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Ecological provision across the regions of India as a function of local cultural capital

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Abstract. This paper aims to review the cultural reasons behind the different water access across the regions of India using the data from National Family Health Survey for the years 2019-2021 and combining it with the cultural data from the Survey on Literacy and Culture of India for the year 2014. I compile the dataset that allows me to test the working hypothesis in the presence of economic controls. The local cultural capital plays a significant role in explaining which type of water source is predominantly used by households. In order to quantify the local cultural capital, the current study employs the Culture Based Development (CBD) paradigm and obtains the cultural heritage (CH) and living culture (LC) components for every region. In addition, cultural heritage and living culture are next used to calculate the local cultural entropy (CE). The results show that the cultural variables always matter yet using only CH and LC have inconclusive directions, while cultural entropy has a persistent positive association with the use of higher quality of sources of water.

Key words: cultural capital, water, India regions, Culture Based development

1 Introduction

Ecological public goods such as access to safe and clean drinking water display marked regional variation across India. Understanding these regional patterns requires moving beyond conventional explanations and examining the underlying value systems that shape collective ecological behaviour (Banerjee, Somanathan 2007). In many contexts, attitudes toward the environment such as how communities perceive, prioritise, and cooperate around ecological resources play a decisive role in determining ecological outcomes. Understanding these attitudes is crucial for explaining why ecological provision varies so markedly across India.

Culture is a natural basis for these attitudinal differences, yet empirical research has long struggled with how to measure culture in a comprehensive and theoretically consistent way. Narrow proxies such as religion, language, caste, or isolated indicators of participation tend to omit substantial parts of the attitudinal structure that guide individual and collective behaviour. This leads to the classical problem of cultural under-specification, explicitly articulated in the Culture Based Development (CBD) paradigm as the first law of cultural quantification: economic models remain under-specified when culture is omitted or incompletely measured (Tubadji 2025b).

CBD provides a systematic framework for fully capturing the cultural determinants of socio-economic behaviour. In CBD, culture is defined as the local code of attitudes for valuing the world, which generates the ordering of preferences individuals rely upon when making choices (Tubadji 2025b). CBD operationalises this comprehensive definition of culture by distinguishing cultural heritage (CH): the inherited identity preserving attitudes of a locality, from living culture (LC): the contemporaneously created adaptive attitudes that reflect openness to new identities and practices (Tubadji 2013, 2020, 2023). Together, CH and LC exhaust the evaluative components that constitute local cultural capital.

To capture how these components interact, CBD introduces cultural entropy (CE), defined as the balance between CH and LC in a locality (Tubadji 2025a,b). CE describes whether a region's attitudinal environment leans toward preservation and closedness (CH dominant) or adaptation and openness (LC dominant). This balance has behavioural implications: CE predicts the direction and magnitude of cultural bias in local decision-making, including whether communities are more likely to embrace or resist collective practices. Since ecological public goods depend on cooperation, adoption of new practices, and alignment around shared environmental norms, CE provides a theoretically grounded mechanism for understanding regional differences in ecological outcomes.

The Indian setting is particularly well suited for such an analysis. India's regions exhibit profound cultural heterogeneity expressed through aesthetic participation, inherited norms, religious practices, and linguistic traditions (Das 2006). While research often reduces culture in India to caste-based structures, the CBD framework allows for a broader and empirically grounded representation of cultural milieu that incorporates both inherited and contemporary cultural expressions. This approach aligns with Neo-Weberian perspectives emphasising the role of value systems in shaping regional development processes (Tubadji 2023, 2020).

Against this backdrop, this study applies the CBD framework to examine how culture shapes ecological provision across the regions of India. Using micro-level data from the Survey on Literacy and Culture of India (2014), we construct CH and LC indicators from a broad set of cultural participation and inherited-norm variables. These cultural capital measures are linked to ecological indicators from the National Family Health Survey (NFHS-5) (2019-2021), focusing on household sources of drinking water. This enables a value-free, CBD consistent empirical assessment of how cultural structures inform regional ecological provision in India.

The main contribution of this paper is to demonstrate that the level of ecological concern across the regions of India is systematically predicted by the structure of local cultural capital, as defined within the Culture Based Development (CBD) paradigm. By employing this CBD based operationalisation, the analysis shows that regional variation in ecological provision, specifically access to safe drinking water, corresponds closely to the CH-LC composition of local cultural capital. Thus, the paper advances the field by providing the CBD informed empirical evidence that ecological behaviour in India is not random or purely institutional but is deeply shaped by the cultural valuation structures embedded in local contexts.

The rest of this paper is structured as follows. Section 2 provides a review of the relevant literature and identifies the gap that this study addresses. Section 3 presents the compiled dataset. Section 4 offers an estimation strategy. Section 5 reports empirical results and offers an interpretation of the findings. Section 6 concludes with a discussion of the implications for understanding regional ecological behaviour in India and outlines directions for future research.

2 Literature Review

2.1 Public goods, ecological goods and the role of local attitudes

The provision of ecological public goods has long occupied a central place in economic theory, owing to the non-excludable and collective nature of environmental resources. Classical public goods theory emphasises the role of institutional arrangements and incentive structures in overcoming free-rider problems (Samuelson 1954, Ostrom 1990). However,

subsequent research in regional science and environmental economics has demonstrated that institutional design alone cannot account for the observed spatial variation in ecological outcomes. Instead, local attitudes, shared norms, and collective valuation systems play a decisive role in shaping the provision, maintenance, and effective use of ecological public goods (Ostrom 2000, Torre, Wallet 2015).

