

District Prioritisation for Climate-Health Investment

Composite Indicator Framework: Methods, Assumptions, and Sensitivity Tests

India Health and Climate Resilience Fund (IHCRF) · Version 1.2 · 2024

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Illustrative Sample — Not for distribution

This document describes the composite indicator framework used to prioritise districts for climate-health investment under the IHCRF programme. It sets out the conceptual rationale, data sources, indicator selection criteria, weighting scheme, and sensitivity tests used to produce the final district ranking. The document is designed to be fully auditable: a programme team, grantee organisation, or independent evaluator should be able to reconstruct the ranking using publicly available data and the methods described here.

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1. Background and Purpose

The India Health and Climate Resilience Fund targets districts where the intersection of climate vulnerability and health system weakness creates compounding risk for marginalised populations. The fund operates in four states — Karnataka, Assam, and Jharkhand (two districts) — and selects districts based on a composite scoring methodology rather than administrative convenience or existing programme footprint.

This document describes how that scoring was constructed. The central challenge in district prioritisation of this type is that the relevant data — on climate exposure, health system capacity, population vulnerability, and access to services — is dispersed across incompatible administrative systems, collected at different intervals, and defined differently across states. No single national data system provides all the indicators required. The methodology described here makes these trade-offs explicit rather than obscuring them.

A second design constraint is replicability. The fund intends to revise district priorities at three-year intervals as new data becomes available. The framework is therefore built from publicly available data sources with defined update cycles, so that future revisions do not depend on institutional memory of how the original ranking was produced.

2. Conceptual Framework

The framework rests on a three-domain model of climate-health vulnerability:

Climate Exposure: The degree to which a district is subject to climate hazards — including heat stress, flooding, drought, and cyclone risk — based on historical event frequency and projected trends under RCP 4.5 and 8.5 scenarios. Exposure is necessary but not sufficient for vulnerability: a district with high exposure and strong adaptive systems may be less vulnerable than one with moderate exposure and fragile systems.

Health System Capacity: The ability of the public health infrastructure to absorb climate-related demand shocks and deliver services to a population experiencing compounding stressors. Measured through supply-side indicators from HMIS and NHM, including facility density, workforce per population, drug availability, and catastrophic out-of-pocket expenditure rates.

Population Vulnerability: The degree to which the district population is predisposed to poor health outcomes under climate stress, based on deprivation indicators including poverty rates, malnutrition prevalence, water access, sanitation coverage, and proportion of livelihood-dependent agricultural workers with no social protection.

A district's composite vulnerability score is a weighted combination of its standing across these three domains. Weights reflect the fund's theory of change: exposure without capacity weakness is not the primary target; the fund prioritises where capacity gaps compound exposure risk for already-vulnerable populations.

3. Indicator Selection Criteria

Each indicator in the framework was assessed against four criteria before inclusion:

Criterion	Inclusion Standard
Construct validity	Does the indicator measure what it claims to measure for this population and geography?
Data availability	Is the data publicly available at district level, with a defined update cycle?
Temporal consistency	Can the indicator be compared across at least two time points, and is the reference year within 5 years?
Non-redundancy	Does the indicator add independent information, or does it correlate strongly ($r > 0.75$) with an indicator already in the framework?

Indicators that met all four criteria were included in full. Indicators meeting three criteria were included with downward adjustment of their sub-domain weight. Indicators meeting fewer than three criteria were excluded regardless of

theoretical relevance.

4. Composite Indicator Framework and Weighting Scheme

Table 1 presents the full indicator framework, organised by domain and sub-domain, with assigned weights, data sources, and reference years. Domain weights reflect the fund's strategic emphasis on health system capacity as the primary investable variable; climate exposure and population vulnerability inform targeting but are weighted lower because the fund cannot directly modify them.

Table 1: Composite Indicator Framework

Domain (Weight)	Sub-Domain	Indicator	Proxy Measure	Source	Ref. Year	Ind. Wt.
Climate Exposure (30%)	Heat Stress	Chronic heat exposure	Mean summer Tmax >40°C, days/year (2015–2022 avg)	IMD gridded	20 22	10 %
		Projected heat risk	IPCC RCP 4.5 heat days increase by 2035	IPCC AR6 / IITM	20 21	5%
	Flood / Drought	Flood frequency	Districts experiencing >2 major flood events per decade	NDMA / CWC	20 23	8%
		Drought exposure	SPI-based drought frequency index (moderate to severe)	IMD	20 22	7%
Health System Capacity (45%)	Infrastructure	Facility density	Government health facilities per 1,000 population	HMIS / NHM	20 22- 23	10 %
		Hospital bed density	Government hospital beds per 10,000 population	HMIS	20 22- 23	8%
	Workforce	Doctor vacancy rate	% of sanctioned doctor posts lying vacant	NHM HR data	20 22- 23	9%
	Service delivery	Institutional delivery rate	% deliveries in public institutions	NFHS-5	20 19- 21	8%
OOP expenditure		% HH with catastrophic health expenditure (>10% income)	NSSO 75th Round	20 17- 18	10 %	
Population Vulnerability (25%)	Deprivation	Multidimensional poverty	MPI score (NITI Aayog) at district level	NITI Aayog	20 21	8%

