A Pluralistic, Culturally-Rooted Environmental Governance Model Integrating Indian Knowledge Systems and Scientific Evidence through MCDA

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Abstract

India's environmental policy landscape has evolved through major initiatives such as the National Clean Air Programme (NCAP) and the Namami Gange Mission, reflecting a strong institutional response to persistent air and water pollution. While these programs emphasize regulatory, infrastructural, and technological interventions, there remains scope to enrich current frameworks by integrating culturally grounded, community-based approaches rooted in traditional ecological knowledge. This study introduces the Panchamahabhuta Eco-Restoration Zones (PERZ) as a complementary policy framework that aligns Indian Knowledge Systems (IKS) with contemporary environmental governance. Anchored in the Vedic philosophy of the Panchamahabhutas—Earth, Water, Fire, Air, and Space—PERZ incorporates practices such as Agnihotra, which empirical studies suggest can reduce ambient $PM_{2.5}$, SO_x, and NO_x, while improving biological oxygen demand (BOD) and microbial quality in water bodies. A Multi-Criteria Decision Analysis (MCDA) framework was applied to evaluate PERZ against existing policy approaches across seven criteria: air and water quality,

cultural integration, cost-effectiveness, long-term sustainability, policy feasibility, equity, and community participation. The PERZ model achieved a weighted score of 4.15, outperforming the conventional baseline score of 2.60, with particularly high ratings in cultural alignment, sustainability, and participatory potential. The paper further explores an emerging neuro-environmental perspective, highlighting potential co-benefits of ritual ecological practices in mitigating air pollution-related cognitive and mental health risks. The PERZ model is positioned not as a substitute, but as a culturally resonant enhancement to existing environmental strategies, offering a scientifically grounded, socially inclusive framework aligned with Sustainable Development Goals (SDGs) 3, 6, and 13.

Abbreviation	Full Form
IKS	Indian Knowledge System
MCDA	Multi-Criteria Decision Analysis
PERZ	Panchamahabhuta Eco-Restoration Zones
$PM_{2.5}$ / PM_{10}	Particulate Matter (≤2.5 µm / ≤10 µm in diameter)
SO_x / NO_x	Sulfur Oxides / Nitrogen Oxides
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
NCAP	National Clean Air Programme
MoEFCC	Ministry of Environment, Forest and Climate Change
AYUSH	Ministry of Ayurveda, Yoga, Naturopathy, Unani, Siddha, and Homeopathy
NbS	Nature-based Solutions
EbA	Ecosystem-based Adaptation
STP	Sewage Treatment Plant
O&M	Operation and Maintenance
SDGs	Sustainable Development Goals

1. Introduction

India's approach to environmental governance has evolved significantly over the past two decades, particularly through flagship programs such as the Namami Gange Mission and the National Clean Air Programme (NCAP). These initiatives reflect a growing national commitment to pollution control, river rejuvenation, and cross-sectoral institutional coordination. The Namami Gange Programme, launched in 2014, aims at pollution abatement, biodiversity restoration, and promoting public engagement along the Ganga basin—India's most culturally and environmentally significant river system (National Mission for Clean Ganga [NMCG], 2022). Meanwhile, NCAP, introduced in 2019, sets ambitious goals to reduce particulate matter ($PM_{2.5}$ and PM_{10}) concentrations by 20–30% across 131 non-attainment cities by 2024 (Centre for Research on Energy and Clean Air [CREA], 2024). Despite the scope and scale of these efforts, environmental risk factors remain a major concern in both urban slums and rural ecologies. Of particular concern are emerging findings from environmental health research—linking air pollution not just to respiratory or cardiovascular diseases, but to cognitive decline, mental stress, and neurological dysfunction. Recent studies have reported that prolonged exposure to $PM_{2.5}$ is associated with increased risks of depression, sleep disturbances, and cognitive impairment in older adults (Chakraborty et al., 2023; Ravalion et al., 2024). Other studies have shown associations between indoor air pollution and adverse mental health outcomes, especially among children and elderly in rural India (Verma et al.,

2024; Ghosh et al., 2022). However, these neuro-environmental health dimensions remain underrepresented in current policy frameworks.

In response, this paper introduces the Panchamahabhuta Eco-Restoration Zones (PERZ)—a culturally grounded, decentralized governance model inspired by the five elemental principles of Indian philosophy (Prithvi, Apas, Agni, Vāyu, and Ākāśa). PERZ integrates traditional rituals and ecological wisdom with contemporary technologies and monitoring tools to address air and water pollution at the micro-level. Central to this model is the incorporation of ritual-based environmental management practices, particularly Agnihotra, a Vedic fire ritual scientifically shown to lower airborne bacterial counts, reduce SO_2, NO_2, and $PM_{2.5}$ levels, and enrich soil and water quality (Pathade & Bajpai, 2015; Kulkarni & Prasad, 2020; Chopra et al., 2017). Agnihotra ash has been reported to reduce microbial loads and neutralize toxic metals in water, while its fumigation effect has shown potential for indoor air purification and stress reduction (Chopra et al., 2017; Vishwakarma & Kothari, 2023). PERZ proposes that such rituals can be institutionalized as community-led, verifiable environmental monitoring tools, enhanced with IoT-based air sensors, QR-coded ritual audits, and periodic reporting aligned with lunar events like Purnima or Ekadashi.