Within regional economics, the concept of territorial capital has been developed to capture these non-material determinants of regional performance. Building on this approach, scholars have argued that cognitive, social, and cultural resources embedded in places mediate the relationship between public investment and observed outcomes (Camagni 2008, van Leeuwen, Nijkamp 2006). van Leeuwen, Nijkamp (2006), for instance, emphasise that regional development depends not only on physical and human capital but also on locally embedded cognitive and normative structures that shape collective behaviour. Similarly, Torre, Wallet (2015) highlights how proximity, shared values, and local interaction norms influence cooperation and collective action, particularly in the provision of public and quasi-public goods.

Despite this growing recognition, empirical studies of ecological public goods often struggle to operationalise local attitudes in a systematic way. Many analyses rely on indirect proxies such as education levels, income, or urbanisation, implicitly assuming that these variables capture underlying preferences for environmental quality. While informative, such proxies do not directly measure the attitudinal structures that govern collective ecological behaviour. As a result, the cultural foundations of ecological public goods provision remain underspecified, motivating the need for frameworks that can rigorously quantify local valuation systems and behavioural predispositions.

2.2 Ecological provision and water access in India: regional disparities

India presents a particularly compelling context in which to study the cultural determinants of ecological public goods provision. Despite substantial policy efforts and large-scale public investment, access to safe and reliable drinking water remains unevenly distributed across regions and social groups. Empirical studies based on nationally representative surveys consistently document wide inter-state and intra-state disparities in access to improved water sources, even after controlling for household wealth, education, and urban-rural residence (Jeuland et al. 2013, Gupta, Spears 2017, Biswas et al. 2024). These persistent disparities suggest that structural and institutional factors alone are insufficient to explain variation in ecological provision.

A growing body of research highlights the importance of behavioural and social factors in shaping water access and sanitation outcomes in India. Research based on large-scale household surveys (e.g., the India Human Development Survey (IHDS)) demonstrates that socio-economic determinants such as income, household size, and urban/rural residence alone do not fully account for differences in water access; even after controlling for these factors, large regional disparities persist (Gurung et al. 2023). Studies examining community participation, social norms, and collective action show that the success of water infrastructure projects depends critically on local cooperation and shared attitudes toward maintenance and use (Banerjee et al. 2017, Coffey et al. 2014). Yet, much of this literature treats culture implicitly, often reducing it to isolated social categories or behavioural outcomes rather than analysing it as a structured and measurable system.

These findings suggest that institutional and infrastructural factors are insufficient to explain the heterogeneity in ecological provision across India. Instead, they point to the need to explore deeper structural factors including cultural and normative contexts that may shape collective demand, maintenance, and effective use of water infrastructure.

Yet, despite the scale and importance of water-access disparities, few studies have adopted a comprehensive, theory-driven cultural framework to explain them (Munshi, Rosenzweig 2016). Most research remains confined to socio-economic predictors, leaving the attitudinal-cultural dimension largely unexamined. This gap calls for a theoretically informed and empirically robust exploration of how local cultural capital influences ecological provision across India's diverse regional landscape.

2.3 *Culture, caste, and broader cultural milieu in India*

Conventional analyses of Indian culture frequently emphasise caste as the main axis of social and cultural variation. Indeed, caste remains a deeply entrenched social structure influencing many aspects of Indian life (Gupta 2000, Natrajan 2011). However, focusing solely on caste or other narrow identity markers risk overlooking the broader, more nuanced cultural milieu that shapes values, preferences, and behaviour.

India's cultural landscape is complex and multifaceted: it includes linguistic diversity, religious pluralism, aesthetic traditions, patterns of cultural participation (music, literature, media), and evolving forms of living culture shaped by modernisation, migration, media exposure, and urban-rural dynamics (Jeuland et al. 2013). These layers of culture often cross-cut caste lines, creating local value systems that may not map simply onto caste divisions.

This broader cultural milieu encompassing both inherited heritage and contemporary cultural practices can influence how communities perceive environmental goods, communal responsibility, technological change, and cooperation. In other words, culture in India should be understood not just through caste or religion, but through a richer tapestry of attitudes, practices, and social habits that together shape collective ecological behaviour (Jadon 2025).

By applying the Culture Based Development paradigm to India (Tubadji et al. 2024), researchers can empirically capture this cultural complexity and move beyond reductive proxies, thereby uncovering how local cultural capital, in its full breadth, affects public-goods provision such as drinking water access. Thus, by integrating the CBD framework into the analysis of ecological provision in India, this study extends existing work on water access and regional inequality by incorporating a theoretically grounded and empirically robust measure of local cultural capital. In doing so, it offers new insights into how cultural heterogeneity shapes ecological public-goods provision across India's regions, complementing and extending the existing literature on institutions, infrastructure, and socio-economic determinants.

2.4 *Culture Based Development (CBD)*

The Culture Based Development (CBD) paradigm, developed by Tubadji, provides a comprehensive theoretical and empirical framework for analysing how culture shapes socio-economic outcomes (Tubadji 2012, 2013, 2025b). CBD departs from conventional approaches that treat culture as a residual, background characteristic or rely on narrow proxies such as religion, language, or ethnicity. Instead, CBD reconceptualises culture as a proto-institution: a locally embedded system of attitudes that governs how individuals and communities value the world and form preferences. In this view, culture operates as a cognitive and behavioural code that precedes formal institutions and materially constrains neither behaviour nor choice directly but structures the valuation processes underlying all socio-economic decisions (Tubadji 2021).

