 and 6), reflecting the relative contribution of breadth and enforceability within that dimension:

$$\text{Dimension Score} = [W_C \cdot \Sigma\, C_i + W_s \cdot \Sigma\, S_i]/N_{max}$$

where W_C and W_s are the weights for coverage and strength, C_i and S_i are the coverage and strength scores of the *i*-th indicator in the dimension, and N_{max} is the maximum attainable weighted score for that dimension (used to normalise the result to a 0–1 scale). The three dimension scores are then averaged to give an overall effectiveness score:

$$\text{Overall Score} = [\text{Policy} + \text{Practice} + \text{Performance}]/3$$

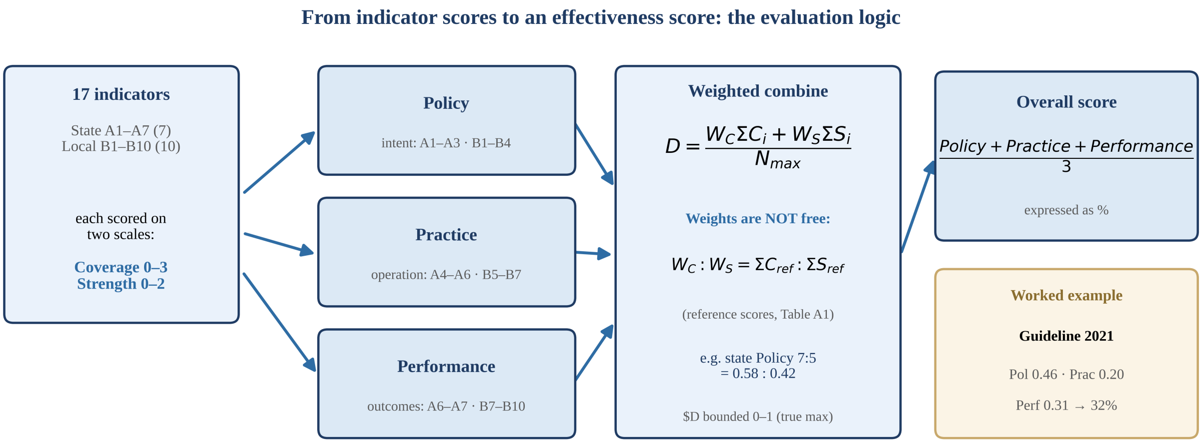

Figure 5. The evaluation logic: illustrated with the Guideline 2021 worked example (developed by author, adapted from [21,57]).

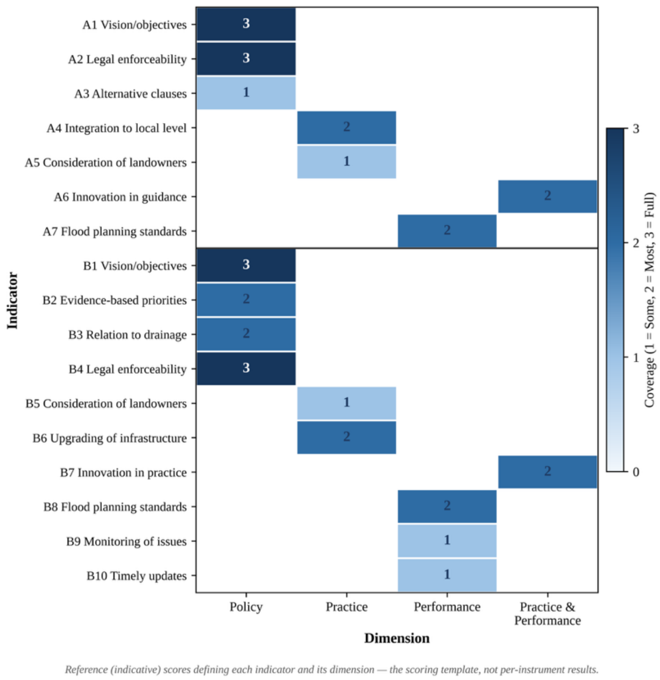

Figure 6. Indicator scoring template: Coverage (developed by author).