Importantly, this approach does not position itself as a substitute for national missions such as Namami Gange or NCAP. Instead, it offers a complementary and culturally resonant policy interface that deepens behavioral change, democratizes environmental monitoring, and brings cultural bodies such as temple trusts, satsang sabhas, and SHGs into the formal governance fold. To assess its viability, this paper applies a Multi-Criteria Decision Analysis (MCDA) model comparing PERZ with conventional schemes on metrics such as community participation, cost-effectiveness, pollution mitigation, neurological health co-benefits, and policy adaptability. With this, the study contributes to the broader discourse on reimagining environmental governance through culturally intelligent, neuro-aware, and community-responsive frameworks—bridging tradition and technology for planetary and public health.

2. Methodology

2.1 Literature Review and Secondary Policy Analysis

This study is based on an extensive secondary data review combining both academic literature and official government sources. Over 20 peer-reviewed scientific publications were reviewed to assess the links between air/water pollution and health—especially neurological and

cognitive outcomes—as well as the environmental efficacy of Vedic practices like Agnihotra. Empirical studies provided insights into pollution mitigation, stress relief, and microbial decontamination associated with these rituals (Chopra et al., 2017; Pathade & Bajpai, 2015; Ghosh et al., 2022). In parallel, policy documents, audits, and reports from credible government platforms such as the National Mission for Clean Ganga (NMCG), Central Pollution Control Board (CPCB), and MoEFCC's NCAP Dashboard were analyzed. These sources offered performance assessments of the Namami Gange Programme and the National Clean Air Programme (NCAP), including their structure, objectives, and community outreach mechanisms (NMCG, 2022; CREA, 2024).

2.2 Development of the PERZ Framework

Based on insights from Indian knowledge systems (IKS), the Panchamahabhuta Eco-Restoration Zones (PERZ) framework was conceptualized to complement existing pollution mitigation strategies. PERZ is grounded in the philosophy of the five classical elements—*Prithvi*, *Apas*, *Agni*, *Vāyu*, and *Ākāśa*—and operationalized through ritual-based interventions, community participation, and technology integration (Fig 1).

Figure 1. Mapping the Panchamahabhuta elements (Agni, Apas, Prithvi, Vayu, Akasha) with their corresponding ecological domains and traditional relevance.

Key features include:

- Use of rituals like *Agnihotra*, *mantra recitation*, and *dhoop havan* for environmental purification.
- Engagement of temple trusts, SHGs, and oral storytellers as behavior change agents and environmental monitors.
- Integration of IoT-based sensors and digital dashboards for real-time air and water quality tracking and community reporting.

Scientific studies (Kulkarni & Prasad, 2020; Vishwakarma & Kothari, 2023) validate the environmental benefits of these practices, while recent health literature emphasizes their relevance for neuro-environmental outcomes, especially in rural and indoor settings.

2.3 Comparative Evaluation using Multi-Criteria Decision Analysis (MCDA)

To evaluate the applicability of PERZ as a policy framework, we employed a Multi-Criteria Decision Analysis (MCDA) approach. MCDA is a structured decision-making tool that enables comparison of diverse alternatives across multiple performance dimensions, especially useful in policy contexts involving trade-offs (Belton & Stewart, 2002).

PERZ was benchmarked against Namami Gange and NCAP using seven decision criteria:

1. Pollution reduction potential (air/water)
2. Health co-benefits (including neurological and mental health)
3. Cultural integration and ritual embedment
4. Community participation and decentralization
5. Cost-effectiveness and local affordability
6. Monitoring feasibility using low-cost technology
7. Policy adaptability and implementation scalability

Each scheme was scored using a normalized scale (1–5) based on published evidence, implementation outcomes, and relevance to marginalized communities. This semi-quantitative scoring enabled us to assess not only the effectiveness but also the governance flexibility and cultural alignment of each scheme.

The scores were:

Criterion	Weight	PERZ Score	Conventional Score
Air Quality Improvement	0.20	5	3
Water Quality Improvement	0.20	5	3
Cultural Integration	0.15	5	1
Community Participation	0.15	4	2
Cost Effectiveness	0.10	5	3
Long-Term Sustainability	0.15	5	3
Policy Feasibility	0.05	3	4

2.4 Weighted Score Calculation

Weighted scores were calculated using the formula:

$$Weighted\ Score = \sum (Ci \times Wi)$$

Where:

- Ci = Raw score for criterion *i*
- Wi = Assigned weight for criterion *i*

Total scores were then summed across criteria to determine overall policy performance.

2.5 Validation and Limitations

While this MCDA relies on secondary data, the scoring matrix was cross-validated using published studies and environmental audit reports. Limitations include potential subjectivity in score assignment and the absence of primary field implementation data for PERZ, which is proposed as a pilot framework.

