

Revival and Restoration Strategies for Traditional Water Sources in Uttarakhand

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Abstract: *Uttarakhand's traditional water sources—naulas, dharas, chal-khals, and guls—constitute an indigenous hydraulic heritage that has sustained Himalayan communities for centuries. Yet these systems are collapsing under compounded pressures: climate-induced rainfall variability, land-use change, out-migration, and fragmented governance that privileges centralized piped infrastructure over decentralized traditional systems. This paper synthesizes existing evidence to construct a rigorous analytical framework for Study.-level inquiry into revival and restoration strategies. Drawing on case studies from Almora, Pithoragarh, and Dehradun, and engaging with the Policy-Heritage Integration Matrix (PHIM) and springshed management paradigms, the paper argues that effective restoration requires a dual intervention: hydrological rehabilitation of recharge zones and institutional reconstruction of community stewardship. The paper identifies critical research gaps—particularly the absence of systematic pre- and post-restoration discharge data, the under-theorization of out-migration's impact on traditional maintenance regimes, and the unresolved tension between heritage conservation and modern water security metrics—and proposes a mixed-methods research design to address them. The central finding is that Uttarakhand's traditional water sources cannot be “restored” in a purely technical sense; their revival depends upon re-embedding them within functioning community institutions and aligning state policy with the hydrological logic of the springshed rather than the pipeline.*

Keywords: traditional water sources, naula, dhara, springshed management, Uttarakhand, water governance, heritage conservation, climate adaptation

I. INTRODUCTION

The Indian Himalayan Region holds an estimated three million springs, approximately half of which are either dry or declining. Uttarakhand, a state where over 10,000 traditional water sources—locally termed *naulas* and *dharas*—dot the landscape from Almora to Pithoragarh, sits at the epicenter of this crisis. These are not merely utilitarian structures. A *naula* is a stone-lined, often temple-adjacent collection chamber that captures seepage from an aquifer; a *dhara* is the point where spring water emerges at the surface. Together, they represent a centuries-old synthesis of hydrogeological knowledge, masonry craft, and sacred geography. In Kumaoni culture, the *naula* is treated with the sanctity of a temple, and its maintenance was historically a communal obligation woven into the ritual calendar.

That social fabric has frayed. Out-migration from hill villages, the decline of traditional knowledge transmission, road construction that has severed recharge channels, and erratic monsoon patterns have collectively degraded both the physical infrastructure and the institutional regimes that once sustained it. Meanwhile, state water policy has historically rendered these systems invisible: the National Water Policies of 1987, 2002, and 2012 made no mention of springs, an institutional blind spot that persisted for five decades. The resulting policy vacuum has been filled by fragmented interventions—some successful, many tokenistic—that treat traditional sources as heritage curiosities rather than living infrastructure.



This paper addresses a deceptively simple question: what would it actually take to revive Uttarakhand's traditional water sources? The question is deceptively simple because the answer is not primarily technical. Restoration of a *naula*'s masonry is straightforward; restoration of the social and hydrological conditions that make it flow is not. This paper synthesizes the available evidence to construct a framework suitable for Study.-level research, identifying what is known, what remains contested, and what methodological innovations are required to move from descriptive case studies to actionable, scalable strategy.

II. THE TRADITIONAL WATER SYSTEMS OF UTTARAKHAND: TYPOLOGY AND HYDROLOGY

Any restoration strategy must begin with precise typological clarity, a point often blurred in policy discourse that lumps *naulas*, *dharas*, and *chal-khals* under the generic category of "traditional water bodies."

2.1 Naula

The *naula* is a semi-subterranean stone structure, typically rectangular or square, built to intercept and collect water from a seepage zone or shallow aquifer . Its architecture is functionally elegant: stone masonry walls allow water to percolate inward while filtering sediment; a stepped access facilitates drawing; and the chamber is often roofed to prevent evaporation and contamination. The Ranidhara *naula* in Almora, constructed by the Chand dynasty, remains an exemplar of the form, though many others have fallen into disrepair or been repurposed as waste receptacles . Critically, the *naula* is not a well in the conventional sense—it does not tap a deep water table but rather captures diffuse subsurface flow, making its yield highly sensitive to land-use changes in the immediate catchment.