These dimension-specific weights are derived from the indicator set rather than chosen by hand: the coverage weight W_C is the dimension's summed reference coverage divided by the sum of its reference coverage and reference strength (Table A1), and W_S = 1 − W_C. For the three state Policy indicators (A1–A3), reference coverage sums to 7 and strength to 5, giving W_C:W_S = 0.58:0.42; Practice and Performance yield 0.56:0.44 and 0.57:0.43, respectively. Tying the weights to each dimension's reference profile keeps the relative emphasis on breadth versus enforceability internal to the framework rather than externally imposed. Figure 5 sets out this evaluation logic end to end, and Figures 6 and 7 present the coverage and strength components of the scoring template. Two indicators, A6 and B7 (innovation), are counted under both Practice and Performance, because innovative and nature-based measures function simultaneously as an operational choice and as a measurable outcome; this is the only such cross-listing and is applied identically at both levels. The resulting rankings are robust to the weighting scheme: equal coverage–strength weighting reproduces the same ordering, with only the two near-tied mid-ranked state instruments interchanging. We treat this weighting as a transparent and defensible choice rather than the only admissible one; alternative schemes such as equal weighting are equally legitimate and, as noted, leave the ranking unchanged.

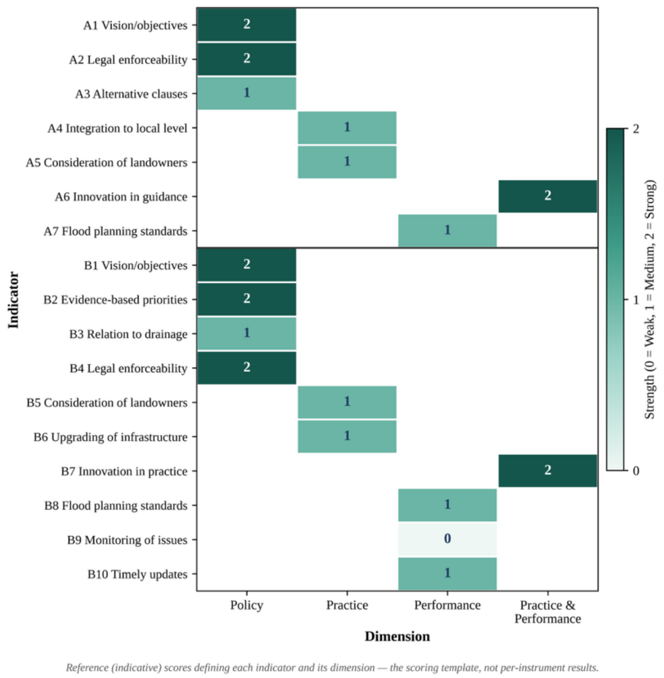

Figure 7. Indicator scoring template: Strength (developed by author).

Note: Reference (indicative) coverage values (0–3) that define each of the seventeen indicators and its dimension. Reference (indicative) strength values (0–2) for each of the seventeen indicators and its dimension, companion to Figure 6. This is the scoring template, not the scores of individual instruments, and the complete scoring workbook is provided as Supplementary Material.

Table 3 demonstrates the full procedure for a single state instrument, the Considering Flooding in Land Use Planning Guideline 2021, taking the reader from the supporting text in the document, through the indicator scores, to the final effectiveness score.

Table 3. Worked example: scoring the Considering Flooding in Land Use Planning Guideline 2021 (developed by author).

Worked Example—Guideline 2021 (Evidence → Score)	Dim.	Cov.	Str.
A1 Vision/objectives—flooding identified as a core concern at the outset	Policy	3	2
A2 Legal enforceability—issued as guidance, not legislation	Policy	0	0
A3 Alternative clauses—alternative freeboard approaches set out for defined cases	Policy	1	1
A4 Integration to local level—advises councils on flood-sensitive planning	Practice	2	1
A5 Consideration of landowners—not addressed	Practice	0	0
A6 Innovation in guidance—not addressed	Prac./Perf.	0	0
A7 Flood planning standards—flood planning level defined	Performance	2	1

Policy = 0.60·Practice = 0.26·Performance = 0.39 → Overall = 42%.

5. Results

Applying the framework to the ten instruments produced a consistent pattern: no instrument, at either level, reached half of the maximum attainable effectiveness score. Table 4 summarises the dimension and overall scores for all ten instruments and provides an immediate overview before the level-specific results are examined in detail. State scores range from 18% to 33% and local scores from 20% to 42%; no instrument reaches 50%, the strongest being the WLSPS 2020 at 42%. Across both levels, Performance is the weakest dimension, indicating that even where flood concerns are recognised in principle, they are seldom carried through into measurable, enforceable outcomes.

Table 4. Summary of policy effectiveness scores for all state and local instruments (developed by author).