To operationalise this valuation code empirically, CBD introduces two fundamental and exhaustive components of cultural capital: *Cultural Heritage (CH)* and *Living Culture (LC)* (Tubadji 2021, 2025b). Cultural Heritage captures inherited, identity-preserving attitudes transmitted across generations, reflecting long-standing symbolic and normative structures within a locality. Living Culture, by contrast, reflects contemporaneously generated, adaptive attitudes shaped through current cultural participation, aesthetic exposure, and social interaction. Together, CH and LC capture the dual role of culture as both a mechanism of continuity and a source of adaptation. By construction, this dual framework avoids the under-specification that arises when culture is measured using isolated or arbitrarily chosen indicators.

Building on this dual structure, CBD further introduces the concept of *Cultural Entropy (CE)*, defined as the balance between Cultural Heritage and Living Culture (Tubadji 2025a,b). CE reflects whether a local cultural system is predominantly preservation-oriented, adaptation-oriented, or balanced between the two. Importantly, CE is not a measure of cultural quantity but of cultural configuration. It captures the internal coherence and openness of a cultural system and predicts the direction and magnitude of

behavioural bias at the local level. Empirical applications show that CE provides a more stable and interpretable predictor of socio-economic outcomes than CH or LC alone, particularly in contexts where cooperative behaviour, institutional uptake, or innovation adoption are required (Tubadji 2013).

A central empirical advantage of the CBD framework lies in its method of cultural measurement. Rather than relying on normative assumptions about which cultural traits matter, CBD constructs CH and LC from a broad set of cultural participation and behavioural indicators using dimensionality-reduction techniques such as principal component analysis (PCA) (Tubadji 2021). This approach ensures that culture is measured in a value-neutral and comprehensive manner, minimising both under-quantification and over-interpretation. As a result, CBD overcomes two persistent limitations in empirical cultural research: first, the tendency to reduce culture to a small number of observable proxies, and second, the risk of conflating cultural effects with socio-economic characteristics.

CBD has been successfully applied across a range of empirical domains, including regional economic performance, innovation, migration, and institutional quality (Tubadji 2013, Tubadji, Nijkamp 2015). These applications demonstrate that culture, when properly operationalised, exerts an independent and systematic influence on behavioural and spatial outcomes. This makes the CBD framework particularly well suited for analysing ecological public goods, where outcomes depend not only on infrastructure and policy but also on shared norms, cooperation, and the willingness to adopt and maintain collective solutions. In such contexts, the CH-LC-CE framework provides a theoretically grounded mechanism for linking local cultural structures to ecological behaviour.

In the context of India, where cultural heterogeneity is extensive and cannot be adequately captured by single dimensions such as caste or religion, CBD offers a uniquely comprehensive framework for quantifying cultural milieu (Tubadji et al. 2024). By capturing both inherited and adaptive cultural attitudes, and by summarising their balance through cultural entropy, CBD enables a systematic investigation of how local cultural capital shapes ecological provision across regions. This study builds on the CBD literature by extending its application to ecological public goods, thereby contributing to both the Culture Based development literature and the broader study of environmental and regional economics.

In sum, the existing literature offers strong theoretical motivation for the role of attitudes and cultural capital in ecological public good provision, and it documents significant regional disparities in water access in India. Yet empirical applications combining ecological outcomes with theoretically grounded, comprehensive measures of cultural milieu remain virtually absent. This is exactly the gap that the present study seeks to fill. By operationalising local cultural capital with CBD's CH, LC and CE framework, and linking it with household-level data on water access, this paper provides a novel, empirically robust investigation of how culture shapes ecological provision across India, thereby contributing to both the ecological public-goods literature and regional-cultural development studies.

3 Data

To operationalise the empirical model, this study compiles a large, harmonised dataset combining ecological provision indicators for 643,210 individuals in India (2019–2021) with cultural characteristics of the local context from 2014. The ecological data are drawn from the National Family Health Survey (NFHS-5), while the cultural data originate from the Survey on Literacy and Culture of India (2014). The temporal sequencing ensures that cultural variables precede the ecological outcomes, thereby reducing simultaneity concerns and enabling an assessment of whether pre-existing cultural structures help explain contemporary ecological provision.

The cultural characteristics of each region are derived from the Survey on Literacy and Culture of India (2014), which provides an extensive account of cultural participation and inherited cultural norms across Indian states and union territories. Eighteen indicators were selected to reflect the range of cultural behaviours relevant to the Culture

Based Development (CBD) theoretical framework. These indicators capture both expressive cultural practices, such as reading books, attending musical or artistic events, and participating in cultural activities and normative or inherited behaviours, including religiously motivated travel and engagement with religion-related mass-media programming. In line with CBD's emphasis on avoiding cultural under-specification, these indicators are used to construct two comprehensive dimensions of local cultural capital: Living Culture (LC), representing contemporaneously generated, adaptive cultural attitudes; and Cultural Heritage (CH), representing inherited, identity-preserving attitudes. To extract these two latent dimensions empirically, principal component analysis (PCA) is employed. PCA reduces the dimensionality of the cultural dataset while retaining its essential variation, yielding statistically robust factor scores for LC and CH (Tubadji, Pelzel 2015, Tubadji et al. 2021, Abdi, Williams 2010). These factors constitute the local cultural capital. Furthermore, their relative balance provides the basis for computing cultural entropy, which captures the CH-LC composition of local cultural structures (Tubadji 2025a). This gives the main explanatory variables in the analysis as – LC_Performance LC_Telecast CH_relig LC_shows along with the derived measure of cultural entropy (CE).

