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From Watershed Evidence to Public Decision: A Framework for Communicating Hydrologic Uncertainty

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Abstract:
Background: *Hydrologic uncertainty is unavoidable in watershed management, yet it is often poorly communicated to stakeholders and decision-makers. Overstating certainty causes poor decisions and credibility loss; understating evidence delays necessary action. The challenge is not to eliminate uncertainty but to communicate it in ways that preserve scientific integrity and support responsible public action.*

Materials and Methods: *This concise framework paper integrates and updates contemporary peer-reviewed literature on uncertainty taxonomy and translational discourse for risk communication, drought hydrologic connectivity, high-frequency low-flow monitoring, hydroclimatic non-stationarity, the natural flow regime, monitoring decision workflows, sensor-grab calibration, and urban stream syndrome, with work on future water balance, fecal indicators, and microplastic science.*

Results: *A Hydrologic Uncertainty Communication Framework is proposed as five components (Evidence Type, Process Inference, Uncertainty Source, Decision Relevance, Ethical Claim Boundary) arranged as a five-pillar capstone layout supporting a Defensible Claim Boundary, coupled with a five-by-five matrix that aligns each component against five uncertainty types (measurement, sampling, model, process, decision).*

Conclusions: *The framework is a science communication and decision-support instrument; it supports the explicit translation of watershed evidence into public decision-making language by aligning the strength of each claim with the strength and scope of the supporting evidence.*

Key Words: *Aleatory uncertainty; Decision support; Epistemic uncertainty; Ethical claim boundary; Evidence type; Hydrologic uncertainty; Process inference; Public decision-making; Risk communication; Science communication; Translational discourse; Uncertainty communication; Watershed management.*

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I. Introduction

Watershed decisions are rarely made with complete information. Streamflow records may be short, water-quality samples may miss events, climate projections may differ across global models, source attribution may be uncertain, and stakeholder expectations may exceed what the available data can support. Yet decisions still have to be made: advisories must be issued or withheld, restoration investments must be prioritized, climate-adaptation plans must be drafted, and regulatory listings must be defended. The challenge for the watershed scientist communicating to public decision-makers is not to eliminate uncertainty but to communicate it in ways that preserve scientific integrity, calibrate stakeholder expectations, and support responsible public action. Beven [1] presented a taxonomy of uncertainty in hydrological systems that distinguishes aleatory uncertainty (random uncertainty well-approximated by statistical distributions, such as sensor measurement noise), epistemic uncertainty (uncertainty arising from limited knowledge of catchment processes, model structure, or boundary conditions), semantic uncertainty (uncertainty arising from how concepts and terms are defined), and ontological uncertainty (uncertainty arising from unknowns and surprises in human-water systems) [1]. Faulkner, *et al.* [2] developed a translational discourse framework for uncertainty communication between scientists developing flood models and forecasts and the practitioners who receive flood risk estimates, arguing that contested ownership of uncertainty articulation can be reduced by formally structured translational discourse between science and professional users of flood risk information. These two foundational contributions establish that uncertainty communication is not a peripheral concern but a central technical and ethical challenge of contemporary watershed science.

Contemporary watershed monitoring research adds urgency to the communication challenge. Previous drought-connectivity work documented that hydrologic connectivity state, not total discharge, drove intra-annual and inter-annual water-quality variation in an intermittent stream network [3], meaning that monitoring records collected under different connectivity states are not directly comparable. Other work showed that water-quality indicators, ecosystem metabolism, and nitrogen uptake all changed measurably during the extreme summer low flow of 2018, with monthly grab sampling underrepresenting those changes [4], implying that the meaning gleaned from a grab-sample concentration depends on the hydrologic state from which it was drawn. Stevenson*, et al.* [5] conducted hydroclimatic non-stationarity work showing that long-term shifts in catchment connectivity and water-age distributions drive stream hydrochemistry on short and long timescales, meaning that historical water-quality relationships may not extrapolate to future conditions. Indeed, effective watershed management must account for cumulative legacy effects of historic land use and natural landscape processes, because focusing only on recent development can misdiagnose the causes of impairment and lead to unrealistic expectations [6]. These findings indicate that hydrologic state, monitoring design, and climatic non-stationarity all change the meaning of watershed evidence. Public communication must therefore state what evidence shows, what it suggests, what remains uncertain, and what decision is justified.