Level	Instrument	Policy	Practice	Perform	Overall
State	CMA 2016	0.67	0.33	0.00	33%
State	SEPP RH 2021	0.33	0.20	0.00	18%
State	Directions 2022	0.33	0.33	0.31	32%
State	Guideline 2021	0.46	0.20	0.31	32%
Local	WLEP 2014	0.50	0.20	0.15	29%
Local	WDCP 2015 (Stormwater)	0.60	0.33	0.21	38%
Local	WLSPS 2020	0.44	0.46	0.35	42%
Local	WDCP 2022	0.35	0.20	0.10	22%
Local	Floodplain Studies	0.60	0.00	0.00	20%
Local	EPL Report	0.40	0.00	0.21	20%

5.1. State Level: Multiple Authorities and Cross-Departmental Fragmentation

In NSW, the state government holds responsibility for planning legislation and policy, administered through the Department of Planning, Housing and Infrastructure. Four key flood-related instruments were assessed against the state indicator set (A1–A7); Table 5 reports the indicator pattern and resulting scores.

Table 5. State-level assessment (developed by author).

Instrument	A1	A2	A3	A4	A5	A6	A7	Pol.	Prac.	Perf.	Overall
CMA 2016	3	3	0	2	1	0	0	0.67	0.33	0.00	33%
SEPP RH 2021	0	3	0	2	0	0	0	0.33	0.20	0.00	18%
Directions 2022	3	0	0	2	1	0	2	0.33	0.33	0.31	32%
Guideline 2021	3	0	1	2	0	0	2	0.46	0.20	0.31	32%

Note: Indicators A1–A7 (cell values are coverage scores: 0 = not addressed, 1 = some, 2 = most, 3 = full; strength scores and the full calculation are in the Supplementary scoring workbook); dimension and overall effectiveness scores. (A1 vision/objectives; A2 legal enforceability; A3 alternative clauses; A4 integration to local level; A5 consideration of landowners; A6 innovation in guidance; A7 flood planning standards).

The evaluation reveals substantial gaps. The strongest performer, the CMA 2016 (33%), benefits from clear objectives and statutory force but records no Performance score, because its outcomes are not operationalised through flood-specific standards. The weakest, SEPP RH 2021 (18%), is the instrument expected to bridge legislation and local planning, yet it neither carries forward the landowner provisions of the CMA 2016 nor embeds inclusive flood-risk considerations, leaving a gap at precisely the point where state intent should translate into local practice. Most notably, none of the four instruments addresses innovative or nature-based strategies (A6 = 0 throughout); where the Guideline 2021 gestures toward innovation, it does so for green-infrastructure precincts rather than for flood management itself [60]. A further limitation is the absence of flexibility for atypical waterfront contexts such as Woollahra, where complex ownership and high property values demand alternative clauses; without them, at-risk areas default to prolonged, case-by-case disputes. The fragmentation across these instruments points to a need for stronger cross-departmental coordination, consistent with arguments that participatory governance and coordinated policy networks are prerequisites for managing complex flood dynamics [17,18].

5.2. Local Level: Enforcement and Engagement Deficits

Six local instruments were assessed against the local indicator set (B1–B10); Table 6 reports the results. The strongest, the WLSPS 2020 (42%), remains below 50%.

Table 6. Local-level assessment (developed by author).

Instrument	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	Pol.	Prac.	Ov.
WLEP 2014	3	0	0	3	0	2	0	0	1	1	0.50	0.20	29%
WDCP 2015	3	2	2	0	1	2	0	2	1	0	0.60	0.33	38%
WLSPS 2020	3	2	0	0	0	2	2	0	1	1	0.44	0.46	42%
WDCP 2022	0	2	2	0	0	2	0	0	0	1	0.35	0.20	22%
Studies	3	2	2	0	0	0	0	0	0	0	0.60	0.00	20%
EPL Report	3	0	2	0	0	0	0	2	1	0	0.40	0.00	20%

Note: Indicators B1–B10 (cell values are coverage scores: 0 = not addressed, 1 = some, 2 = most, 3 = full); Policy, Practice, and overall effectiveness scores (Performance scores omitted for space; see Table 4). (B1 vision/objectives; B2 evidence-based priorities; B3 relation to drainage; B4 legal enforceability; B5 consideration of private landowners; B6 infrastructure upgrading; B7 innovation in practice; B8 flood planning standards; B9 monitoring of contemporary issues; B10 timely updates.).

The strongest instrument, the WLSPS 2020 (42%), is instructive about what drives better outcomes. It records the highest Practice (0.46) and Performance (0.35) scores of any instrument, and the difference is attributable to its character rather than to chance: as a recent (2020), strategic, evidence-based statement, it sets explicit priorities, anticipates monitoring of contemporary risks (B9), and commits to timely review (B10). Older or more narrowly prescriptive documents lack these features: the Floodplain Studies and the EPL Report, for example, are technically informative (high Policy) but score zero on Practice because they create no operational obligations. The contrast indicates that strategic, regularly updated instruments translate into stronger implementation than static, prescriptive ones.