Ecological provision is measured using data from the National Family Health Survey (NFHS-5), collected between 2019 and 2021. The NFHS is a nationally representative, large-scale household survey system conducted under the aegis of the Ministry of Health and Family Welfare. Since its inception in 1992-93, the NFHS has pursued two core objectives:

1. to provide essential data on health and family welfare for national and state-level policy formulation, and

2. to generate information on emerging health and welfare concerns for programme design and academic research (Ministry of Health and Family Welfare 2025).

The principal outcome variable used in this study is the household's primary source of drinking water (*hv201*), which serves as an indicator of ecological provision. This variable distinguishes between protected and unprotected sources and is widely used in environmental and public health research to capture ecological quality at the household level. It serves as the central dependent variable in all empirical specifications.

In addition, the NFHS provides several covariates used as control variables in the empirical model. These include:

- the household wealth index (*hv270*),
- the number of household members (*hv009*), and
- the type of place of residence (*hv025*, distinguishing urban and rural households).

To account for unobserved temporal heterogeneity, year fixed effects are included in the specifications.

The final dataset is created by merging the ecological and household-level information from NFHS-5 with the region-specific cultural measures constructed from the 2014 cultural survey. This merged structure enables an empirical test of the CBD hypothesis that regional ecological provision is shaped by the pre-existing local cultural capital structure, operationalised through LC, CH, and cultural entropy. By linking earlier-period cultural indicators with subsequent ecological outcomes, the dataset provides a robust empirical foundation for analysing how cultural valuation patterns influence ecological behaviour across the regions of India.

4 Estimation Strategy

The estimation strategy has three main steps. Step 1 implements the quantification of local CH and LC through principal component factor analysis. Step 2 entails testing the different sources of drinking water for their dependence on the local CH and LC. Step 3 investigates the dependence of all the sources of drinking water on Cultural Entropy.

Step 1 uses the Cultural Literacy Survey for India and 18 cultural consumption variables and cultural behaviour (such as religious practices, time spent on reading books, attending music events etc.) related variables. These variables are used in PCA to reduce the complexity of culture, according to CBD to CH and LC. These factors sum up the local cultural capital of the context in which the individual is embedded.

Step 2 aims at analysing how regional differences in ecological provision are explained by cultural factors (model 1). In this estimation, for the outcome variable, I am using the data from NFHS on different sources of drinking water such as piped into dwelling, yard, neighbor; public tap/standpipe; tube well or borehole; protected well; unprotected well, etc. For the independent variable, the cultural variables derived in Step 1 are used where the PCA is conducted using the individual data on culture from the Cultural Literacy Survey for India.

Given the categorical nature of the dependent variable, empirical analysis employs discrete choice models. Specifically, when modelling the full range of drinking water sources (hv201), a multinomial logit model (MNL) is used to account for the unordered and multi-category structure of the outcome variable (Ben-Akiva, Lerman 1985). For robustness and ease of interpretation, selected specifications are also estimated using binary logit models, where individual water sources (e.g., piped water, public tap) are analysed as dichotomous outcomes.

The multinomial logit framework is appropriate in this context as it allows for the estimation of the probability of choosing a particular water source relative to a base category, conditional on cultural and household characteristics. Robust standard errors are used in all specifications to address potential heteroskedasticity. Compared to linear probability models, this approach provides a more theoretically consistent framework for modelling choice behaviour across multiple water-source categories.

> ***HO1:*** *The provision of ecological public goods is predicted by local cultural milieu.*

This is stated as:

$$\text{Water\_Source}_i = f(\text{CH}_j, \text{LC}_j, \text{Z}_i) \tag{1}$$

where i stand for the individual, j stands for the region and:

- Water_Source: individual source of drinking water
- CH: cultural heritage, i.e. the inherited culture from the past
- LC: living culture, i.e. the cultural preferences and participation in the present
- Z: a set of control variables

Step 3 evaluates whether the balance between CH and LC, captured by Cultural Entropy (CE), provides a more coherent explanation of ecological provision. CE is constructed using a Shannon entropy formulation based on the relative contributions of CH and LC.

To facilitate interpretation and robustness, the analysis complements the multinomial framework with binary logit models, where specific water sources (e.g., piped water, public tap) are modelled as dichotomous outcomes. This allows a clearer interpretation of how cultural balance influences the likelihood of accessing particular types of water infrastructure. The corresponding hypothesis is:

> ***HO2:*** *The provision of ecological public goods is predicted by the cultural entropy.*

Cultural entropy is substituted for CH and LC in the estimation model to assess whether the attitudinal balance of the region, rather than the separate components, explains drinking water provision. This is presented in the model 2. This is stated as:

$$\text{Water\_Source}_i = f(\text{CE}_j, \text{Z}_i) \tag{2}$$

where, again, i stand for the individual, j stands for the region and:

- Water_Source: individual source of drinking water
- CE: cultural entropy, i.e. the balance between CH and LC
- Z: a set of control variables

The use of multinomial and binary logit models is appropriate given the categorical nature of the dependent variable. These models ensure that predicted probabilities lie within the (0,1) interval and provide a theoretically consistent framework for modelling discrete choice behaviour (Ben-Akiva, Lerman 1985). Robust standard errors are used in all specifications to address potential heteroskedasticity.