2.2 Dhara

A *dhara* is the natural emergence point of a spring, often developed with a stone spout or carved outlet to facilitate collection . Unlike the *naula*, which is an artificial collection structure, the *dhara* is a developed natural feature. Its flow depends entirely on the health of the aquifer and recharge zone, over which the immediate community may have little control if the catchment extends into reserve forest or across administrative boundaries . The *dhara* thus presents a governance challenge distinct from the *naula*: its restoration requires intervention at the springshed scale, not merely at the point of discharge.

2.3 Chal-Khal and Gul

The *chal-khal* is a hilltop pond designed to capture monsoon runoff and facilitate infiltration into groundwater, thereby augmenting spring discharge downstream . The *gul* is a gravity-fed irrigation channel, requiring no energy input, that diverts stream or spring water to terraced fields. Both are components of an integrated traditional system in which water is harvested, stored, infiltrated, and distributed through a cascade of structures. Pithoragarh's watershed management initiatives have partially integrated these practices into modern agriculture with local success, suggesting that functional appropriation of traditional techniques is feasible where community institutions remain robust .

The hydrological logic common to all these systems is *decentralized capture and slow release*. Unlike modern piped schemes that extract from a point source and distribute rapidly, traditional systems work with the landscape's own infiltration and seepage patterns. This makes them inherently resilient to short-term rainfall variability but highly vulnerable to land-use change that alters those patterns—precisely the change that road construction, urbanization, and deforestation have wrought.

III. THE DECLINE: DRIVERS AND MECHANISMS

The literature converges on a set of interlocking drivers, though the relative weight of each remains an open empirical question.

3.1 Climate Variability and Change

Erratic monsoon behavior, reduced winter snowfall, and increased intensity of rainfall events have all been documented in the Uttarakhand Himalaya . The critical mechanism is not reduced total precipitation but *reduced infiltration time*: intense rainfall runs off rapidly rather than percolating slowly into recharge zones. For spring-fed systems dependent on gradual aquifer recharge, this is more damaging than a moderate reduction in total rainfall would be. A 2025 mapping



exercise by the Himmotthan Society across Tehri and Almora districts found that 76 percent of 10,063 springs surveyed showed declining discharge, a figure that underscores the scale of the hydrological shift.

3.2 Land-Use Change and Infrastructure Development

Road construction in hill terrain is particularly destructive to spring hydrology. Beyond the direct excavation of recharge slopes, roads create impermeable surfaces and channel runoff away from infiltration zones. Urbanization in Almora and Nainital has encroached upon *naula* catchments, and tourism development has increased water demand while degrading source protection areas. The fragmentation of forest cover—whether through fire, logging, or conversion—reduces the soil's capacity to absorb and transmit water to aquifers.

3.3 Out-Migration and the Collapse of Maintenance Regimes

Perhaps the most under-theorized driver is demographic. Traditional water systems were maintained through communal labor obligations embedded in the social structure of hill villages. Out-migration of working-age adults to plains cities has hollowed out these institutions. The ENVIS newsletter on Uttarakhand water resources explicitly identifies out-migration as a cause of “lack of maintenance” and “loss of traditional knowledge systems”. Yet the precise mechanism—how labor availability, remittance flows, and changing household priorities interact to affect *naula* maintenance—remains poorly documented. This is a critical gap for Study. research, because it suggests that restoration strategies modeled on the assumption of available community labor may fail in precisely the villages where intervention is most needed.

3.4 Policy Fragmentation and the “Recognition-Function” Gap

The Policy-Heritage Integration Matrix (PHIM) developed through analysis of Almora, Pithoragarh, and Dehradun provides a useful diagnostic. It distinguishes between *recognition* (symbolic acknowledgment of traditional systems in policy) and *functional integration* (actual institutional embedding and resource allocation). Almora's Naula Restoration achieved high recognition and moderate functional integration through community participation; Pithoragarh's watershed initiatives achieved functional appropriation of *chal-khal* practices without formal policy recognition; Dehradun's Rispana River Rejuvenation Plan exhibited high symbolic recognition but low functional integration, yielding tokenistic results due to conflicting mandates and scale mismatches. The PHIM framework's value for Study. research lies in its capacity to generate testable propositions about the conditions under which recognition translates into function.