Two structural weaknesses recur across the local level. First, statutory enforceability is concentrated almost entirely in the WLEP 2014: of the six instruments, only the LEP has binding legal force (B4). Local floodplain planning otherwise relies on non-statutory guidance, and NSW's long-standing "merit-based" approach to flood-prone land allows councils to weigh social and economic factors case by case rather than imposing firm controls, which provides flexibility at the cost of legal certainty. Development control plans contain detailed flood guidance but lack statutory authority, so councils can approve projects that depart from their flood recommendations. Grech and Bewsher document a "concerning trend" in NSW flood-planning maps whereby protective controls in newer instruments have been weakened, making stringent risk-avoidance progressively harder to apply [61]. Second, the flood studies underpinning local planning are outdated, published between 2007 and 2019, with none updated in the past five years, which reduces their reliability as the climate and the urban fabric change [62]. Experts have argued for moving beyond the static 1% annual-exceedance-probability benchmark toward probable-maximum-flood scenarios that better reflect actual risk [63].

The engagement deficit is equally clear. The Floodplain Studies score zero on Practice, and only the WDCP incorporates community engagement and landowner communication; no formal initiative for landowner engagement was captured through the document review. This matters because effective FRM depends on coordination between government and residents, yet the "shared responsibility" arrangement leaves expectations misaligned: officials expect owners to protect their own properties, while many residents regard flooding as government's responsibility [13]. Industry review has likewise found that engaging high-risk communities remains a major challenge and that public education on flood risk is underfunded relative to emergency response [39,64].

5.3. Synthesis of Key Deficiencies

Reading the two levels together reveals that the deficiencies are not random but structured, and that they recur across the cross-scalar system. Table 7 consolidates the principal deficiencies, the evidence for each at state and local levels, and the indicators that capture them. The pattern is consistent: instruments tend to score adequately on Policy (recognition and intent) but fall away on Practice and especially Performance, the dimensions concerned with operationalisation and outcomes. In other words, the system articulates flood concerns but does not reliably enforce, fund, update, or socialise the responses, and the failure compounds where state intent is not carried into local practice.

Table 7. Synthesis of key deficiencies across the cross-scalar planning system (developed by author).

Deficiency	At State Level	At Local Level	Indicators
Statutory enforceability concentrated	Force confined to the CMA; guidance and SEPP largely advisory	Only the WLEP is binding; DCPs lack statutory authority	A2, B4
Private landowners overlooked	Landowner provisions weak and not carried into SEPP	Engagement limited to the DCP; no formal landowner initiative	A5, B5
No innovative or nature-based measures	A6 = 0 across all four instruments	Innovative approaches encouraged but rarely mandated	A6, B7
Weak outcomes and monitoring	Performance $\leq$ 0.31; CMA and SEPP score 0	Performance $\leq$ 0.35; several instruments score 0 on Practice	A7, B8, B9
Outdated flood data/currency	Static 1% AEP emphasis	Flood studies 2007–2019; none updated in 5 years	B10
Minimal community engagement	Not addressed	Only the DCP engages landowners/community	A5, B5, B9

5.4. Policy Currency (2024–2026)

Flood policy in NSW has moved quickly since the 2022 NSW Flood Inquiry [16], so we re-examined the currency of every instrument to June 2026. Most remain the operative versions assessed above, and the routine Woollahra LEP and DCP amendments made in 2024–2026 concern matters such as floor-space ratios and parking rather than flooding, leaving the local scores unchanged. Three developments are material and are incorporated here (Table 8).

Table 8. Policy currency update (summarised by author).

Instrument/Area	Change Since the Analysis (to June 2026)	Status	Implication for the Assessment
Coastal Management Act 2016	Minor technical amendment (Aug 2024)	In force	No change to flood substance; score retained.
Post-Inquiry guidance (PS 24-001, 2024)	New circular operationalising the 2022 Flood Inquiry; risk-based, climate-informed assessment	In force	Newly scored at ≈32%; stronger practice integration, below 50%, but non-statutory.
SEPP (Resilience and Hazards) 2021	Draft Climate Change and Natural Hazards SEPP exhibited Feb–Mar 2026	Proposed	Will embed climate-adjusted controls; assessed qualitatively.
Coastal hazard evidence	NSW Coastal Erosion and Inundation Hazards Exposure Assessment (2025)	Published	Updates foreshore hazard projections; not a planning instrument.
Woollahra floodplain studies	Rose Bay and Double Bay datasets refreshed (2026)	In force	Partially addresses the data-currency gap (B10) for those catchments.
Estuary Planning Levels (2015)	To be superseded by the Outer Sydney Harbour Coastal Management Program	In progress	Will integrate flood, erosion, and ecology under the CMA 2016; qualitative.