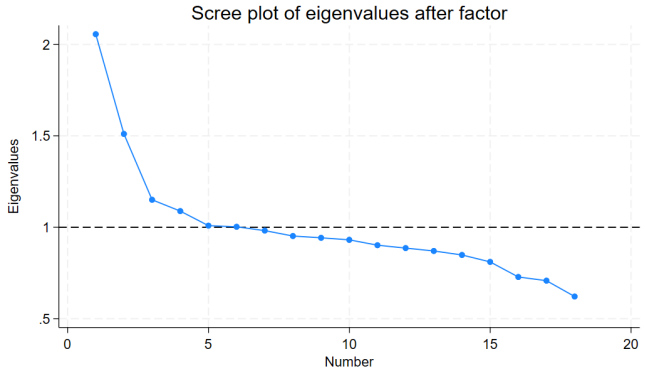
5 Result

Table 1: Principal Component Analysis – Factors of Local Cultural Capital

Variable	LC_Performance	LC_Telecast	CH	LC_shows	Uniqueness
Club	-0.014	0.064	0.689	-0.025	0.502
Cultural Group	0.033	-0.045	0.727	0.017	0.460
Reading books	-0.012	0.455	0.154	0.089	0.682
Radio/Tape	-0.008	0.716	-0.025	0.032	0.485
T.V. Programmes	-0.016	0.629	-0.073	0.010	0.496
Cinema	0.084	0.509	0.175	-0.074	0.490
Video Show	0.101	0.185	-0.035	-0.024	0.560
Drama	0.403	0.100	0.210	0.090	0.719
Dance	0.616	0.052	-0.003	0.046	0.585
Musical programmes	0.234	0.012	0.129	0.335	0.782
Religious programmes	0.001	0.014	-0.009	0.732	0.458
Sports & Games	0.017	0.067	0.057	-0.051	0.342
Circus/Magic show	0.655	-0.019	-0.094	-0.004	0.546
Puppet & other show	0.708	-0.015	0.024	-0.024	0.493
Museum/Exhibition	0.570	-0.013	0.142	-0.005	0.613
Educational	0.160	0.012	0.237	0.049	0.912
Recreational	0.061	-0.010	0.181	0.062	0.533
Religious	-0.014	0.020	-0.004	0.658	0.527

Source: Survey on Literacy and Culture of India (2014)

Using 18 cultural variables from the Literacy Culture Survey of India (2014), five-factor variables are obtained that are labelled according to the variable composition (as defined by the loadings within each factor). Table 1 presents the rotated factor loadings. The factors obtained from the above factor analysis are next aggregated on the regional level. This regional summary of the factors is used as a quantitative description of the local cultural context in which the individuals from the WVS are situated.



Source: Survey on Literacy and Culture of India (2014)

Figure 1: Scree Plot Visualisation

Figure 1 presents the scree plot of eigenvalues obtained from the factor analysis used to construct measures of local cultural capital (Tubadji 2023). The horizontal axis reports the factor number, while the vertical axis displays the corresponding eigenvalues, indicating the proportion of total variance explained by each latent factor. The dashed horizontal line at an eigenvalue of one represents the Kaiser criterion, which is commonly used to guide factor retention (Braeken, Assen 2017). The plot reveals a pronounced decline in eigenvalues across the first few factors, followed by a marked flattening of the curve. The first factor explains the largest share of variance, with the second and third factors also contributing meaningfully. Beyond approximately the fourth or fifth factor, eigenvalues approach or fall below unity, and the slope of the curve becomes relatively flat, indicating that additional factors add limited explanatory power.

This pattern suggests that the multidimensional structure of cultural participation and inherited norms can be parsimoniously represented by a small number of latent dimensions. Retaining a limited set of factors avoids overfitting while preserving the substantive cultural variation embedded in the data. Consistent with the Culture Based Development framework, these dominant factors are interpreted as capturing the core components of local cultural capital, corresponding to living culture and cultural heritage, which together summarise the cultural context in which individuals are embedded.

The retained factors explain a substantial proportion of the total variance, and factor selection is guided by both the Kaiser criterion (eigenvalues greater than one) and visual inspection of the scree plot (Figure 1).

Tables 2 and 3 report the estimated association of Cultural Heritage (CH) and Living Culture (LC) on households' choice of drinking water sources. The results are obtained from multinomial logit models, and coefficients are interpreted in terms of changes in the log-odds of selecting a given water source relative to the reference category. Overall, both CH and LC exhibit strong statistical significance across most specifications, indicating that local cultural capital is systematically associated with patterns of water-source use. However, the direction of these associations varies across water-source categories, suggesting that the relationship between culture and ecological provision is not uniform.

For LC_Performance, the estimated coefficients are positive and statistically significant across most protected water sources. This indicates that higher levels of active cultural participation are associated with a greater likelihood of households relying on improved water sources (e.g., piped water, protected wells) relative to the base category. This pattern is consistent with the idea that active engagement in cultural activities may foster social interaction, awareness, and cooperative behaviour that supports the adoption of improved ecological infrastructure. In contrast, LC_Telecast consistently exhibits negative and statistically significant coefficients across both protected and unprotected water categories. This suggests that higher levels of passive cultural consumption (e.g., media exposure) are associated with a lower likelihood of relying on these water sources relative to the reference category. One possible interpretation is that passive forms of cultural engagement may not translate into collective behavioural change or local cooperation in the same way as active participation. The coefficients on Cultural Heritage (CH) are generally positive and statistically significant across most specifications, indicating that inherited cultural structures are associated with a higher likelihood of using various water sources. However, the magnitude and consistency of these effects vary across categories, reflecting the context-specific role of inherited norms in shaping ecological behaviour. The results for LC_shows are more mixed, with positive and significant association in some specifications and weaker or insignificant effects in others. This further supports the notion that different dimensions of living culture operate through distinct behavioural channels and may influence ecological outcomes in heterogeneous ways.