The novel contribution of this article is the Hydrologic Uncertainty Communication Framework: five components (Evidence Type, Process Inference, Uncertainty Source, Decision Relevance, Ethical Claim Boundary) arranged as a five-pillar capstone layout supporting a Defensible Claim Boundary capstone, coupled with a five-by-five crosswalk matrix that aligns each component against five uncertainty types (measurement, sampling, model, process, decision) following the taxonomy presented by Beven [1]. A targeted peer-reviewed literature search confirmed the absence of an equivalent five-component-plus-uncertainty-type matrix crosswalk that translates the Beven [1] uncertainty taxonomy and the Faulkner*, et al.* [2] translational discourse into a watershed-scientist communication instrument. The framework is intended to make uncertainty communication a disciplined practice rather than a vague disclaimer, and to align watershed claims with the strength and scope of the supporting evidence so that public decisions can be made responsibly even when scientific certainty is incomplete.

II. Prior Work and Rationale

Abesh*, et al.* [7] conducted SWAT modeling work documenting that calibrated future water-balance projections for a representative mountainous watershed under CMIP5 GCMs and Representative Concentration Pathways RCP 4.5 and RCP 8.5 yield consistent increases in precipitation and evapotranspiration across the 2030s, 2050s, and 2070s. Results illustrated model uncertainty in its archetypal form: a calibrated model run forward under multiple plausible climate scenarios produces a defensible envelope of projections, but each individual projection is itself uncertain in ways that depend on model structure, input data, and scenario selection. Hubbart*, et al.* [8] conducted a 22-site fecal-indicator comparison documenting that Escherichia coli and Enterococcus concentrations varied systematically with adjacent land-use practice and receiving-water physicochemistry across mixed land-use watersheds. Results showed measurement and sampling uncertainty: microbial concentrations depend on sampling timing, handling, detection method, and the temporal and spatial representativeness of the sample set. A microplastic review by Petersen and Hubbart [9] documented that most microplastic transport processes and environmental impacts remain poorly understood and identified 16 specific research and translation gaps. Results indicated emerging-issue uncertainty: the analytical methods, source-attribution logic, and management response options are still developing, even as management decisions about microplastics are being made today.

A practical communication framework is needed because contemporary watershed evidence is powerful but methodologically and conceptually complex. Rozemeijer*, et al.* [10] conducted an international synthesis on high-frequency water-quality monitoring documenting that practical uptake of integrated monitoring depends on explicit articulation of the regulatory or management decision the data will inform. The synthesis further offered a novel decision workflow that begins with the management question and works backward to data and analytical design. Villa*, et al.* [11] compared work across 108 monitoring stations showing that turbidity-as-surrogate calibration for suspended solids returns a site-specific mean R-squared of 0.72 with substantial site-to-site variation, meaning that evidence strength itself is quantifiable and varies across watersheds. An urban-stream-syndrome synthesis by Walsh*, et al.* [12] showed that flashy hydrographs, impervious surface, and altered channel geomorphology change source-pathway alignment, complicating the translation of watershed-scale claims to urban audiences who may experience flooding and water-quality consequences directly. The natural-flow-regime framework of Poff and colleagues provides the conceptual basis for treating magnitude, frequency, duration, timing, and rate of change as five distinct flow-regime dimensions [13], meaning that a single discharge statistic cannot represent the hydrologic context against which water-quality evidence must be interpreted.

The rationale for the framework is therefore both ethical and technical. Public decision-makers need information that is honest enough to be trusted and clear enough to be useful. Overstating certainty leads to poor decisions and a loss of credibility when subsequent evidence reveals overreach. Understating evidence delays necessary action when a precautionary or proportionate response is warranted. The taxonomy of uncertainty types [1] and the translational discourse approach [2] together establish that uncertainty communication is a disciplined activity that can be improved through structured practice. The framework proposed here translates those foundations into a watershed-scientist communication instrument for use during manuscript preparation, technical report writing, stakeholder presentations, advisory drafting, and grant proposal justification.