The clearest in-force change is the release of Planning Circular PS 24-001 (March 2024), which supplements the 2021 guidance and operationalises the Flood Inquiry by directing consent authorities toward a risk-based, climate-informed approach to flood-prone land [65]. Assessed on the same framework and indicator set as the other state instruments, PS 24-001 attains Policy 0.46, Practice 0.20, and Performance 0.31, for an overall effectiveness of approximately 32% on the corrected scale, comparable to the other recent state instruments and, like them, below 50% (its exact coding is provisional; see Supplementary workbook). Its relative emphasis lies in integrating flood risk into day-to-day decision-making rather than in enforceability or measurable standards, which remain limited because it is non-statutory guidance rather than a binding instrument. This is an informative result: even the most recent reform remains below 50%, and its relative strength lies in integration rather than enforceability, which reinforces rather than overturns the study's central finding.

Three further reforms are in train but not yet operative, and because an instrument that is not in force has no measurable performance, we assess them qualitatively rather than scoring them. First, a draft State Environmental Planning Policy (Climate Change and Natural Hazards), publicly exhibited in February–March 2026, is intended to replace SEPP (Resilience and Hazards) 2021 and to embed climate-adjusted hazard consideration, such as sea-level-rise-informed floor levels, in development assessment [66]. Second, the NSW Coastal Erosion and Inundation Hazards Exposure Assessment (2025) updates statewide coastal-hazard projections of direct relevance to Woollahra's harbour foreshore, though it is technical evidence rather than a planning instrument [67]. Third, the Outer Sydney Harbour Coastal Management Program, in development under the Coastal Management Act 2016, will supersede the legacy 2015 Estuary Planning Levels and integrate flood, erosion, and ecological management for the harbour [68]. These reforms target precisely the deficiencies this study identifies (weak enforceability, dated data, and limited climate adaptation), which both corroborates the diagnosis and indicates that the system is beginning to move in the directions recommended here. Their evaluation, once enacted, is a natural extension of this work.

6. Discussion

The results show a planning system that recognises flood risk in principle but does not enforce, update, or socialise its responses in practice, and that loses coherence across levels. This section interprets that pattern by placing the specific findings in conversation with the literature, organised around the study's central themes: the treatment of private landowners, the role of affluence and property in collective action, the cross-scalar disconnect, and the pathways available to address these gaps.

6.1. Weak Landowner Consideration and the Limits of Shared Responsibility

The most consistent deficiency, weak consideration of private landowners (A5 and B5), is best understood through the "shared responsibility" paradigm. Australian flood governance formally distributes responsibility between public agencies and private owners, but the results suggest the distribution is uneven: instruments assume owner action without creating the obligations, incentives, or engagement needed to secure it, reproducing the misalignment Box et al. observe between official expectations and resident perceptions [13]. This restraint is not merely an oversight. Imposing firm controls or works on privately held, high-value waterfront land raises the prospect of disputes over the effective "taking" of private property rights, and policy may avoid this confrontation by defaulting to advisory, merit-based provisions, precisely the pattern visible in the concentration of enforceability in a single instrument [61]. Yet experience from major infrastructure projects shows that structured landowner engagement and negotiated access are achievable where sufficient institutional effort is invested [69]. Shared responsibility, in this setting, functions less as a partnership than as a gap into which collective resilience falls.

6.2. The Critical Nexus: Affluence, Private Property, and Collective Action

Woollahra's affluence is not incidental to these findings; it is a structural variable in the policy analysis. High property values strengthen owners' incentives and capacity to resist controls that might constrain development or amenity, while extensive private foreshore ownership removes the public land on which coordinated defences would otherwise be built. The result is a collective-action problem with a particular signature: the very wealth that could fund private resilience also entrenches the fragmentation that prevents collective resilience, because each owner optimises for their own parcel (an individual seawall here, a temporary barrier there) while the shoreline as a system remains undefended [15,34]. Compound-flood challenges in other high-value coastal cities reinforce the case for system-scale rather than parcel-scale responses [70]. Where retreat or buy-back of private land is contemplated, municipal experience shows how strongly property rights and institutional capacity constrain implementation [71], and alternative tenure models such as community land trusts have been proposed to reconcile equity with resilience [72]. This nexus helps explain why strong statutory tools are politically costly to apply in exactly the places that most need integrated action, and why affluent coastal suburbs warrant treatment as a distinct governance category rather than as generic "urban" flood settings.