Taken together, the findings from Tables 2 and 3 highlight an important limitation: while CH and LC are individually significant, their effects are difficult to interpret jointly due to their heterogeneous and sometimes contrasting directional patterns across water-source categories. This complexity is consistent with the theoretical expectations of the Culture Based Development (CBD) framework, which distinguishes between inherited, preservation-oriented attitudes captured by CH and adaptive, contemporaneously generated attitudes captured by LC. These two cultural forces need not exert effects in the

Table 2: Individual Sources of Protected Drinking Water and their Dependence on the Local CH and LC

VARIABLES	(1) piped into dwelling	(2) piped into dwelling	(3) piped into dwelling	(4) protected well	(5) protected well	(6) protected well	(7) protected spring	(8) protected spring	(9) protected spring
LC_Performance	0.512***	0.321***	0.286***	0.368***	0.199***	0.171***	0.516***	0.315***	0.280***
	(0.060)	(0.045)	(0.043)	(0.058)	(0.044)	(0.041)	(0.061)	(0.046)	(0.044)
LC_Telecast	-0.467***	-0.448***	-0.428***	-0.109***	-0.202***	-0.198***	-0.498***	-0.645***	-0.681***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.016)	(0.017)	(0.019)
CH	0.198***	0.153***	0.147***	0.233***	0.186***	0.186***	0.289***	0.238***	0.238***
	(0.011)	(0.010)	(0.010)	(0.013)	(0.012)	(0.012)	(0.015)	(0.015)	(0.015)
LC_shows	0.146***	0.107***	0.110***	0.004	-0.040***	-0.038***	0.078***	0.029***	0.031***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)	(0.008)	(0.008)	(0.008)
Wealth_Index		0.940***	0.721***		0.608***	0.558***		0.099***	0.110***
		(0.003)	(0.003)		(0.006)	(0.006)		(0.011)	(0.011)
Num_member		-0.136***	-0.095***		-0.137***	-0.128***		-0.079***	-0.081***
		(0.002)	(0.002)		(0.004)	(0.004)		(0.007)	(0.007)
2020 Year FE		-0.589***	-0.505***		-1.000***	-0.963***		-1.830***	-1.865***
		(0.010)	(0.010)		(0.017)	(0.017)		(0.042)	(0.042)
2021 Year FE		-0.751***	-0.774***		-1.871***	-1.832***		-1.986***	-1.984***
		(0.010)	(0.010)		(0.023)	(0.023)		(0.043)	(0.042)
Urban/Rural			-1.547***			-0.382***			0.360***
			(0.009)			(0.015)			(0.040)
Constant	-0.153***	-2.074***	0.913***	-2.076***	-2.421***	-1.668***	-3.390***	-2.398***	-3.066***
	(0.006)	(0.014)	(0.023)	(0.008)	(0.022)	(0.035)	(0.014)	(0.040)	(0.085)
Observations	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1;

Source: Author's calculations using Survey on Literacy and Culture of India (2014) and NFHS-5 (2019–2021).

Table 3: Individual Sources of Unprotected Drinking Water and their Dependence on the Local CH and LC

VARIABLES	(1) public tap	(2) public tap	(3) public tap	(4) unprotected well	(5) unprotected well	(6) unprotected well	(7) unprotected spring	(8) unprotected spring	(9) unprotected spring
LC_Performance	0.406***	0.276***	0.249***	-0.246	-0.033	-0.010	0.485***	0.300***	0.266***
	(0.065)	(0.041)	(0.039)	(0.341)	(0.246)	(0.228)	(0.062)	(0.046)	(0.044)
LC_Telecast	-0.428***	-0.424***	-0.427***	-0.204***	-0.251***	-0.263***	-0.529***	-0.673***	-0.719***
	(0.006)	(0.006)	(0.006)	(0.011)	(0.009)	(0.008)	(0.019)	(0.019)	(0.021)
CH	0.120***	0.096***	0.095***	0.163***	0.144***	0.146***	0.308***	0.253***	0.253***
	(0.012)	(0.011)	(0.011)	(0.028)	(0.021)	(0.020)	(0.016)	(0.016)	(0.017)
LC_shows	0.085***	0.078***	0.080***	0.012	0.019**	0.018**	0.051***	0.013	0.013
	(0.003)	(0.003)	(0.003)	(0.010)	(0.008)	(0.008)	(0.011)	(0.011)	(0.011)
Wealth_Index		0.072***	0.025***		-0.404***	-0.362***		-0.442***	-0.388***
		(0.003)	(0.004)		(0.008)	(0.008)		(0.015)	(0.015)
Num_member		-0.105***	-0.098***		-0.026***	-0.030***		-0.052***	-0.058***
		(0.002)	(0.002)		(0.003)	(0.003)		(0.007)	(0.007)
2020Year FE		-0.008	0.011		-0.352***	-0.391***		-1.830***	-1.902***
		(0.011)	(0.011)		(0.018)	(0.018)		(0.048)	(0.048)
2021 Year FE		-0.177***	-0.165***		-0.205***	-0.241***		-1.346***	-1.410***
		(0.011)	(0.011)		(0.018)	(0.018)		(0.038)	(0.039)
Urban_Rural			-0.410***			0.635***			0.876***
			(0.012)			(0.030)			(0.062)
Constant	-0.857***	-0.511***	0.304***	-2.159***	-1.012***	-2.259***	-3.527***	-1.652***	-3.365***
	(0.006)	(0.013)	(0.026)	(0.029)	(0.030)	(0.063)	(0.015)	(0.042)	(0.126)
Observations	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1;