III. Literature-Based Evidence

Each of the five framework components is anchored on distinct peer-reviewed primary literature. The Evidence Type component is anchored on the Rozemeijer*, et al.* [10] monitoring decision workflow; on the Villa*, et al.* [11] quantitative sensor-grab calibration evidence, and on the Huang*, et al.* [4] high-frequency low-flow work, which documented the qualitative difference between high-frequency sensor and grab-sample evidence types. The Evidence Type component asks the scientist to specify whether the supporting information comes from continuous monitoring, grab sampling, modeling, literature synthesis, spatial analysis, or professional judgment, and to state the implications for the strength of the evidence.

The Process Inference component is anchored on the Wang*, et al.* [3] drought-connectivity work, which documented that connectivity state drives water-quality outcomes through specific transport processes; on the Stevenson*, et al.* [5] hydroclimatic non-stationarity work, which documented that catchment connectivity and water-age distributions drive stream hydrochemistry through process-based mechanisms; on the Hubbart*, et al.* [8] fecal-indicator work, which documented that microbial concentrations vary systematically with land-use-mediated transport processes; and on the Walsh*, et al.* [12] urban-stream-syndrome synthesis, which documented that the urban-stream syndrome is a process-level explanation rather than a phenomenon-only description.

The Uncertainty Source component is anchored on the Beven [1] facets-of-uncertainty taxonomy; on the Faulkner*, et al.* [2] translational discourse work, which documented that uncertainty communication requires explicit articulation of which uncertainty type is dominant; on the Abesh*, et al.* [7] future water-balance work, which illustrates model uncertainty under multi-GCM and multi-RCP ensembles; and on the Villa*, et al.* [11] evidence strength work, which illustrates measurement and sampling uncertainty in quantified form. The five uncertainty types are measurement (aleatory uncertainty from instruments, laboratory procedures, detection limits, sample handling), sampling (when and where observations are collected), model (assumptions, calibration, input data, scenario selection), process (multiple mechanisms could explain the same observation), and decision (scientific evidence must be weighed against cost, risk tolerance, regulation, and public values).

The Decision Relevance component is anchored on the Rozemeijer*, et al.* [10] monitoring decision workflow, which documented that decision-relevance must be articulated first and the analytical chain designed to support it; on the Faulkner*, et al.* [2] translational discourse work, which documented that the practitioner's decision mission shapes the appropriate uncertainty articulation, and on the Hubbart*, et al.* [8] fecal-indicator work, which documented that microbial water-quality decisions require context-informed interpretation of receiving waters rather than concentration-only reporting.

The Ethical Claim Boundary component is the framework's most distinctive element and is anchored on the Faulkner*, et al.* [2] translational discourse work, which argued that contested ownership of uncertainty articulation can be reduced by formally structured translational discourse and explicit codes of practice for uncertainty estimation in different application areas; on the Beven [1] uncertainty taxonomy, which argued that condition trees and audit trails support explicit articulation of the assumptions underlying any uncertainty assessment; on the Petersen and Hubbart [9] microplastic review, which identified the gap between detection and management decision as a translation-and-uncertainty-communication challenge; and on the natural-flow-regime framework, which provides the conceptual basis for distinguishing between strong claims about magnitude-frequency-duration-timing-rate-of-change and weaker claims about specific ecological consequences [13]. The Ethical Claim Boundary requires the scientist to state, in a single sentence, the strongest defensible claim and the claims that should not be made. Examples of such claims could include: the existing evidence supports targeted monitoring, but not source attribution; the evidence supports concern about thermal vulnerability, but not biological impairment; the evidence supports prioritizing road-crossing inspection but not estimating sediment-load reduction; or the evidence supports a climate-sensitivity hypothesis, but not a calibrated forecast.