6.3. Policy Fragmentation as a Cross-Scalar Disconnect

The gap between adequate Policy scores and weak Practice and Performance scores is the empirical signature of the cross-scalar disconnect described in the governance literature [73]. State instruments establish intent but do not always carry it into enforceable local controls; the SEPP, expected to bridge the levels, is the weakest performer and fails to transmit the CMA's landowner provisions downward. This is the "friction" between scales made concrete: responsibility is divided, but the mechanisms that would align the divisions (consistent standards, coordinated networks, and shared accountability) are underdeveloped [17,18]. Coordinated funding mechanisms, such as national flood-mitigation programmes, can help bridge the divide where local capacity is limited [74]. The two-level evaluation localises the break, showing that the system's failure is less about any single instrument than about the joints between them.

6.4. Pathways Forward: Green Infrastructure, Adaptive Governance, and Technology

The deficiencies point toward three connected responses. The first is to mainstream green infrastructure (GI). Where grey defences are precluded by private ownership and foreshore controls, GI is not a secondary option but the principal feasible class of measure, and global evidence indicates that nature-based approaches are frequently cost-effective relative to engineered alternatives [35]. Vegetated swales, raingardens, permeable surfaces, and foreshore revegetation can reduce runoff and dissipate flood energy while delivering ecological and amenity co-benefits, and they can be embedded in development controls and incentivised on private land.

The second is adaptive, participatory governance that closes the engagement deficit. Public participation should move beyond consultation toward shared stewardship: trained community "flood wardens," accessible flood-action guides, and co-designed maintenance of local assets convert residents from bystanders into partners [75,76], building on the role that community networks play in social resilience [77]; survey evidence from Greater Sydney shows persistent gaps in residents' flood-risk perception that targeted engagement must close [78]. International models, such as Hong Kong's flood-resilience guides and the United Kingdom's volunteer warden networks, show how informed communities strengthen preparedness [79,80], while major cities such as New York have integrated sea-level projections into long-term planning [81]. This is also where the historical record can be mobilised: documenting and communicating past floods builds risk awareness and local memory, and recent work shows how documentary heritage and historical flood analysis can be used both to recover "lost" hazards and to inform territorial planning [82,83]. Embedding historical flood knowledge in community engagement is a low-cost, high-value complement to technical measures.

The third is the targeted use of technology to improve information flow and decision support. An integrated platform can link real-time monitoring to analytics and to clearly differentiated applications for residents, planners, and property owners (Figure 8). Networks of low-cost sensors tracking rainfall, water level, and tidal conditions can feed predictive analytics that issue early warnings, as in the Town of Cary's shift from reactive to proactive management [84], while AI-supported scenario modelling lets planners test interventions before committing to them [85], an approach now being formalised through "digital risk twins" for disaster risk management [86]. Pairing such tools with property-level retrofit advisories and a shared risk dashboard aligns private and public action around a common operating picture [76]. These tools must be deployed with care, however: reviews of AI-driven flood adaptation warn that smart systems can entrench inequities unless their governance is designed to be just [87]. Technology does not substitute for enforceable standards or engagement, but it lowers the cost of both.