Source: Author's calculations using Survey on Literacy and Culture of India (2014) and NFHS-5 (2019–2021).

same direction for every form of ecological provision (Tubadji et al. 2024). In certain contexts, inherited norms may provide social cohesion that facilitates community reliance on specific water sources, while in others, adaptive cultural behaviours may better support the acceptance of new technologies or infrastructure. The sign variation observed in the regressions therefore, reflects a genuine behavioural heterogeneity rooted in the dual nature of cultural capital (Tubadji 2025a,b). From an empirical perspective, however, such complexity renders it difficult to obtain a coherent interpretation of how cultural structure, in its entirety, shapes sources of water provision when CH and LC are entered separately.

To address this limitation, the analysis turns to Cultural Entropy (CE) (Tubadji 2025a,b), which synthesises the relationship between CH and LC into a single indicator. CE captures the balance between inherited and adaptive cultural attitudes in each region, thereby reflecting the broader cultural configuration rather than its individual components. I have summed the three LC (LC_Performance, LC_Telecast, LC_shows) factors together into one aggregate LC value and CH-relig as the CH value. Then, I used the CE measure to quantify the balance between this aggregate LC and CH as a total of local cultural capital.

Tables 4 and 5 present the results when Cultural Entropy (CE) is used as the key explanatory variable. These estimates are derived from both multinomial and binary logit models, allowing for a clearer interpretation of the relationship between cultural structure and ecological provision. In contrast to the previous results, CE exhibits a consistently positive and statistically significant association with the likelihood of using protected drinking water sources. This indicates that regions characterised by a more balanced relationship between Cultural Heritage and Living Culture are more likely to adopt improved water sources such as piped water, protected wells, and protected springs.

The positive coefficients on CE imply that greater cultural balance increases the log-odds of relying on improved water infrastructure. Substantively, this suggests that neither purely preservation-oriented nor purely adaptation-oriented cultural systems are optimal; rather, it is the equilibrium between the two that supports effective ecological provision. The binary logit specifications reinforce this interpretation. When specific water sources are modelled as dichotomous outcomes, CE remains a strong and statistically significant predictor, confirming that cultural balance increases the probability of accessing improved water sources.

The cultural entropy results provide a coherent behavioural interpretation that is missing when CH and LC are analysed separately. Rather than attributing ecological behaviours to one cultural component in isolation, CE demonstrates that it is the attitudinal equilibrium between tradition and adaptability that best predicts the availability and use of protected drinking-water sources. This finding aligns closely with CBD's conceptualisation of culture as a proto-institution whose influence arises not from individual traits but from the underlying attitudinal system through which communities interpret and respond to ecological solutions. By showing that the balance of cultural attitudes, rather than their isolated elements, is associated with improved water-source use, the results highlight the critical role of local cultural structures in shaping ecological provision across the regions of India.

6 Conclusion

This paper has examined regional disparities in ecological public goods provision in India through a Culture Based Development (CBD) perspective, focusing on access to drinking water as a critical ecological outcome. Responding to long-standing Neo-Weberian concerns with how culturally embedded values shape collective economic behaviour (Weber 1916), the study moves beyond purely material or institutional explanations and demonstrates that ecological outcomes are systematically related to the local cultural context. By operationalising culture as local cultural capital, captured through living culture and cultural heritage, and their balance through cultural entropy, the analysis provides a theoretically grounded and empirically robust framework for understanding regional ecological inequalities.

Table 4: Individual Sources of Protected Drinking Water and their Dependence on the Cultural Entropy (CE)

VARIABLES	(1) piped into dwelling	(2) piped into dwelling	(3) piped into dwelling	(4) protected well	(5) protected well	(6) protected well	(7) protected spring	(8) protected spring	(9) protected spring
CE_abs_India_New	0.717***	0.804***	0.845***	1.238***	1.489***	1.472***	1.031***	1.557***	1.541***
	(0.014)	(0.016)	(0.017)	(0.036)	(0.031)	(0.031)	(0.068)	(0.055)	(0.054)
Wealth_Index		0.957***	0.735***		0.610***	0.557***		0.093***	0.098***
		(0.003)	(0.003)		(0.006)	(0.006)		(0.011)	(0.011)
Num_member		-0.148***	-0.105***		-0.146***	-0.135***		-0.097***	-0.097***
		(0.002)	(0.002)		(0.004)	(0.004)		(0.007)	(0.007)
2020.Year		-0.527***	-0.461***		-0.998***	-0.959***		-1.705***	-1.709***
		(0.010)	(0.010)		(0.017)	(0.017)		(0.041)	(0.041)
2021.Year		-0.688***	-0.734***		-1.862***	-1.826***		-1.855***	-1.841***
		(0.009)	(0.010)		(0.023)	(0.023)		(0.042)	(0.041)
Urban_Rural			-1.568***			-0.410***			0.260***
Constant	-0.872***	-2.873***	0.137***	-3.115***	-3.638***	-2.818***	-4.375***	-3.770***	-4.256***
	(0.011)	(0.017)	(0.025)	(0.029)	(0.033)	(0.042)	(0.054)	(0.055)	(0.094)
Observations	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Source: Author's calculations using Survey on Literacy and Culture of India (2014) and NFHS-5 (2019–2021).