IV. Proposed Framework

The Hydrologic Uncertainty Communication Framework, presented in Figures 1 and 2, comprises five components arranged as a five-pillar capstone layout and a paired five-by-five matrix. Figure 1 shows the five components (Evidence Type, Process Inference, Uncertainty Source, Decision Relevance, Ethical Claim Boundary) as five vertical pillars, each supporting a horizontal "Defensible Claim Boundary" capstone bar. The pillar layout is intentional: each pillar must be present for the capstone (the defensible public claim) to be supported, and the absence of any one pillar weakens the claim regardless of how strong the others are. Figure 2 presents the five-by-five crosswalk matrix, in which each of the five framework components is aligned against five Beven [1] uncertainty types (measurement, sampling, model, process, decision) with a dominant-signal note and a brief criterion for each component-by-uncertainty-type combination. The framework is ultimately a science communication and decision-support instrument; it organizes the available evidence so that watershed claims can be matched to the specific evidence type, process mechanism, uncertainty source, and decision context in which the claim is made.

Component 1: Evidence Type. The scientist (or qualified practitioner) identifies whether the information comes from continuous monitoring, grab sampling, modeling, literature synthesis, spatial analysis, or professional judgment, and states the evidence-strength implications [4,10,11]. Evidence Type sets the upper bound on what claims the supporting data can carry.

Component 2: Process Inference. The scientist (or qualified practitioner) identifies the mechanism that the evidence is believed to represent, such as thermal loading, sediment transport, low-flow concentration, microbial source-pathway transport, or hydrologic connectivity [3,5,8,12]. Process Inference forces the claim to be mechanistic rather than correlational.

Component 3: Uncertainty Source. The scientist (or qualified practitioner) identifies whether the uncertainty is measurement-based (aleatory), sampling-based, model-based, process-based, or decision-based, using the Beven taxonomy [1,2,7,11]. Uncertainty Source replaces vague "uncertainty" disclaimers with a disciplined articulation of which uncertainty type is dominant.

Component 4: Decision Relevance. The scientist (or qualified practitioner) identifies the specific decision the evidence is intended to inform: E.g., advisory issuance, regulatory listing, restoration prioritization, monitoring redesign, manuscript claim [2,8,10]. Decision Relevance anchors the framework to a specific, actionable choice rather than to general academic discourse.

Component 5: Ethical Claim Boundary. The scientist (or qualified practitioner) writes a single sentence that states the strongest defensible claim and the claims that should not be made, framed as "the evidence supports X, but not Y" [1,2,9,13]. Ethical Claim Boundary is what protects credibility and prevents both overreach and unwarranted timidity.

Crosswalk Matrix. The framework also requires an explicit crosswalk evaluation, presented in Figure 2. The five Beven [1] uncertainty types (measurement, sampling, model, process, decision) are the column axis, and the five framework components are the row axis. Each of the 25 cells names a dominant signal (Strong, Moderate, Weak, or Limited) and a brief criterion. The crosswalk supports a written uncertainty-communication report that documents, for each component, which uncertainty types are most salient, and which are not, so that the resulting public claim is calibrated to the strongest uncertainty signal rather than to a generic disclaimer. The crosswalk is consulted alongside the five-pillar capstone (Figure 1) and produces an audit trail that can be reviewed by technical peers, decision authorities, and stakeholders.