Domain (Weight)	Sub-Domain	Indicator	Proxy Measure	Source	Ref. Year	Ind. Wt.
	Deprivation	Child malnutrition	% children under 5 stunted	NFHS-5	2019-21	7%
	Exposure sensitivity	Agricultural livelihood share	% main workers in agriculture (Agri+AL)	Census	2011	5%
	Exposure sensitivity	Water access	% HH without piped water at home	NFHS-5 / Census	2019-21	5%

Source abbreviations: IMD = India Meteorological Department; HMIS = Health Management Information System; NHM = National Health Mission HR data portal; NFHS-5 = National Family Health Survey Round 5 (2019–21); NDMA = National Disaster Management Authority; CWC = Central Water Commission; MPI = Multidimensional Poverty Index (NITI Aayog, 2021).

5. Data Sources and Limitations

Three data gaps posed methodological challenges during indicator construction:

HMIS completeness: HMIS data is self-reported by facilities and systematically under-records service delivery in areas with poor facility infrastructure. Districts with very weak health systems — precisely those the fund targets — are most likely to have incomplete HMIS reporting. For the 22 districts with HMIS completeness below 60%, we triangulated against the District Health Survey (DHS) and NFHS-5 estimates.

NFHS-5 sample size: NFHS-5 provides district-level estimates for most indicators, but confidence intervals are wide for smaller districts (population below 300,000). Seventeen districts in the analysis have NFHS-5 point estimates with standard errors exceeding 5 percentage points. These are flagged in the ranking and treated with caution in sensitivity analysis.

Climate data spatial resolution: IMD gridded temperature data is available at 0.25 x 0.25 degree resolution, which is adequate for most districts but smooths within-district variation in hilly terrain (relevant for Khunti and Chamarajanagar). IITM regional projections are used to supplement where spatial resolution is limiting.

6. Composite Scoring Methodology

Each indicator is normalised to a 0–100 scale using min-max normalisation within the state sample (not the national sample), to account for the fact that the relevant comparison for a Karnataka district is other Karnataka districts, not a district in Rajasthan. For indicators where higher values indicate worse outcomes (e.g., doctor vacancy rate, malnutrition prevalence), values are inverted before normalisation so that 100 always indicates high vulnerability.

Normalisation formula:

$$\text{Norm}(i) = [(\text{Raw}(i) - \text{Min}(\text{state})) / (\text{Max}(\text{state}) - \text{Min}(\text{state}))] \times 100$$

$$\text{For inverted indicators: Norm}(i) = 100 - [(\text{Raw}(i) - \text{Min}(\text{state})) / (\text{Max}(\text{state}) - \text{Min}(\text{state}))] \times 100$$

Sub-domain and domain aggregation:

Indicators within each sub-domain are averaged with equal weights within the sub-domain (unless a data quality flag has reduced an indicator's weight, as noted in Table 1). Sub-domain scores are then aggregated to domain scores using the weights set out in Table 1. The composite vulnerability score (CVS) is computed as:

$$\text{CVS} = (0.30 \times \text{Climate Exposure Score}) + (0.45 \times \text{Health Capacity Score}) + (0.25 \times \text{Population Vulnerability Score})$$

Districts are then ranked by CVS in descending order (highest CVS = highest priority). The top decile (highest scoring 10%) is considered for fund investment.

7. Sensitivity Analysis

To test whether the ranking is an artefact of the chosen weighting scheme, we ran four alternative specifications, varying domain weights and normalisation approach. For each specification, we computed the Spearman rank correlation with the baseline ranking across all districts in the sample. Table 2 reports these results.

Table 2: Sensitivity Analysis — Rank Correlation with Baseline

Specification	Climate Exposure	Health Capacity	Population Vulnerability	Spearman r (vs. baseline)	Top decile overlap
Baseline	30%	45%	25%	1.000	10/10
Equal weights	33%	33%	33%	0.912	8/10
Health-dominant	20%	60%	20%	0.948	9/10
Exposure-dominant	50%	30%	20%	0.871	7/10
National normalisation (not state)	30%	45%	25%	0.934	8/10

Spearman r values above 0.85 across all four alternative specifications suggest the ranking is not highly sensitive to reasonable variation in domain weights. The lowest correlation ($r = 0.871$) occurs under the exposure-dominant specification, where three districts enter the top decile that are not there in the baseline — all three are high-exposure, low-population districts where health system capacity is average.