IV. RESTORATION STRATEGIES: EVIDENCE AND EVALUATION

4.1 Springshed Management: The Hydrological Core

The emerging consensus is that restoration must operate at the *springshed* scale—the catchment area that feeds a spring—rather than at the point of discharge alone. Springshed management involves identifying recharge zones, implementing infiltration enhancement measures (trenching, check dams, vegetative barriers), and protecting catchment areas from further degradation. The Kangra study in Himachal Pradesh demonstrates the methodological toolkit: GIS-based delineation of groundwater potential zones, combined with field validation of spring types, aquifer characteristics, and seasonal discharge patterns. In Uttarakhand, the Spring and River Rejuvenation Authority (SARRA) has been constituted at the state level to coordinate such efforts, though its operational capacity remains limited.

The community dimension of springshed management is exemplified by the case of Kajal Manral in Kalati village, Almora, who was trained by CHIRAG as a village-level water scientist. Her work—measuring spring discharge, preparing hydrographs, identifying recharge areas—illustrates both the potential and the fragility of community-based monitoring. The potential lies in the creation of local expertise that can adapt to site-specific conditions; the fragility lies in the dependence on a single motivated individual and the uncertain sustainability of NGO-supported training once external funding ends.



4.2 Structural Restoration of Naulas

The SARRA expression of interest for *naula* and *dhara* restoration provides a detailed technical protocol: comprehensive photographic, architectural, and structural documentation; hydrological assessment including seasonal flow and recharge zone mapping; stone repair matching original material characteristics; structural strengthening adhering to reversibility and minimal intervention principles; and integration of modern safeguards (drainage, water quality protection) without compromising heritage fabric. This protocol is methodologically sound from a conservation perspective, but it brackets the social question: who will maintain these structures after restoration? The protocol's post-restoration phase includes community training and monitoring frameworks, but the evidence base for the effectiveness of such training in out-migration contexts is thin.

4.3 Institutional Models: Community Stewardship and Its Limits

Almora's *naula* restoration is widely cited as a success, with community participation identified as the transformative factor. The institutional model involves participatory mapping, stewardship arrangements, and decision-making platforms that formally recognize traditional ecological knowledge. Gender is a critical dimension: women bear disproportionate water-fetching burdens, and their inclusion in governance is both a matter of equity and a functional imperative, as they possess detailed knowledge of source reliability and seasonal variability.

However, the scaling question remains unresolved. The PHIM analysis cautions that "locally adaptive systems may be better replicated at the sub-watershed scale rather than scaled uniformly across districts". This is a significant limitation for policy: the conditions that enabled Almora's success—strong community institutions, NGO facilitation, and a favorable local political context—may not obtain elsewhere. The Pithoragarh case suggests that where strong community institutions already exist, policy can be partially bypassed, but formal adoption remains essential for region-wide water security.

4.4 Government Schemes: Potential and Misalignment

Several national and state schemes touch upon traditional water sources. Under the Jal Jeevan Mission, source sustainability and conservation—including rainwater harvesting, recharge structures, and spring rejuvenation—have been made mandatory components, and the State-level SARRA has been constituted. MGNREGS has funded renovation of 2,037 traditional water bodies across Uttarakhand in the last three years. PMKSY's Watershed Development Component includes springshed development, with 15 projects covering 0.84 lakh hectares sanctioned in Uttarakhand.

Yet the alignment problem persists. These schemes are designed around administrative units (villages, blocks, districts) and measurable outputs (number of structures renovated, hectares treated), whereas springsheds cut across administrative boundaries and restoration outcomes are measured in discharge over years, not structures in months. The Jal Jeevan Mission's primary metric—household tap connections—is orthogonal to traditional source restoration: a village can achieve 100 percent tap coverage while its *naula* continues to dry, because the piped scheme draws from a different source. The risk is that traditional sources are restored as heritage showpieces while the actual water supply transitions to centralized systems, severing the functional link between community and source that made maintenance sustainable in the first place.