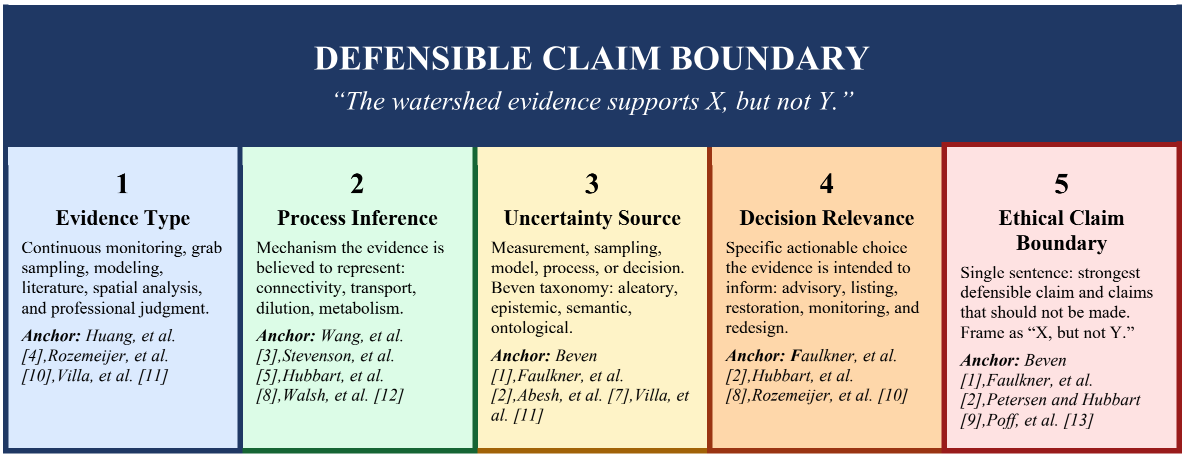

Figure 1: The Five-Pillar Capstone Layout (Evidence Type, Process Inference, Uncertainty Source, Decision Relevance, Ethical Claim Boundary) is arranged as five vertical pillars, each supporting a horizontal Defensible Claim Boundary capstone (bar at the top). Each pillar must be present for the capstone to be supported, and the absence of any one pillar weakens the public claim regardless of the strength or certainty of the other pillars.

Component ↓ / Uncertainty type →	**Measurement** *aleatory; sensor and lab*	**Sampling** *when, where, how often*	**Model** *structure, inputs, scenario*	**Process** *multiple mechanisms*	**Decision** *values, cost, risk*
Component 1 **Evidence Type**	**Strong** *Sensor specs and laboratory detection limits.*	**Strong** *Temporal and spatial representativeness.*	**Moderate** *Whether models are part of the evidence base.*	**Weak** *Evidence type doesn't resolve process directly.*	**Limited** *Evidence type is upstream of decision.*
Component 2 **Process Inference**	**Moderate** *Measurements inform but rarely confirm process.*	**Moderate** *Sampling design must match the process question.*	**Strong** *Process-based models test mechanism explicitly.*	**Strong** *Process inference is the component's defining concern.*	**Moderate** *Process plausibility shapes decision confidence.*
Component 3 **Uncertainty Source**	**Strong** *Aleatory uncertainty quantifiable from sensor stats.*	**Strong** *Sampling uncertainty quantifiable from design.*	**Strong** *Model uncertainty quantifiable via ensembles.*	**Strong** *Process uncertainty is epistemic; harder to quantify.*	**Strong** *Decision uncertainty integrates evidence with values.*
Component 4 **Decision Relevance**	**Moderate** *Measurement strength supports decision urgency.*	**Moderate** *Sampling design shapes what decisions are defensible.*	**Moderate** *Model output guides scenario decisions, not certainty.*	**Moderate** *Process clarity makes the decision interpretable.*	**Strong** *Decision context is the component's defining concern.*
Component 5 **Ethical Claim Boundary**	**Strong** *Measurement strength sets upper bound on claim.*	**Strong** *Sampling scope sets representativeness of claim.*	**Strong** *Model assumptions appear explicitly in claim.*	**Strong** *Process inference is what claim must defend.*	**Strong** *Decision audience determines claim language.*

Figure 2: The Component-by-Uncertainty-Type Crosswalk Matrix, including five framework components (rows: Evidence Type, Process Inference, Uncertainty Source, Decision Relevance, Ethical Claim Boundary) are aligned against five uncertainty types (columns: Measurement, Sampling, Model, Process, Decision) drawn from the Beven [1] 2016 facets-of-uncertainty taxonomy. Each of the 25 cells names a dominant signal (Strong, Moderate, Weak, or Limited) and a brief criterion. Color coding (blue for Strong, amber for Moderate, pale amber for Weak, red for Limited) corresponds to the dominant signal. The matrix is consulted alongside the five-pillar capstone (Figure 1) to produce a written uncertainty-communication report that, for each component of a public claim, identifies which uncertainty types are most salient and which are not. Row 5 (Ethical Claim Boundary) shows Strong across all columns because every public claim must explicitly address all five uncertainty types; this row is the framework's integrative requirement. Row 3 (Uncertainty Source) is the diagnostic row that identifies which uncertainty type dominates for the specific claim under construction; this row translates the Beven [1] taxonomy from theoretical categories into watershed-scientist practice.