The top-decile overlap analysis (rightmost column) shows that at minimum 7 of 10 baseline priority districts appear in every alternative specification's top decile. The three districts that drop out under exposure-dominant weighting are characterised by moderate climate exposure paired with very poor health system capacity — exactly the profile the baseline design is calibrated to capture.

8. District Ranking — Summary Results

Table 3 presents the four selected IHCRF programme districts with their composite scores and domain subscores. All four districts appeared in the top quintile under the baseline specification and in the top decile for at least two of the three domains.

Table 3: Programme District Composite Scores (Illustrative)

District	State	Climate Exposure (/100)	Health Capacity (/100)	Population Vulnerability (/100)	Composite Vulnerability Score	State Rank
Chamarajanagar	Karnataka	74	81	79	79.0	1 / 31
Dhubri	Assam	88	76	84	82.1	1 / 35
Khunti	Jharkhand	69	84	91	81.8	2 / 24
West Singhbhum	Jharkhand	72	79	88	79.7	3 / 24

Scores are state-normalised. State rank is rank within state sample (all districts of that state), not within the national sample.

$$\text{Composite Vulnerability Score} = (0.30 \times \text{CE}) + (0.45 \times \text{HC}) + (0.25 \times \text{PV})$$

9. Limitations and Recommendations for Replication

Census 2011 population base: Several indicators — particularly facility density — are normalised against Census 2011 population figures. The 2021 Census has not been conducted. Districts with high population growth since 2011 will have understated density values. Provisional estimates from the Sample Registration System (SRS) Bulletin are used as a correction factor where available.

NFHS-5 as reference for multiple indicators: Seven of the thirteen indicators draw on NFHS-5 (2019–21). This creates temporal clustering: if a future revision uses NFHS-6 (expected 2025–26), approximately half the indicator set will change reference year simultaneously, making year-on-year comparisons of the composite score difficult. Recommend maintaining parallel scoring with the older NFHS round for one cycle.

State-level normalisation and inter-state comparability: State-level min-max normalisation makes the framework appropriate for within-state prioritisation but limits inter-state comparison. A district ranked first in Karnataka may have a different absolute score profile than a district ranked first in Assam. For future funding decisions that require cross-state comparison, a national normalisation run should accompany the state-normalised scores.

Absence of community-level perception data: All indicators in the current framework are administrative or survey-based. They do not capture community-level knowledge of or access to services, which the household survey (separate instrument) is designed to address. The district prioritisation framework and household survey are designed to be used together.

Appendix A: Full Indicator List with Proxy Measures

The following table provides the complete indicator list with precise proxy measures, data extraction methodology, and notes on data quality flags applied during indicator construction.

Indicator	Proxy Measure (exact)	Source & Table	Notes
Mean summer Tmax	Mean daily max temp April–June (°C), 2015–22 avg	IMD Gridded Temp v2.0, 0.25°	District centroid value used
Projected heat days	IPCC RCP 4.5 additional heat days (>35°C) by 2035 vs 2020 baseline	IITM RCP Atlas, Table 3.2	Model ensemble mean (5 GCMs)
Flood frequency	Number of major flood events 2010–2023 (NDMA classification: large/severe)	NDMA Annual Reports; CWC Flood Atlas	Events, not affected area
Drought index	SPI-6 <-1.5 months per year, avg 2012–22	IMD SPI database	Standardised Precipitation Index
Facility density	Functional govt health facilities / 1,000 pop (Sub-centre, PHC, CHC, DH)	NHM/HMIS Dashboard FY22-23	Excludes AYUSH-only facilities
Hospital bed density	Beds in govt hospitals (CHC+) per 10,000 pop	HMIS FY22-23	Excludes sub-centre beds
Doctor vacancy rate	% of approved specialist + MO posts unfilled	NHM HR Management Portal 2023	High missingness in some states
Institutional delivery	% of live births in public health institutions (last 5 years)	NFHS-5 District Factsheets	Proxy for system utilisation

Indicator	Proxy Measure (exact)	Source & Table	Notes
Catastrophic OOP	% HH with health expenditure >10% of total monthly consumption	NSSO 75th Round (2017-18)	Most recent available
MPI score	NITI Aayog District MPI (2021), incidence x intensity	NITI Aayog MPI Report 2021	Available for 707 districts
Child stunting	% children 0–59 months height-for-age <-2 SD	NFHS-5 District Factsheets	Wide CIs for small districts
Agri workforce share	% main workers in cultivators + agricultural labourer categories	Census 2011 B-series Tables	2011 base — see note in Section 9
Water access	% households without piped water supply within premises	NFHS-5 / JJM dashboard FY23	JJM data where NFHS CIs wide