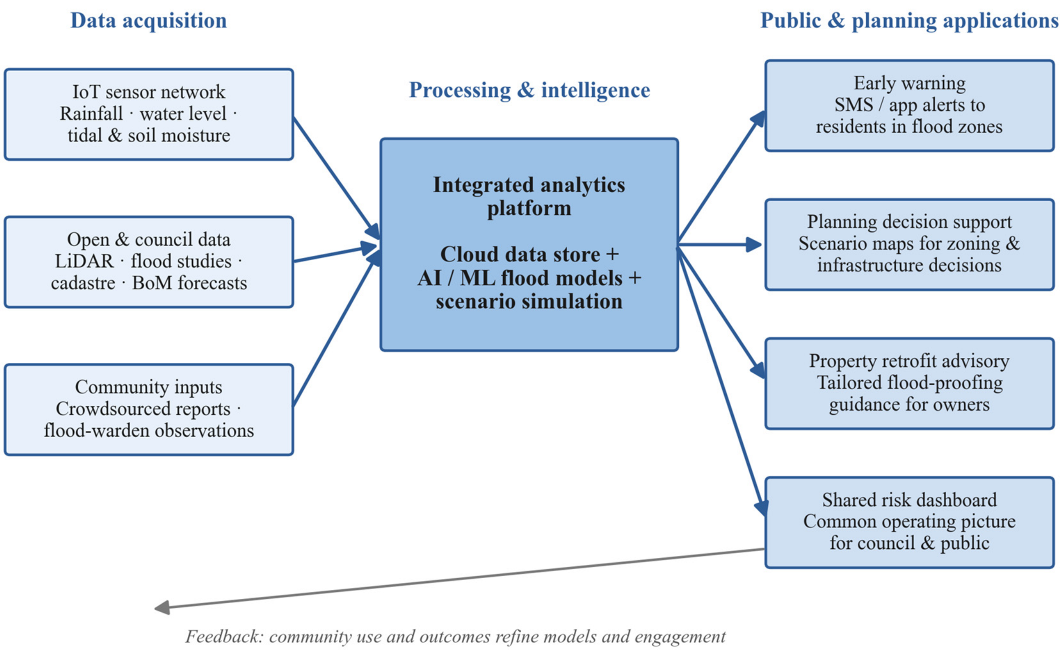

Figure 8. An integrated technology platform for flood resilience (developed by author).

6.5. Contribution

The study makes an empirical, a theoretical, and a methodological contribution. Empirically, it provides a systematic, evidence-based evaluation of how state and local planning instruments jointly manage flood risk in an affluent, fully developed coastal setting (an under-examined context in Australian planning scholarship) and shows that the principal failures lie in operationalisation rather than recognition. Theoretically, it extends plan-evaluation methods [21–24] into FRM and demonstrates how abstract claims about fragmented multi-level governance become visible as measurable, locatable plan deficiencies, while adding nuance to urban-resilience theory by foregrounding private property as a constraining variable. Methodologically, it offers a transparent, indicator-based framework that other jurisdictions can adapt to audit their own flood planning across scales.

6.6. Limitations

Several limitations bound the findings. First, the evaluation analyses written instruments and therefore captures formal policy rather than on-the-ground implementation; informal practices, local initiatives, and the lived realities of implementation are not observed [75]. Stakeholder interviews, expert panels, or participatory methods would complement the document analysis and are a priority for future work. Second, the scoring framework may not fully separate the functions of strategic and statutory documents: instruments that set high-level direction can score low on Performance not because they are ineffective but because operational outcomes are not their role, as the Floodplain Studies and EPL Report illustrate. Refining the framework with document-type-specific criteria or expert validation would sharpen this distinction. Third, the state-local implementation gap means that execution varies with each council's resources, expertise, and capacity, so effectiveness on the ground may diverge from the instruments themselves; testing the framework across multiple LGAs would establish its adaptability and external validity. The coding was also undertaken by the lead author against the explicit rubric and is fully documented for audit in the Supplementary workbook, but it was not independently double-coded; formal inter-coder reliability testing would further strengthen confidence in the scores and is a useful validation step for future work. Finally, NSW flood policy is changing rapidly; we addressed this with a currency review (Section 5.4), but the proposed reforms assessed there cannot be scored on performance until they are in force.

7. Conclusions and Recommendations

This study evaluated how New South Wales state and local planning instruments jointly manage flood risk in Woollahra, an established, affluent coastal suburb. Using a transparent, indicator-based framework, it found that no instrument reached half of the maximum effectiveness score, that Performance was the weakest dimension throughout, and that the system's central failure is a cross-scalar disconnect in which strategic intent is not carried into enforceable, current, and landowner-inclusive practice. These findings translate directly into action.

7.1. Strategic Recommendations

Reform should target the dimensions that scored weakest. The priorities are to give flood controls genuine statutory force, to bring private land and equity into the policy frame, to mainstream green infrastructure, to rebuild community engagement around historical knowledge, to keep flood data current, to deploy smart monitoring, and to repair cross-scalar coordination and funding. Table 9 sets out each priority with concrete legislative and procedural tools, and the level best placed to lead.

7.2. Future Research

Three directions follow. First, the framework should be applied across multiple coastal LGAs and over time, to test whether the deficiencies observed in Woollahra are systemic or local and to establish the framework's adaptability. Applying it to the NSW reforms now being enacted, particularly the proposed Climate Change and Natural Hazards SEPP, would also test whether they close the gaps identified here. Second, qualitative methods (interviews with planners, emergency managers, residents, and developers) should be used to capture the implementation realities that document analysis cannot reach. Third, pilot interventions in green infrastructure and smart monitoring should be evaluated for their measurable effect on flood mitigation and community resilience, providing feedback to both theory and practice.

Table 9. A framework for action (developed by author).