V. Practical Application

The framework is designed for use during manuscript preparation, technical report writing, stakeholder presentations, advisory drafting, and grant proposal justification. The scientist (or qualified practitioner) first compiles the available evidence base: continuous monitoring records, grab samples, model output, literature synthesis, spatial analysis, and professional judgment. The five components of Figure 1 are then evaluated against the available evidence, and the five-by-five crosswalk matrix of Figure 2 is consulted to identify, for each component, which uncertainty types are most salient. The output is a brief uncertainty-communication report (one to two pages for routine claims, longer for consequential ones) that documents Evidence Type, Process Inference, Uncertainty Source, and Decision Relevance, and that concludes with the Ethical Claim Boundary sentence: "the evidence supports X, but not Y." The report serves as the audit trail supporting the public claim and can be reviewed by technical peers, decision authorities, and stakeholders (Table 1).

A worked example may clarify the intended use. Consider a hypothetical late-summer water-quality report for a small Appalachian watershed of approximately 18 square kilometers, in which a sequence of three grab samples collected over four weeks shows Escherichia coli concentrations above the recreational-use criterion. The watershed manager must decide whether to issue a public advisory before a planned recreational event the following weekend. Applying the framework: Component 1 (Evidence Type) documents that the evidence is three discrete grab samples taken at the public-access point during late-summer low flow [4,10,11]. Component 2 (Process Inference) infers that the elevated concentrations most plausibly reflect a combination of reduced dilution under low flow and proximate land-use sources (pasture and residential septic) that the watershed already includes; the alternative process (a single transient point-source release) cannot be ruled out without storm-event sampling [3,8,12]. Component 3 (Uncertainty Source) identifies sampling uncertainty (only three grab samples; one site) and process uncertainty (multiple plausible mechanisms) as dominant, with measurement uncertainty subordinate (laboratory detection is reliable) and model uncertainty absent (no model is used here) [1,2,11]. Component 4 (Decision Relevance) identifies the decision as a binary advisory issuance before a recreational event, with consequences for public health on one side and for credibility and public communication on the other [2,8,10]. Component 5 (Ethical Claim Boundary) states: "The three late-summer grab samples support a precautionary advisory in advance of the recreational event, but they do not support source attribution to a single pathway or a quantified assessment of risk magnitude." This claim boundary is communicated to the public alongside the advisory, and it preserves the scientist's, or qualified practitioners', credibility because the boundary does not overstate what three grab samples can defend; broader source attribution and quantitative risk would require storm-event sampling and additional analysis [1,2,7][9,13]. The framework's value here is that it converts a clinically simple but ethically complex decision (three samples above criterion, issue advisory or not) into a defensible public communication that documents the evidence base, the process inference, the uncertainty sources, the decision context, and the ethical claim boundary, and that supports both the immediate decision and any subsequent challenge or refinement.

Table 1: Hydrologic Uncertainty Communication Framework application matrix. Each row identifies a screening component, the evidence to examine, the practical use of that evidence in uncertainty articulation, and the principal peer-reviewed anchor citations. The matrix is intended for direct use during manuscript preparation, technical report writing, stakeholder presentations, advisory drafting, and grant proposal justification. It is a science-communication and decision-support instrument.