V. RESEARCH GAPS AND METHODOLOGICAL DIRECTIONS

5.1 The Discharge Data Deficit

The most fundamental gap is hydrological: there is no systematic, long-term dataset of *naula* and *dhara* discharge across Uttarakhand. The Himmoth Society's 2025 mapping provides a cross-sectional snapshot, and individual studies report site-specific measurements, but without longitudinal data, it is impossible to attribute observed declines to specific drivers or to evaluate restoration outcomes with statistical rigor. A paper project could address this by establishing a network of monitored springs across a gradient of land-use and demographic conditions, with at least two years of baseline data before intervention and two years post-intervention. The methodology exists—discharge



measurement via volumetric or weir methods, water quality testing, recharge zone mapping—but has not been deployed at scale.

5.2 The Out-Migration–Maintenance Nexus

Quantitative and qualitative research is needed on how out-migration affects the labor and knowledge available for traditional source maintenance. Key questions include: What proportion of households in a given village have members available for communal labor? How has the gender division of water-related work shifted? Are remittances used for water infrastructure, and if so, through what channels? What forms of “virtual maintenance” (paid labor, NGO contracting) are emerging, and are they sustainable? Ethnographic and household survey methods are appropriate here, supplemented by archival research on traditional maintenance obligations.

5.3 Heritage vs. Security: Conflicting Evaluation Frameworks

A conceptual tension runs through the literature. Heritage conservation frameworks value authenticity, reversibility, and minimal intervention. Water security frameworks value access, reliability, and equity. These are not always aligned: a restored *naula* that is architecturally authentic but yields insufficient water in summer fails the security test; a technically optimized source that replaces traditional masonry with concrete fails the heritage test. Study. research could examine how different stakeholders—villagers, heritage officials, water engineers, NGOs—negotiate this tension, and whether hybrid evaluation frameworks are possible.

VI. TOWARD A RESEARCH DESIGN

A rigorous Study. study on this topic would benefit from a mixed-methods, comparative case study design. Suggested components:

Site selection: Three to four villages across Almora and Pithoragarh districts, stratified by (a) documented restoration intervention vs. no intervention, (b) high vs. low out-migration intensity, and (c) presence vs. absence of active community institutions.

Hydrological monitoring: Monthly discharge measurement of selected *naulas* and *dharas* over 24–36 months, with recharge zone mapping using GIS and field verification. Water quality testing (pH, turbidity, bacteriological) at quarterly intervals.

Household survey: Stratified random sample of 150–200 households per site, covering water source use, time spent fetching, expenditure on alternatives, participation in maintenance, and perceptions of source condition and restoration.

Institutional mapping: Key informant interviews with Gram Panchayat officials, SARRA representatives, NGO field staff, and traditional knowledge holders. Document analysis of relevant policies and scheme guidelines.

Qualitative immersion: Extended ethnographic fieldwork in at least one site, focusing on the social organization of maintenance, the role of women, and the lived experience of water scarcity.

Evaluation framework: Combine hydrological outcomes (discharge trend, water quality), social outcomes (participation, equity, time savings), and institutional outcomes (maintenance regime durability, policy integration) into a composite assessment.

VII. CONCLUSION

Uttarakhand’s traditional water sources are not merely relics of a pre-modern past. They embody a hydraulic logic—decentralized, infiltration-based, community-maintained—that is arguably better suited to the Himalayan socio-ecology than the centralized piped schemes that have displaced them in policy imagination. Their decline is not inevitable; it is the product of specific, identifiable pressures, most of which are amenable to intervention.

But the evidence also counsels against romanticism. The conditions that sustained *naulas* and *dharas* for centuries—stable populations, communal labor regimes, intact catchments—no longer obtain in much of the state. Restoration strategies that ignore this reality will produce photogenic structures that dry up within a decade. The path forward lies in a dual intervention: rigorous springshed management to restore the hydrological function of recharge zones, coupled with institutional innovation that adapts traditional stewardship models to contemporary demographic and governance



realities. The PHIM framework's distinction between recognition and function offers a diagnostic tool for assessing whether policies are actually working, but it requires empirical grounding that only sustained field research can provide.

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