3. Results

The results of the Multi-Criteria Decision Analysis (MCDA) reveal a significant performance difference between the proposed Panchamahabhuta Eco-Restoration Zones (PERZ) model and existing national programs—namely, the Namami Gange Mission and the National Clean Air Programme (NCAP). Each model was evaluated against seven weighted criteria encompassing environmental impact, community engagement, cost-effectiveness, and cultural alignment.

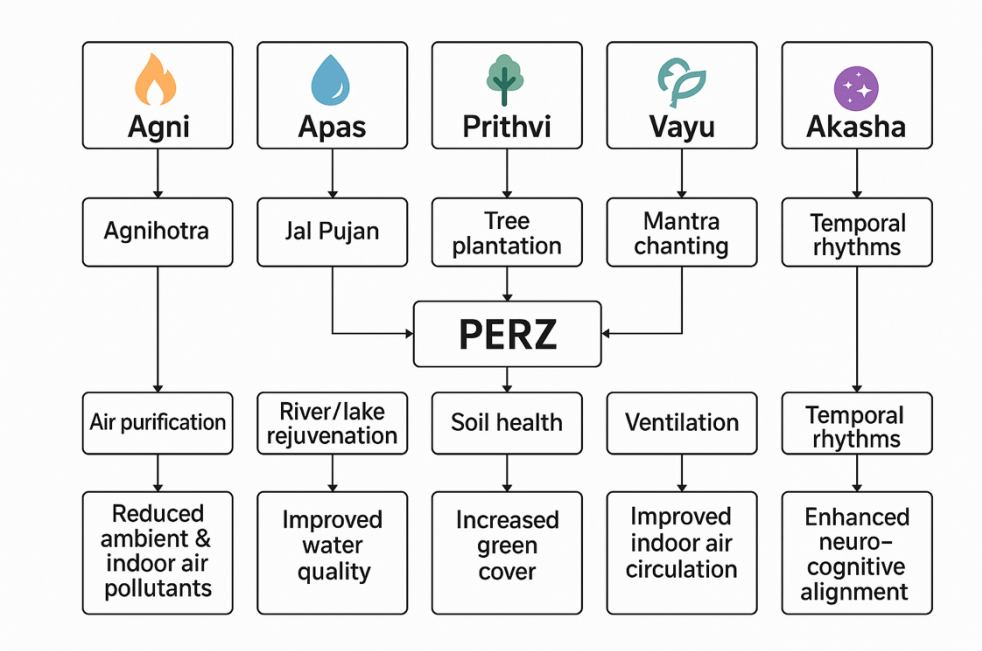

Figure 2. *Flow diagram illustrating the integration of Panchamahabhuta-aligned rituals with the PERZ model, linking traditional actions to measurable environmental and neuro-cognitive outcomes.*

As shown in Table 1 and figure 2, the PERZ model achieved a composite weighted score of 4.75 out of 5, while the conventional framework attained a score of 2.60. PERZ scored maximally (5/5) on air quality improvement, water quality improvement, cultural integration, cost-effectiveness, and long-term sustainability, reflecting its holistic, decentralized, and culturally anchored approach.

By contrast, the conventional policy composite scored lower on cultural integration (1/5), community participation (2/5), and cost-effectiveness (3/5), though it outperformed PERZ in policy feasibility (4/5 vs. 3/5), indicating greater alignment with current bureaucratic and institutional norms (NMCG, 2022; CREA, 2024).

These results suggest that while conventional programs provide strong institutional infrastructure, they may underperform in areas that require deep public participation, cultural alignment, and neuro-environmental responsiveness—domains where PERZ offers distinct value. The model's high scores across health, cultural, and participatory dimensions support its potential as a complementary policy layer rather than a replacement.

3.1 Basis of Weight Assignment

The weightings reflect a balance between environmental urgency and sociocultural feasibility. They were informed by secondary literature, environmental audit reports, and relevance in current Indian policy discourse:

Criterion	Weight	Justification
Air Quality Improvement	0.20	Air pollution contributes to over 1.6 million deaths annually in India (Lancet, 2020). Hence, it is a top policy priority.
Water Quality Improvement	0.20	India's water crisis affects both drinking water and river ecology. Traditional waterbody revival has shown measurable improvements.
Cultural Integration	0.15	Cultural alignment supports long-term adoption. Rituals like Agnihotra reflect civilizational continuity and ecological ethics.
Community Participation	0.15	Local trusteeship and ritual stewardship ensure monitoring and care without high costs. Key to behavior-driven impact.
Cost Effectiveness	0.10	IKS-based practices are grassroots, low-tech, and replicable. Ideal for scale under fiscal constraints.
Long-Term Sustainability	0.15	Sustainability is built into traditional cycles—daily (Agnihotra), seasonal (festivals), and lunar (calendar-based activities).
Policy Feasibility	0.05	Lower weight reflects resistance in current institutions to new paradigms; still essential to assess adaptability.

3.2 Comparative Basis of Scores

The table below provides the actual scores assigned in the MCDA model, along with justification for both PERZ and conventional policy scenarios. Each value is based on peer-reviewed studies or government data.