Component	Evidence to examine	Practical use	Anchors
1. Evidence Type	Continuous monitoring, grab samples, model output, literature, spatial analysis, and professional judgment.	Sets the upper bound on what claims the evidence can carry.	[4,10,11]
2. Process Inference	Mechanism the evidence is believed to represent (connectivity, transport, dilution, metabolism).	Forces the claim to be mechanistic rather than correlational.	[3,5,8,12]
3. Uncertainty Source	Measurement, sampling, model, process, or decision. Beven taxonomy.	Replaces vague disclaimers with disciplined articulation.	[1,2,7,11]
4. Decision Relevance	Specific actionable choice the evidence is intended to inform.	Anchors the framework to a specific decision rather than to general discourse.	[2,8,10]
5. Ethical Claim Boundary	Single sentence: strongest defensible claim and claims that should not be made.	Protects credibility; prevents overreach and unwarranted timidity.	[1,2,9,13]

VI. Limitations

The primary limitation of this article is that the Hydrologic Uncertainty Communication Framework is not empirically validated. The paper is designed as a concise framework contribution that integrates contemporary peer-reviewed scholarship on uncertainty taxonomy and translational discourse for risk communication, drought hydrologic connectivity, high-frequency monitoring during extreme low flow, hydroclimatic non-stationarity, the natural flow regime, monitoring decision workflows, sensor-grab calibration evidence strength, and urban stream syndrome, together with prior peer-reviewed work, into a science-communication and decision-support instrument [8]. The framework should not be considered a formal uncertainty quantification method, a statistical confidence interval procedure, a model-ensemble protocol, or a risk-assessment standard. It cannot replace technical uncertainty analysis; it is a communication scaffold that runs alongside and downstream of such analysis. A second limitation is that the framework depends on the integrity and expertise of the scientist or other qualified practitioner applying it. It can be misused if claim boundaries are written defensively rather than honestly, or if uncertainty articulation is invoked to delay action that the evidence actually supports. The framework should therefore be paired with technical review, citation support, and transparent documentation. A third limitation is that the five-by-five crosswalk simplifies a continuous and multidimensional uncertainty landscape into 25 categorical cells; this simplification is appropriate for communication and audit but should not substitute for quantitative uncertainty analysis when consequential regulatory or restoration decisions are pending. A fourth limitation is that the framework was developed from a watershed-science perspective and may require adaptation for other environmental disciplines (e.g., air quality, soils, ecology, climate science) that have their own communication conventions and uncertainty taxonomies. A fifth limitation is that the framework is silent on the institutional and political dimensions of uncertainty communication: the question of who is authorized to issue what claim is a matter for institutional policy and professional ethics rather than for the framework itself. Future work could test the framework through pilot applications with watershed-scientist communicators, inter-rater reliability analyses across analyst experience levels and decision contexts, comparison of framework-organized public claims against unstructured communications, and longitudinal observation of public credibility and decision-outcome consequences when the framework is applied versus when it is not.

VII. Conclusions

Hydrologic uncertainty is not a weakness to hide; it is a condition to communicate accurately. The Hydrologic Uncertainty Communication Framework presented in this article organizes the translation from watershed evidence to public decision around five components (Evidence Type, Process Inference, Uncertainty Source, Decision Relevance, Ethical Claim Boundary) arranged as a five-pillar capstone, with a paired five-by-five crosswalk that aligns each component against published uncertainty types (measurement, sampling, model, process, decision). It can be applied without new data collection by using prior peer-reviewed scholarship, current peer-reviewed literature, and available site-level evidence, and it produces public claims whose strength is calibrated to the strength and scope of the supporting evidence.

The framework's broader value is that contemporary watershed communication is rarely improved by adding more disclaimers alone; what improves communication is the explicit articulation of which types of uncertainty are dominant, which decisions the evidence is intended to inform, and which claims the evidence cannot defend. The framework is supported by current peer-reviewed primary literature on uncertainty taxonomy and translational discourse for risk communication, drought hydrologic connectivity, high-frequency monitoring during extreme low flow, hydroclimatic non-stationarity, the natural flow regime, monitoring decision workflows, sensor-grab calibration evidence strength, and urban stream syndrome, and it is offered as a practical contribution at the intersection of science communication, public decision-making, environmental governance, and applied watershed practice. The framework is a science-communication and decision-support instrument; it should be paired with formal technical uncertainty analysis when consequential decisions are pending, and it should be updated as the literature on uncertainty taxonomy, translational discourse, and contemporary watershed monitoring evolves. Its central message is simple: the strength of a watershed claim must match the strength and scope of the evidence.

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