Table 5: Individual Sources of Unprotected Drinking Water and their Dependence on the Cultural Entropy (CE)

VARIABLES	(1) public tap	(2) public tap	(3) public tap	(4) unprotected well	(5) unprotected well	(6) unprotected well	(7) unprotected spring	(8) unprotected spring	(9) unprotected spring
CE_abs_India_New	0.687***	0.745***	0.737***	0.485***	0.724***	0.739***	1.195***	1.821***	1.820***
	(0.017)	(0.019)	(0.019)	(0.033)	(0.035)	(0.035)	(0.077)	(0.066)	(0.064)
Wealth_Index		0.092***	0.042***		-0.396***	-0.353***		-0.440***	-0.399***
		(0.003)	(0.004)		(0.007)	(0.007)		(0.015)	(0.015)
Num_member		-0.117***	-0.109***		-0.033***	-0.037***		-0.071***	-0.074***
		(0.002)	(0.002)		(0.003)	(0.003)		(0.007)	(0.007)
2020.Year		0.058***	0.083***		-0.340***	-0.371***		-1.750***	-1.785***
		(0.011)	(0.011)		(0.018)	(0.018)		(0.046)	(0.046)
2021.Year		-0.111***	-0.098***		-0.180***	-0.212***		-1.269***	-1.305***
		(0.011)	(0.011)		(0.017)	(0.017)		(0.037)	(0.037)
Urban_Rural			-0.436***			0.627***			0.752***
Constant	-1.557***	-1.278***	-0.409***	-2.607***	-1.676***	-2.930***	-4.642***	-3.234***	-4.718***
	(0.013)	(0.018)	(0.029)	(0.026)	(0.032)	(0.068)	(0.062)	(0.062)	(0.135)
Observations	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197	643,197

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Source: Author's calculations using Survey on Literacy and Culture of India (2014) and NFHS-5 (2019–2021).

The results show that both living culture and cultural heritage are significantly associated with drinking-water sources across Indian regions, but the direction of these associations is not uniform. This finding highlights an important insight: cultural influences on public-goods provision cannot be interpreted through isolated cultural dimensions alone. When analysed through the lens of cultural entropy: the balance between inherited and adaptive cultural orientations, the relationship between culture and ecological provision becomes more coherent and interpretable. Regions characterised by lower cultural entropy, reflecting a more adaptive and balanced cultural structure, tend to exhibit more favourable access to protected drinking-water sources. This supports the CBD proposition that collective outcomes depend not only on the presence of cultural capital but on its internal configuration (Tubadji 2012, 2021).

These findings contribute directly to the Neo-Weberian agenda of the Special Issue by empirically demonstrating how culturally embedded attitudes toward responsibility, cooperation, and collective welfare translate into measurable regional differences in public-goods provision. In the spirit of Weber's Religion of India (1916), the study shows that ecological outcomes are shaped by culturally conditioned preferences and behavioural codes rather than by economic capacity alone. At the same time, by applying CBD as a modern empirical extension of Weber's legacy, the paper bridges cultural economics and regional science, offering a quantitative methodology capable of capturing culture as a spatially embedded, multidimensional phenomenon.

From a methodological standpoint, this study underscores the importance of comprehensive cultural measurement. Unlike approaches that rely on single proxies such as caste, religion, or language, the CBD framework avoids both under-quantification and under-specification of culture by jointly modelling cultural heritage and living culture and by explicitly accounting for their interaction through cultural entropy (Tubadji 2025a,b, Tubadji, Nijkamp 2015). The use of factor analysis to construct theoretically meaningful cultural dimensions further demonstrates how complex cultural data can be reduced parsimoniously without sacrificing interpretability.

From a policy perspective, the findings suggest that ecological public goods provision can be enhanced by fostering a balanced cultural environment that integrates both cultural heritage and living culture. Policymakers could incorporate culturally sensitive approaches in the design and implementation of water infrastructure projects, for instance, by promoting community participation initiatives that build on local traditions while encouraging adaptive practices. Public awareness campaigns, cultural programs, and local governance mechanisms can be aligned to strengthen this balance, thereby improving both the adoption and sustainability of ecological infrastructure.

6.1 Limitations and Directions for Future Research

Several limitations point to promising avenues for future research. First, while this study exploits rich individual-level and regional data, the cultural measures are derived from cross-sectional cultural surveys. Future work could benefit from panel cultural data to analyse the dynamic evolution of cultural entropy and its long-term effects on ecological outcomes. Second, the analysis focuses on drinking-water provision as a key ecological public good; extending the framework to other ecological domains, such as sanitation, waste management, or air quality, would allow for a more comprehensive assessment of culture–ecology linkages.

Methodologically, future studies could integrate spatial econometric techniques to explicitly model cultural spillovers across regions, in line with CBD's emphasis on spatial clustering and cultural diffusion (Tubadji, Angelis 2023). In addition, combining CBD based cultural measures with institutional quality indicators could further disentangle the interaction between cultural and formal governance mechanisms in shaping public goods provision. Finally, comparative applications across countries or regions, particularly between India and other culturally diverse economies, would deepen the Neo-Weberian comparative perspective promoted by this Special Issue.

Overall, this paper demonstrates that ecological public goods provision is not merely a technical or administrative challenge but a culturally embedded process. By operationalising Weberian insights through the Culture Based Development paradigm, the

study offers a novel empirical contribution to understanding how cultural structures shape regional development outcomes in India and beyond.

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