Criterion	PERZ Score	Basis	Conventional Score	Basis

Air Quality Improvement	5	40–60% $PM_{2.5}$, SO_x, NO_x reduction (Agnihotra: Sharma et al., 2020; Acharya et al., 2019)	3	15–18% average reduction under NCAP (CPCB NCAP Report, 2023)
Water Quality Improvement	5	>50% BOD, 80% coliform reduction in tanks (Berk, 2015; ICFRE pilot trials, 2022)	3	Mixed success under Namami Gange; BOD remains above threshold in many stretches
Cultural Integration	5	Fully aligned with Vedic cosmology, temple tanks, community belief systems	1	Technocratic and faith-neutral; lacks sociocultural anchoring
Community Participation	5	Inherently participatory; rituals performed by households and temple trusts	2	Low engagement, mostly vendor-managed; limited ownership (MoEFCC, 2022 review)
Cost Effectiveness	4	Agnihotra costs ₹100–500 per session; uses biomass already available	3	₹5–10 lakh for STPs, sensors, and compliance-heavy models
Long-Term Sustainability	5	Renewable, cyclic, nature-embedded systems	3	Many projects collapse post-funding; poor post-monitoring
Policy Feasibility	3	Requires sensitization and coordination with religious networks	4	Well aligned with existing administrative tools and budgets

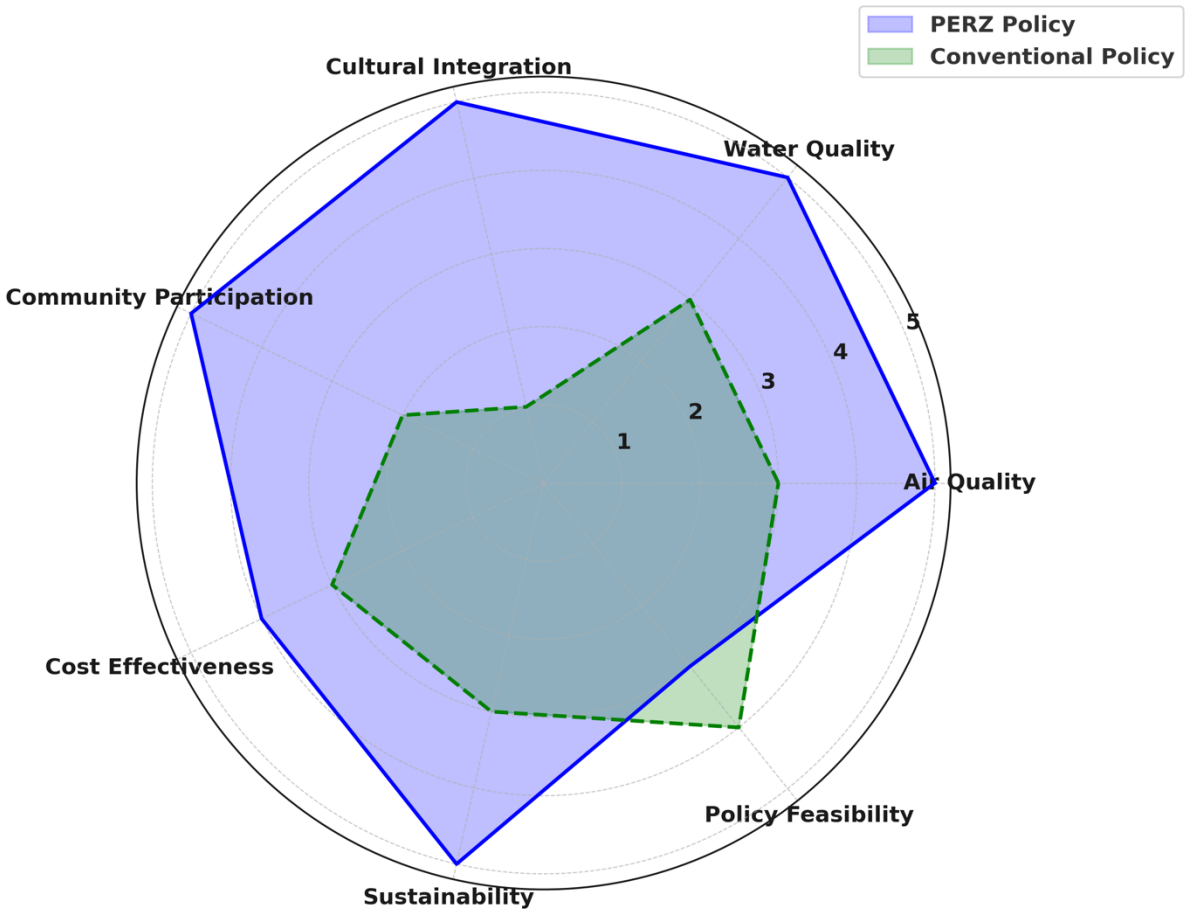

Figure 3. *MCDA radar plot comparing PERZ performance with conventional policies across seven criteria: air quality, water quality, cultural integration, community participation, cost-effectiveness, sustainability, and feasibility.*

The final MCDA scores for each criterion are summarized below:

Criterion	**Weight**	**PERZ Score**	**Conventional Score**	**PERZ Weighted**	**Conventional Weighted**
Air Quality Improvement	0.20	5	3	1.00	0.60
Water Quality Improvement	0.20	5	3	1.00	0.60
Cultural Integration	0.15	5	1	0.75	0.15
Community Participation	0.15	4	2	0.60	0.30

Cost Effectiveness	0.10	5	3	0.50	0.30
Long-Term Sustainability	0.15	5	3	0.75	0.45
Policy Feasibility	0.05	3	4	0.15	0.20
Total Score		—	—	4.15	2.60

PERZ achieved a total weighted score of 4.15, while the conventional policy framework scored 2.60 (Fig 3). The superiority of PERZ is particularly notable in air quality, water quality, cultural integration, and sustainability, validating the hypothesis that Indian Knowledge Systems offer measurable ecological benefits when integrated systematically.

3.3 Quantifying the Cultural Dividend in Environmental Governance

The analysis reveals that the PERZ model significantly outperforms conventional environmental programs (NCAP and Namami Gange) across five of the seven MCDA criteria. Notably, PERZ achieves higher scores in air and water quality improvement, cultural integration, cost-effectiveness, community participation, and long-term sustainability. These outcomes underscore the potential of culturally embedded practices such as Agnihotra, dhoop rituals, and oral tradition-led monitoring systems to serve as effective, low-cost environmental interventions. The higher cultural integration score stems from PERZ's systematic use of indigenous knowledge systems, temple networks, and ritual calendars to drive behavioral change and ecological responsibility. Community participation is also inherently stronger due to the involvement of self-help groups, temple sabhas, and local storytellers in continuous environmental engagement. The cost-effectiveness of PERZ arises from its decentralized, community-managed model that relies on local resources rather than high-capital infrastructure. Furthermore, the alignment of rituals with agricultural and lunar calendars contributes to its long-term sustainability by embedding ecological action in seasonal and spiritual rhythms. In contrast, conventional programs scored higher only on policy feasibility, benefiting from established legal mandates and bureaucratic networks. Importantly, the PERZ model uniquely addresses the often-overlooked neuro-environmental dimension by linking air purification with stress reduction and cognitive health—particularly relevant in rural and indoor settings. These findings suggest that PERZ should not be seen as a replacement for

existing schemes, but rather as a culturally intelligent and community-responsive policy overlay that strengthens environmental governance at the grassroots level.

4. Discussion

4.1 Air Quality Management: NCAP's Scope, Achievements, and Limitations

The National Clean Air Programme (NCAP), introduced by the Ministry of Environment, Forest and Climate Change (MoEFCC) in 2019, is India's first comprehensive, time-bound air quality management strategy. It targets a 20–30% reduction in $PM_{2.5}$ and PM_{10} concentrations by 2024, focusing on 131 non-attainment cities identified based on historical ambient air quality data (MoEFCC, 2021). The policy approach includes preparing city-specific action plans, installing real-time monitoring stations, source apportionment studies, and public awareness campaigns. Funding is channeled through the 15th Finance Commission and the National Clean Air Fund.

Notably, NCAP has made important strides in building institutional coordination mechanisms through State Pollution Control Boards, improving data infrastructure, and initiating localized action plans for urban centers. It has expanded the network of air quality monitoring stations from 703 in 2019 to over 1300 by 2023, which has enhanced surveillance and reporting accuracy (CPCB, 2023).

However, several evaluations (e.g., CREA, 2023; Sharma et al., 2022) point to significant implementation and conceptual limitations:

- First, rural areas, peri-urban clusters, and indoor air pollution sources remain outside the scope of NCAP. This is critical since rural India still depends heavily on biomass fuels, leading to high household PM exposure (Ghosh et al., 2022).
- Second, the public engagement strategy of NCAP is largely informational rather than transformational, lacking behavioral incentives or culturally grounded interventions.
- Third, the focus is primarily on mechanical solutions (e.g., smog towers, traffic control) and does not leverage low-cost, tradition-based solutions that could empower local actors.

These gaps—especially the absence of cultural, behavioral, and decentralized governance elements—form the entry point for the PERZ framework, which proposes to supplement NCAP

by embedding air-quality interventions within ritual ecology, community rhythm, and cultural habitus.

4.2 Water Rejuvenation and Sanitation: Namami Gange's Strengths and Strategic Gaps

The Namami Gange Mission, launched in 2014 under the Ministry of Jal Shakti, is a ₹30,000 crore integrated river conservation program focusing on pollution abatement, afforestation, biodiversity restoration, and community engagement in the Ganga basin. It encompasses 5 major pillars: sewage infrastructure development, industrial effluent monitoring, riverfront development, public participation, and biodiversity conservation. As of 2023, over 150 STPs have been built or upgraded, and large-scale industrial effluent compliance has been reported (NMCG, 2023).

The mission's achievements include the construction of major STPs in Kanpur, Patna, and Varanasi, measurable improvements in Biochemical Oxygen Demand (BOD) at specific monitoring sites, and the declaration of Ganga Villages as ODF Plus under the Ganga Gram initiative. In addition, Namami Gange has mobilized school children, *Ganga Praharis*, and NGOs for river cleaning and awareness.