Priority	Recommended Action	Example Instruments/Tools	Lead
Enforceable standards	Move flood controls from guidance into binding instruments	Flood overlays and mandatory flood planning levels in the LEP; statutory weight for key DCP provisions	State + Local
Private land & equity	Engage and incentivise owner-level resilience on private (foreshore) land	Development-consent conditions; transferable development rights; foreshore management agreements; rates-based incentives	Local + State
Green infrastructure	Mainstream nature-based measures as the primary feasible defence	GI requirements in the DCP; raingardens, bioswales, permeable surfaces; foreshore revegetation	Local
Community engagement	Build awareness using historical flood knowledge	Flood wardens; plain-language flood-action guides; historical-flood mapping and storytelling [82,83]	Local
Data currency	Keep flood evidence current and forward-looking	Scheduled five-yearly study updates; sea-level and rainfall projections; probable-maximum-flood scenarios	Local + State
Smart technology	Use monitoring and analytics for warning and decision support	IoT sensor network; AI scenario modelling; shared risk dashboard (Figure 8)	Local + State
Cross-scalar coordination	Close the implementation gap with shared mechanisms and funding	Joint state-local task forces; Commonwealth mitigation funding; state technical assistance	State + Local

7.3. Concluding Perspective

Facing the tide in established coastal cities is less a problem of knowing the hazard than of governing the response. Woollahra shows that planning systems can acknowledge flood risk fully while still failing to enforce, fund, update, or share the measures that would reduce it, and that private property and affluence are not background details but central variables in that failure. Closing the gap between intent and implementation, through enforceable standards, green infrastructure, engaged communities, current data, and coordinated, well-resourced action across scales, offers a practical path to resilience for Woollahra and for the many high-value coastal cities that share its predicament.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land15081390/s1. The complete indicator scoring workbook is provided as supporting information with this article and enables full reproduction of Tables 4–6.

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Appendix A. Indicator Definitions and Scoring Rationale

Table A1. Definitions, indicative scores, and scoring rationale for the indicators used at the state (A1–A7) and local (B1–B10) levels.

Element	Dimension	Cov.	Str.	Definition and Scoring Rationale
A1 Vision/objectives	Policy	3	2	Flooding identified among the goals/objectives at the outset. Full coverage and strong, as objectives are explicit and aligned with planning principles.
A2 Legal enforceability	Policy	3	2	Mandatory legal effect rather than purely advisory. Full and strong owing to enforceable legal language applying jurisdiction-wide.
A3 Alternative clauses	Policy	1	1	Alternative measures provided where standard provisions do not apply. Some coverage; medium strength as flexibility is present but variable.
A4 Integration to local level	Practice	2	1	Advice to councils on incorporating flooding into land-use planning. Most coverage; medium strength due to variable local implementation.
A5 Consideration of landowners	Practice	1	1	Addresses the rights, responsibilities, and works of landowners. Some coverage; medium strength, with limited enforceable guidance.
A6 Innovation in guidance	Practice & Performance	2/2	2/2	Incorporates innovative measures (e.g., nature-based solutions). Most coverage; strong where forward-looking approaches are demonstrated.
A7 Flood planning standards	Performance	2	1	Clear flood standards (e.g., flood planning level). Most coverage; medium strength given consistency challenges in application.
B1 Vision/objectives	Policy	3	2	Explicit flood-related goals and objectives. Full coverage; strong owing to comprehensive scope.
B2 Evidence-based priorities	Policy	2	2	Priorities and actions grounded in evidence and risk assessment. Most coverage; strong reliance on research and best practice.
B3 Relation to drainage systems	Policy	2	1	Links flood policy to urban drainage. Most coverage; medium strength given variable integration.
B4 Legal enforceability	Policy	3	2	Legally binding provisions. Full coverage; strong owing to binding nature.
B5 Consideration of private landowners	Practice	1	1	Acknowledges roles and concerns of private landowners. Some coverage; medium strength owing to partial treatment.
B6 Upgrading of infrastructure	Practice	2	1	Proposes infrastructure upgrades for resilience. Most coverage; medium strength given implementation challenges.
B7 Innovation in practice	Practice & Performance	2/2	2/2	Encourages innovative planning methods. Most coverage; strong owing to potential impact, though rarely mandatory.

Table A1. *Cont.*

Element	Dimension	Cov.	Str.	Definition and Scoring Rationale
B8 Flood planning standards	Performance	2	1	Establishes and applies flood standards. Most coverage; medium strength given uneven application.
B9 Monitoring of contemporary issues	Performance	1	0	Monitors emerging risks and changing climate conditions. Some coverage; weak owing to limited proactive mechanisms.
B10 Timely updates	Performance	1	1	Regular updates reflecting new data. Some coverage; medium strength owing to periodic rather than systematic updating.

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