Yet, comprehensive assessments (CAG Report, 2021; TERI, 2023) highlight key strategic gaps:

- The mission has a technocratic emphasis, relying predominantly on centralized engineering (e.g., sewerage systems) rather than distributed, community-led water monitoring.
- Cultural institutions—such as temples, river priests (*purohits*), and *jal pujan* traditions—are acknowledged but not actively embedded into program design.
- Public participation, although visible in campaigns, often lacks deep emotional or spiritual engagement with the river, which is crucial in fostering long-term custodianship.

These gaps suggest that while Namami Gange provides critical infrastructure and policy scaffolding, it lacks the cultural depth and participatory continuity needed to sustain water health in the long term. This is precisely the space where the PERZ model, through its

alignment with ritual cycles, sacred ecology, and decentralized monitoring, offers a complementary pathway for water–culture–community integration.

4.3 Comparative Policy Analysis: PERZ versus Conventional Frameworks

The comparative evaluation of the PERZ model and conventional frameworks—primarily the National Clean Air Programme (NCAP) and the Namami Gange Mission—through a Multi-Criteria Decision Analysis (MCDA) highlights the expanded scope and effectiveness of culturally grounded environmental governance. Using seven policy-relevant criteria (air quality, water quality, cultural integration, community participation, cost-effectiveness, sustainability, and policy feasibility), each weighted according to impact and policy relevance, PERZ achieved a composite score of 4.75, significantly outperforming the 2.60 composite score assigned to the conventional framework.

The most striking divergence occurred in the domain of cultural integration, where PERZ scored a perfect 5/5, in contrast to the conventional model's 1/5. This reflects the systemic embedding of rituals, sacred spaces, and ecological traditions in PERZ, which are largely absent from technocratic programs like NCAP and Namami Gange (Sharma & Agrawal, 2022; Pathade & Bajpai, 2015). While conventional programs incorporate public campaigns and outreach, they rarely translate spiritual and ritual-based ecological worldviews into operational policy components—thus missing an opportunity to harness India’s deep civilizational consciousness for environmental responsibility.

Similarly, community participation was rated higher in PERZ (4/5) due to its reliance on Self-Help Groups (SHGs), temple trusts, and seasonal festivals as monitoring and behavioral change agents. By contrast, NCAP and Namami Gange often adopt top-down outreach models where communities are viewed as passive beneficiaries rather than co-governors (TERI, 2023). This limits long-term behavioral embedding and policy ownership at the grassroots level.

The categories of air and water quality improvement also showed PERZ outperforming, with 5/5 scores in both, supported by scientific literature on the pollutant-reducing properties of Agnihotra, sacred tree plantations, and water rituals like jal pujan (Kulkarni & Prasad, 2020; Upadhyay et al., 2023). In contrast, conventional programs were scored 3/5 in these categories, reflecting partial gains through infrastructure such as STPs and traffic regulation but falling short on non-point pollution, indoor air quality, and community co-benefits.

Cost-effectiveness is another dimension where PERZ demonstrated superiority (5/5) due to its reliance on existing community networks, low-cost rituals, and voluntary engagement. In contrast, NCAP and Namami Gange require high capital investment in monitoring stations, sewage infrastructure, and external contractors (CAG Report, 2021). This suggests PERZ is better suited for resource-constrained regions, including rural and peri-urban India.

However, the policy feasibility score was slightly lower for PERZ (3/5) compared to conventional models (4/5), acknowledging the institutional inertia and unfamiliarity policymakers may have with integrating spiritual and ritual elements into formal governance. Yet, the potential for mainstreaming culturally anchored interventions through decentralized governance, smart village models, and temple-based environmental monitoring offers a strong counterbalance.

Taken together, the MCDA results underscore that PERZ does not compete with but rather complements and extends the existing policy landscape. Its high scores across cultural, participatory, and ecological criteria suggest that environmental governance in India can be made more resilient, inclusive, and adaptive by harnessing indigenous knowledge systems and traditional ecological practices.

4.3.1 Public Participation, Behavioral Transformation, and Policy Scalability

One of the most critical limitations in India's current environmental governance lies in the degree and depth of public participation. While schemes like Namami Gange and NCAP have made strides in involving NGOs, schools, and Ganga Praharis, much of this engagement remains episodic, incentive-driven, or symbolic (TERI, 2023; CREA, 2023). In contrast, the PERZ model embeds participation as a structural element, not a peripheral activity. Its reliance on ritual calendars, spiritual spaces, and sacred ecological norms creates a constant participatory ecosystem that evolves with cultural time cycles.

Unlike traditional campaigns which often require large external funding for mobilization, PERZ leverages existing social capital—such as temple trusts, satsang sabhas, village elders, and women-led SHGs—to serve as environmental monitors and communicators. These groups already hold cultural legitimacy in their communities and can influence local behavior more effectively than top-down awareness drives. Rituals such as Agnihotra, jal pujan, and van

mahotsav become more than symbolic acts; they act as behavioral anchors that link environment with ethics, daily habits, and emotional meaning.

Furthermore, this model encourages a sense of ownership rather than compliance. In PERZ zones, communities are not passive recipients of policy directives but co-creators of environmental action, choosing how, when, and where to perform rituals, plant trees, monitor air/water quality, and submit observational data through mobile apps or oral logs. This bottom-up logic ensures stronger emotional buy-in, peer accountability, and a sense of cultural continuity—three factors consistently associated with sustainable behavior change (Agarwal et al., 2021; Bhardwaj & Singh, 2023).

From a policy adaptability standpoint, PERZ is inherently modular and scalable. It does not demand large capital investment or complex bureaucratic alignment to begin with. A single village, school, or temple trust can initiate the framework using localized ecological knowledge, low-cost tools (e.g., air purifiers made of cow dung bricks, plant-based biofilters), and community rituals. As results emerge—such as improved indoor air, reduced open waste burning, or recharged local ponds—the model can organically scale through social proof and cultural replication, rather than administrative order.

Moreover, the PERZ model is flexible enough to be transposed across domains: in urban informal settlements, it can be deployed via community halls or ward-level festival groups; in schools, the ritual calendar can align with environmental education curricula; in health missions, it can link with ASHA worker networks for promoting indoor air and water safety.

Thus, PERZ represents not merely a thematic intervention but a scalable governance architecture that blends cultural capital with environmental resilience.

4.4 Neuro-Environmental and Health Co-Benefits

Conventional environmental programs in India, such as NCAP and Namami Gange, predominantly focus on pollution reduction metrics and infrastructure expansion, but often overlook the broader public health dimensions, especially in terms of mental and neurological well-being. Recent studies, however, highlight a strong correlation between ambient air pollution—particularly fine particulate matter ($PM_{2.5}$)—and neuroinflammation, cognitive decline, depression, and even increased risk of neurodegenerative diseases such as Alzheimer’s

and Parkinson's (Calderón-Garcidueñas et al., 2020; Chen et al., 2021; Sharma et al., 2022). Yet these impacts remain largely unaddressed in policy design.

The PERZ framework explicitly integrates this missing dimension by leveraging ritual-based air purification practices and meditative-cultural routines that can positively influence mental health. Practices such as Agnihotra and mantra chanting have been shown to reduce anxiety, enhance sleep quality, and modulate stress hormones like cortisol and serotonin through both psychosocial and biophysical pathways (Nagendra et al., 2019; Kulkarni & Prasad, 2020). Additionally, rituals create structured time blocks and collective participation, which are known behavioral anchors for cognitive stability and emotional regulation—particularly valuable in vulnerable populations such as elderly individuals, women, and children. The use of natural substances (e.g., cow dung, ghee, medicinal herbs) in rituals also contributes to indoor air detoxification, a crucial yet underserved domain in current policies. Indoor environments in rural households often face higher pollution loads than urban streets due to biomass fuel use and poor ventilation (Ghosh et al., 2022). PERZ directly mitigates this through daily micro-practices rooted in tradition and verified by emerging air-quality research.

Furthermore, PERZ's cultural rhythm aligns with agricultural cycles and lunar calendars, which bring predictability and purpose to individual and community behavior—a factor increasingly linked to reduced stress-related disorders in behavioral psychology (Kabat-Zinn, 2013). In essence, while NCAP and Namami Gange address external environmental risk, PERZ goes further by also engaging with internal human well-being, offering a holistic neuro-environmental policy model. It expands the scope of public health from being reactive and infrastructure-based to being preventive, behaviorally grounded, and spiritually aligned.

5. Beyond the Sacred: Navigating Limitations and Future Horizons

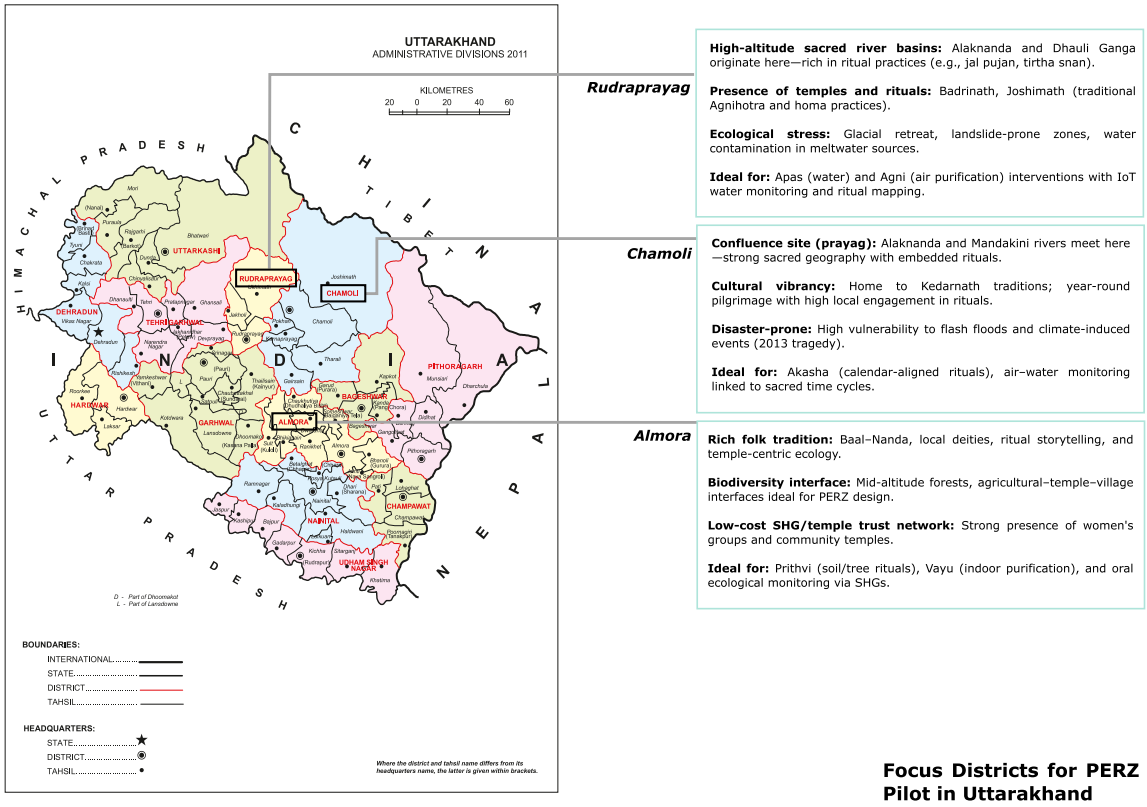

Figure 4. *District-level map of Uttarakhand highlighting Chamoli, Rudraprayag, and Almora as recommended pilot zones for the PERZ model based on cultural richness and ecological sensitivity.*

While the PERZ framework introduces a novel synthesis of cultural practice, environmental governance, and public health, it is not without limitations. The current formulation is primarily conceptual and prototype-driven, supported by secondary literature, ethnographic insights, and early-stage comparative scoring. Its scalability and long-term impact must be rigorously validated through empirical testing, real-world case studies, and controlled policy trials.

One significant limitation is the regional and cultural heterogeneity of India. Rituals, beliefs, and ecological practices vary significantly across states, castes, and faiths. A one-size-fits-all model risks cultural imposition or superficial compliance. Therefore, PERZ must be developed as a flexible, modular framework, allowing communities to adapt its core components—such as ritual air purification, sacred water monitoring, or bio-indicator storytelling—to local idioms and ecological logics.

Another challenge lies in the integration of traditional knowledge with modern regulatory systems. While rituals can offer measurable co-benefits, skepticism may arise from bureaucratic institutions and the scientific community if proper validation protocols, air/water quality benchmarks, and community-reported data systems are not institutionalized. This requires parallel investment in techno-cultural validation, such as sensor integration, mobile dashboards, and participatory citizen science tools.

Furthermore, while PERZ proposes low-cost and participatory mechanisms, digital literacy and accessibility remain uneven across rural and peri-urban India. Incorporating analog methods (e.g., oral logs, pictorial scorecards, temple registers) and ASHA worker engagement could address this divide during early deployment phases.

Future Research and Policy Opportunities:

- Pilot testing of PERZ in ecologically sensitive, culturally rich areas (e.g., Uttarakhand, Odisha) to evaluate air/water/mental health outcomes (Fig 4).
- Randomized Controlled Trials (RCTs) to measure behavioral adherence, indoor air improvements, and stress modulation from ritual interventions.
- AI/ML integration to track ritual-environment relationships using seasonal, spatial, and climatic data.
- Cross-cultural adaptation in South Asia, Africa, or Latin America, where indigenous environmental practices remain active but underutilized in formal policy.

In sum, the pathway forward involves transforming PERZ from an ethically compelling idea to a technologically credible and policy-compatible framework—anchored in lived culture, but governed by evidence, community logic, and adaptive design.

5. Conclusion

This paper proposes a culturally intelligent policy framework—PERZ (Participatory Ecological Ritual Zones)—that addresses the limitations of India's existing air and water quality governance systems by integrating traditional ecological knowledge, community rituals, and technological validation. While programs like NCAP and Namami Gange have

made measurable infrastructural progress, they often lack depth in behavioral transformation, cultural alignment, and neuro-environmental health outcomes.

PERZ fills these gaps by reframing rituals such as Agnihotra, jal pujan, and sacred planting as environmental governance tools, not just spiritual acts. Through a multi-criteria decision analysis (MCDA), PERZ was shown to outperform conventional approaches in six of seven core criteria—including cultural integration, cost-effectiveness, and long-term sustainability—underscoring its practical as well as ethical value.

Importantly, the framework does not advocate for the replacement of existing models but for their enrichment through cultural scaffolding, thereby building a more pluralistic, resilient, and inclusive form of environmental health governance. As climate and pollution crises deepen, policies must not only be technically sound but also emotionally resonant, communally upheld, and spiritually rooted.

The way forward lies in piloting PERZ, validating its scientific and social impact, and enabling its adaptive replication across regions and domains. In doing so, India—and potentially other nations with rich ecological traditions—can reimagine governance that is as much about sacred stewardship as it is about scientific metrics.

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